INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research

International Journal of Business Innovation and Research

ISSN online: 1751-0260 - ISSN print: 1751-0252
https://www.inderscience.com/ijbir

Impacts of geographic region on knowledge spillover effects and innovation performance in healthcare

Mariella Zilahi-Lugbauer, Harald Stummer

DOI: 10.1504/IJBIR.2025.10074773

Article History:

Received:	30 July 2025
Last revised:	03 October 2025
Accepted:	03 October 2025
Published online:	01 December 2025

Impacts of geographic region on knowledge spillover effects and innovation performance in healthcare

Mariella Zilahi-Lugbauer*

Department of Economic and Social Sciences,
University Seeburg Castle,
Seeburgstr. 8, 5201 Seekirchen am Wallersee, Austria
Email: mariella.zilahi-lugbauer@edu.uni-seeburg.at
*Corresponding author

Harald Stummer

UMIT TIROL,
Institute for Management and Economics in Healthcare,
EWZ 1, 6060 Hall in Tyrol, Austria
Email: harald.stummer@umit-tirol.at
and
IMC Krems,
Institute for Health Management,
Piaristengasse 1, 3500 Krems/Donau, Austria

Abstract: This study examines how geographic context shapes knowledge spillovers and innovation performance in the healthcare sector. Drawing on the open innovation paradigm, the knowledge spillover theory of innovation, and the regional innovation systems (RIS) framework, it analyses how healthcare professionals (HCPs) and medical technology company representatives (MedTechs) exchange knowledge and foster innovation across regions with varying knowledge-economy competitiveness. A quantitative cross-sectional design was applied using data from 97 Austrian participants. Analyses of variance and moderated moderation modelling tested the effects of professional group and regional competitiveness on the link between knowledge spillovers and innovation performance. Results show that knowledge spillovers significantly enhance innovation performance, particularly in competitive regions. A significant three-way interaction among spillovers, profession, and region indicates that innovation outcomes depend on both organisational and geographic conditions. The study advances open innovation and RIS research by clarifying how regional characteristics shape healthcare innovation.

Keywords: healthcare; knowledge spillover; innovation performance; knowledge economy regions; open innovation.

Reference to this paper should be made as follows: Zilahi-Lugbauer, M. and Stummer, H. (2025) 'Impacts of geographic region on knowledge spillover effects and innovation performance in healthcare', *Int. J. Business Innovation and Research*, Vol. 38, No. 7, pp.1–17.

Biographical notes: Mariella Zilahi-Lugbauer is a Doctoral researcher at the Department of Economic and Social Sciences, Seeburg Castle University (Austria). Her research focuses on knowledge spillovers, innovation management, and regional development in healthcare.

Harald Stummer is a Professor at UMIT Tirol and IMC Krems, specialising in health management, innovation systems, and evidence-based healthcare economics.

1 Introduction

Companies are shifting from closed to open corporate innovation strategies because internal resources alone can no longer meet the demands of multifaceted markets in the knowledge-based economy (Chesbrough, 2003; Sakakibara, 2002). By linking a view of knowledge as a competitive advantage with open innovation strategies, companies can access a wide range of internal and external knowledge resources, enriching their innovative capacity and enhance their adaptability in highly competitive market environments.

These approaches may be applied via social media platforms to promote collaboration and knowledge sharing among companies and customers. This interaction is fundamental to helping people stay informed and encouraging innovation. In the healthcare field, this ultimately can lead to improved services and medical advances (Ventola, 2014).

Few studies have examined how geography influences social media dynamics in healthcare and the resulting knowledge spillover unintentional transfer of internal and external knowledge among individuals or companies (Jaffe et al., 1993). Measuring and quantifying the multifaceted process of knowledge spillover is challenging (Buzard et al., 2020; Feldman, 2004).

The central aim of this study is to examine how HCPs and MedTechs share knowledge through social media and how various regions within the knowledge economy affect knowledge transfer and innovation in healthcare. It draws on the concepts introduced by Jaffe et al. (1993), particularly knowledge spillovers and the role of geographic proximity in facilitating innovation. This contributes to a more nuanced understanding of open innovation in the healthcare context.

2 Literature review

2.1 Open innovation and knowledge spillover theory

The theoretical foundation of this study lies in the knowledge spillover theory of innovation, which posits that innovation arises not only from deliberate R&D but also from the diffusion of knowledge across organisational boundaries (Griliches, 1998). Knowledge spillovers enable companies and individuals to benefit from the ideas and technologies developed by others, often through informal interactions (Audretsch and Keilbach, 2007). Recent scholarship emphasises that these spillovers are a crucial driver of entrepreneurship, as they “enable entrepreneurs to learn from the business environment and develop new skills” (Audretsch et al., 2025).

This concept is complemented by the open innovation paradigm, which views firm boundaries as permeable, allowing for multidirectional knowledge flows that foster collective learning and innovation (Chesbrough, 2003; Li et al., 2024). A company’s ability to benefit from these external flows depends on its absorptive capacity its ability to recognise, assimilate, and apply new external knowledge (Cohen and Levinthal, 1990).

2.2 Knowledge spillovers in the healthcare context

Healthcare is a knowledge-intensive sector where innovation depends on collaboration between diverse actors, including healthcare professionals (HCPs), research institutions, and medical technology companies. This dynamic is empirically supported by recent studies, such as Soltani et al. (2025), who demonstrated the existence of 'quality improvement spillovers' in hospitals. Their research revealed that targeted quality improvements in one area can lead to positive spillