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**FIRM PERFORMANCE AND REGIONAL  
INNOVATION MECHANISMS: THE MODERATING  
ROLE OF ABSORPTIVE CAPACITIES**



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**ABSTRACT**

Universities are associated with knowledge spillovers, which are assumed to enhance the exploitation of entrepreneurial opportunities and the transformation of new knowledge into economic knowledge. These positive externalities have a basic assumption in common: sufficient absorptive capacities of regional innovation system actors. Taking a firm perspective, this study investigates the impact of both university spillovers and firms' absorptive capacities on firms' financial performance, using a multilevel approach. Our results clearly show that knowledge spillovers do not have a per se stimulating effect. It is the interaction between firms' absorptive capacities and local knowledge spillovers, which proves to have a positive and significant effect. Our findings give thus impetus to a call for more comprehensive public policy strategies.

**INTRODUCTION**

As knowledge and the exploitation thereof have become driving forces underlying economic growth and prosperity, especially universities and research institutions are increasingly perceived as key actors within regional innovation systems as they produce and disseminate new knowledge for firms and markets and engage in collaborative networks with industry. It is the spillover of knowledge from research intensive universities and departments which influences a firm's location decision and fosters regional agglomeration economies (Audretsch, Lehmann, & Warning, 2005). The existence of spillover effects is a necessary yet not sufficient regional prerequisite to foster firm performance. Firms need to possess entrepreneurial absorptive capacities to understand new knowledge as well as recognize its value to ultimately engage in entrepreneurial technology transfer activities and transform new knowledge into economic knowledge, i.e. innovative products, services, and technologies. In this context, Qian and Acs (2013) introduced the absorptive capacity theory of knowledge spillover entrepreneurship, which describes the necessity of both new knowledge and ideas as well as respective absorptive capacities to achieve, defend, and extend firms' competitive advantages. Whereas previous studies have investigated the importance of knowledge flows and firms' absorptive capacities either on a regional level (Fritsch & Medrano Echalar, 2015; Lau & Lo, 2015; Miguélez & Moreno, 2015; Mukherji & Silberman, 2013) or on a firm level (Kostopoulos, Papalexandris, Papachroni, & Ioannou, 2011; Moilanen, Østbye, & Woll, 2014; Wales, Parida, & Patel, 2013; Zahra & Hayton, 2008), this study tries to provide a more holistic approach as it explicitly focuses on firm level performance while considering the regional context, using a multilevel approach.

Taking firm data from the Thomson Datastream, the German Patent and Trademark Office as well as regional data from the German Federal Statistical Office, we apply a 2-level approach on a sample of 450 knowledge-intensive publicly listed and traded firms which have their core business activities in Germany, encompassing a timeframe ranging from 1998 to 2012. Our results suggest that firm performance is positively shaped by the firm's R&D intensity, whereas knowledge spillovers do not have a per se stimulating effect. It is the interaction between firms' absorptive capacities and regional knowledge spillovers which proves to have a positive and significant effect on firms' economic performance. We can further show that high competition within regional innovation systems translates into lower firm performance while a solid economic environment stimulates firms' vitality. Thus, our results reinforce the absorptive capacity theory of knowledge spillover entrepreneurship in that only the co-existence of new knowledge and adequate knowledge capacities facilitate knowledge-based entrepreneurial technology transfer activities and the transformation of knowledge spillovers into economic knowledge, ultimately resulting in higher levels of firm performance.

The study further adds to the literature by providing insights into the effects of regional innovation mechanisms on firm performance. The public sector, i.e. research-intensive universities and associated knowledge spillovers, possesses the potential to boost the private sector, i.e. firms and associated performance, given sufficient levels of absorptive capacities (see Bishop, D'Este, & Neely, 2011). Mechanisms within regional innovation systems thereby shape entrepreneurial activities of firms and potentially foster (through economic prosperity) or hinder (through increased competition) firms' exploitation of entrepreneurial opportunities provided by a region's inherent knowledge flows. Thus, our research fits into a growing literature examining the economic impact of distinct regional innovation mechanisms on firm level performance and associated entrepreneurial technology transfer activities of prevalent market participants (Audretsch, Hülsbeck, & Lehmann, 2012; Guerrero et al., 2015; Hayter & Link, 2015).

### HYPOTHESES DEVELOPMENT

A growing body of literature focuses on the influence of a conducive environment and flourishing regional development on firm performance. We assume that the co-existence of knowledge spillovers from universities and absorptive capacities within firms as well as a stimulating economic surrounding lead to a higher economic performance and therefore sustained regional development and growth. Lau and Lo (2014) confirm that a better utilization of regional innovation systems enhances the absorptive capacities of firms and consequently their innovation performance. Hence, prior research approves the importance of absorptive capacities for a successful dealing with external knowledge.

The theoretical concept of entrepreneurial ecosystems (see Stam, 2015) and the knowledge spillover theory of entrepreneurship follow the assumption that entrepreneurial activities are not only a consequence or output based on a given opportunity, but also a critical prerequisite and source of technical progress and economic growth. Thus, the level of knowledge that leads to spillovers and entrepreneurship is endogenous, influenced by knowledge, human capital, and R&D. Reversely, knowledge spillovers enhance the level of local knowledge, human capital, and R&D outcomes, indicating the self-reinforcing nature of spillovers. A fruitful regional innovation system generates higher levels of knowledge spillovers that result in higher levels of innovation and economic performance. These insights lead to our first hypothesis.

*Hypothesis 1: High levels of local knowledge spillovers lead to a higher level of economic performance of firms.*

The concept of absorptive capacities describes the ability to “recognize the value of new, external information, assimilate it, and apply it to commercial ends” (Cohen & Levinthal, 1990, p. 128). Following this definition, the ability to evaluate and utilize external knowledge depends on prior knowledge, especially in the same field, technical context, or product market. It is obvious that especially in high technology and knowledge-intensive industries the in-depth understanding of state-of-the-art techniques and updated knowledge is central to value external developments and innovations. Focusing on individuals, learning is cumulative and results are the best if there is a relation between new and consisting knowledge (Cohen & Levinthal, 1990). Prior research investigating how and under what circumstances firms’ absorptive capacities positively influence their performance attest an overall positive relation (Chen, Lin, & Chang, 2009; Cohen & Levinthal, 1990; Lane, Salk & Lyles, 2001; Tsai, 2001; Zahra & George, 2002). Based on these results, we assume that a higher level of absorptive capacities within a firm results in a better economic performance, i.e. our second hypothesis.

*Hypothesis 2: The existence of absorptive capacities within firms leads to a higher level of economic performance of firms.*

Qian and Acs (2013) subsume the related topics of knowledge spillover entrepreneurship and absorptive capacities and establish a more holistic framework by developing the absorptive capacity theory of knowledge spillover entrepreneurship. A central finding is that entrepreneurship is a transmitter of knowledge spillovers and thus is central for regions to foster human capital as the basis of all entrepreneurial activities. The quality and intensity of knowledge spillovers, for example from universities, on the one hand, and the specification of absorptive capacities of firms on the other hand, as well as the interaction of both explains differences in the economic performance of firms in the same region. We consequently hypothesize that absorptive capacities and knowledge spillovers are complementary and result in a higher level of economic performance of firms.

*Hypothesis 3: A complementary effect between local knowledge spillovers and absorptive capacities of firms leads to a higher level of economic performance of firms.*

## METHOD

Our primary goal is to analyze the dependency of firm performance on internal firm characteristics as well as on external regional characteristics. As we specifically want to investigate the interdependency of firms’ absorptive capacities and local knowledge spillovers, our dataset consists of 450 knowledge-intensive publicly listed and traded firms, which have their core business activities in Germany. We deliberately focus on knowledge-based firms as only high technology industries are influenced by potential spillovers (Audretsch & Keilbach, 2007). We capture firm performance by firms’ operating income, firms’ absorptive capacities by firms’ R&D spendings, and the existence of local knowledge spillovers by universities’ level of income resulting from third-party funding activities.

Based on our panel data, the most straightforward method to investigate the impact of internal and external characteristics on firm performance is to employ a multilevel approach. Whereas internal characteristics, i.e. firm data, can be assigned to the micro level of our dataset, external characteristics, i.e. regional data, can be assigned to the macro level of our dataset. Thus, we apply a 2-level hierarchical model which takes both the micro as well as the macro level into account. We employ a random intercept model in order to assess to impact of internal and external characteristics on firm performance:

$$Y_{ijt} = \gamma_0 + \gamma_1 X_{ijt} + \gamma_2 V_{jt} + \gamma_3 Z_{ijt} + U_{0j} + R_{ij}$$

where  $Y_{ijt}$  is firm performance, measured by the operating income, of firm  $i$ , nested within region  $j$  at time  $t$ . Vector  $X_{ijt}$  represents explanatory variables at level one, i.e. internal (firm) characteristics of

firm  $i$ , nested within region  $j$  at time  $t$ , whereas vector  $V_{jt}$  represents explanatory variables at level two, i.e. external (regional) characteristics of region  $j$  at time  $t$ . Thus, vector  $X_{ijt}$  includes firms' absorptive capacities, firm size as well as firms' asset utilization and captures 'direct effects' within our model. Vector  $V_{jt}$  includes the level of local knowledge spillovers, the regional economic and innovative performance, regional density as well as university characteristics, i.e. university size and focus, and captures 'contextual effects' within our model. Vector  $Z_{ijt}$  captures the interaction of level-one units  $i$ , i.e. firms, and level-two units  $j$ , i.e. regions, at time  $t$ . By incorporating an interaction term within our random intercept model, we are able to investigate the 'combined effect' of absorptive capacities and knowledge spillovers, i.e. the impact of both internal and external characteristics on firm performance. Random effects are captured by  $U_{oj}$  which are assumed to be independent and normally distributed with expected value 0.  $R_{ij}$  represents the error term. We lag all dependent variables by one year to control for reverse causality.

## RESULTS

The results of our random intercept model are depicted in table 1. Model I investigates the isolated influence of conducive regional endowments that allow knowledge spillovers on firms' economic performance and reveals a negative, yet insignificant effect of local knowledge spillovers on firm performance. All further model specification except Model II reinforce the insignificant effect of the existence of knowledge spillovers on firm performance, resulting in a rejection of hypothesis 1. We consequently cannot confirm previous findings in that firms which engage in R&D outsourcing activities by relying on knowledge spillovers per se benefit from being located in dynamic environments (see Gilley & Rasheed, 2000). However, sufficient regional factors and resources, i.e. adequate levels of human capital, suppliers, and customers, may enhance firm performance as indicated by the positive and significant variable regional vitality. The results further show that the existence of high competition within innovative industries, as indicated by our variable regional industry competition capturing the innovative capacity of a region, has a negative and significant effect on firm performance. We thus contribute to the ongoing discussion on whether competition helps or hinders performance (see Slater & Narver, 1994). Our results suggest that especially in high technology industries, competitive pressure undermines technological innovation and technology transfer processes. The technical orientation of a university as well as the number of students do not seem to significantly influence firm performance.

In addition to the impact of external regional characteristics, Model I as well as all other model specifications further reveal a significant and positive effect of R&D expenditures, our proxy for firms' absorptive capacities, i.e. internal firm characteristics, on firms' financial performance. We can consequently confirm hypothesis 2 in that the existence of absorptive capacities within firms leads to a higher level of economic performance of firms. We thereby reinforce previous findings which found that firms with higher R&D expenditures and thus enhanced technological innovation capabilities experience superior financial performance (see Camisón & Villar-López, 2014; Sher & Yang, 2005). We can also confirm previous results in that the influence of firm size on firm performance is positive and significant as indicated by the variable firm size (see Lee, 2009). Finally, we are able to shed light on the impact of firms' asset utilization on firm performance (see Cheng, Lin, Hsiao, & Lin, 2010). We find a positive yet insignificant relationship between firms' process capital, i.e. the efficiency with which a firm is deploying its assets in generating income, and firm performance.

The evaluation of our third hypothesis is based on the interaction between firms' absorptive capacities and prevalent local knowledge spillovers. All model specifications, i.e. Model II to V, reveal positive and significant coefficients of the interaction between internal firm characteristics and external regional characteristics. External knowledge spillovers may complement internal R&D activities and in

turn may lead to an enhanced economic performance. We can consequently confirm hypothesis 3 in that a complementary effect between local knowledge spillovers in regions and firms' absorptive capacities leads to a higher level of economic performance of firms, hence confirm the results of previous studies focusing on R&D spillover effects and R&D cooperation (see Belderbos, Carree, & Lokshin, 2004; Chen, Chen, Liang, & Wang, 2013). We thus reinforce the absorptive capacity theory of knowledge spillover entrepreneurship (Qian & Acs, 2013). Knowledge-based entrepreneurial technology transfer activities and the transformation of knowledge spillovers into economic knowledge are based on the co-existence of new knowledge and adequate knowledge capacities, ultimately resulting in higher levels of firm performance.

As with all research, our study is subject to a number of limitations. Measuring the existence of knowledge spillovers by focusing on knowledge provided by the public sector does not capture the total amount of potential local knowledge flows. Also private sector research activities lead to knowledge spillovers, so-called R&D spillover effects, which should ideally be considered as well. We further base our multilevel approach on a rather small unbalanced panel which is not ideal as larger sample sizes could substantiate recommendations derived from our results. Additionally, further control variables could be included within the analyses, e.g. university-firm collaborations as well as firm-firm collaborations to differentiate distinct types of knowledge spillovers and examine their individual impact on firm performance.

## DISCUSSION & IMPLICATIONS

This study has taken investments of knowledge-intensive publicly listed and traded firms in corporate capital, i.e. investments in R&D, as a starting point and has investigated the influence of the co-existence of both higher knowledge contexts and firms' absorptive capacities on firm performance. Our results reveal that the existence of local knowledge spillovers does not have a per se positive impact on firm performance. It is the co-existence of adequate absorptive capacities and high levels of knowledge spillovers which enable firms to benefit from local knowledge flows, thus penetrate the knowledge filter. Beyond knowledge spillovers, both internal firm characteristics such as size as well as external regional characteristics such as regional economic vitality further shape firm performance. Contributing to an ongoing discussion whether local competition helps or hinders firm performance, this study finds evidence that within knowledge-intensive high technology industries, high levels of competition rather counteract augmented firm performance.

Beyond implications for knowledge-intensive firms to not only base their location decisions on higher knowledge contexts, but also on their inherent capacities to absorb and exploit local knowledge spillovers, our findings might also provide an impetus to reconsider current public policy strategies. Much research effort has been devoted to guiding policymakers how to enhance the efficiency and effectiveness of public sector organizations within regional innovation systems, enabling especially public research organizations such as universities to produce more knowledge, thus supply the private sector with additional knowledge inputs through technology transfer. Our results clearly show that this policy approach is by far not sufficient and only one side of the coin. Idiosyncratic regional prerequisites, i.e. prevalent absorptive capacities of firms, have to be considered by policymakers, in order to achieve the ultimate goal of public policy: regional economic prosperity. Consequently, a comprehensive policy approach is needed which balances the support provided to knowledge producing regional actors such as universities as well as knowledge exploiting actors such as knowledge-based firms. Economic growth is not based on new knowledge but on the exploitation thereof, yet requiring sufficient regional absorptive capacities. Thus, our study shows that the traditional technology transfer model is insufficient, as it does not capture the context of knowledge production and exploitation, hence oversimplifies the complexity

of respective processes. Scholars like Stam (2015) have already provided more comprehensive frameworks, which emphasize the importance of the entrepreneurial context. Future research should deliberately examine the effects of more comprehensive public policy approaches encouraging public-private sector interactions by taking both the local knowledge context as well as firms' capabilities to exploit respective opportunities into account. One-size-fits-all policy approaches are unlikely to be successful, as "contexts will always matter and need to be appreciated for determining the most relevant accent at every stage of the process" (Stam & Bosma, 2015, p. 297). Therefore, more nuanced models of technology transfer need to be conceptualized which take respective fuzzy processes and their actual contexts into consideration. We thus reinforce the call of Bradley et al. (2013) for alternative views of technology transfer for public-private sector interactions.

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**Table 1: Multilevel regression estimating firm performance**

	Model I	Model II	Model III	Model IV	Model V
<i>L.</i> Absorptive capacities	0.629***	0.332***	0.337***	0.279***	0.290***
	(0.045)	(0.057)	(0.057)	(0.058)	(0.059)
<i>L.</i> Knowledge spillovers	-0.033	<b>-0.338*</b>	-0.303	-0.249	-0.215
	(0.176)	<b>(0.179)</b>	(0.191)	(0.182)	(0.195)
<i>L.</i> AbCap * KS		2.5*10 <sup>-6</sup> ***	2.5*10 <sup>-6</sup> ***	2.4*10 <sup>-6</sup> ***	2.4*10 <sup>-6</sup> ***
		(3.1*10 <sup>-7</sup> )	(3.1*10 <sup>-7</sup> )	(3.2*10 <sup>-7</sup> )	(3.2*10 <sup>-7</sup> )
<i>L.</i> Regional industry competition			-7,609***		-5,658***
			(2,052)		(1,808)
<i>L.</i> Regional vitality			11.86**		8.38*
			(5.31)		(4.51)
<i>L.</i> Regional density			190.3*		98.92
			(105.4)		(91.29)
<i>L.</i> University size			-0.64		0.11
			(1.34)		(1.17)
<i>L.</i> Technical focus			-24,380		25,558
			(89,742)		(76,737)
<i>L.</i> Firm size				82,091***	78,329***
				(12,311)	(12,630)
<i>L.</i> Asset utilization				12,171	8,679
				(66,127)	(66,228)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Total observations	3,144	3,144	3,144	3,023	3,023

Note: Standard errors are in brackets. The asterisks \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% level, respectively.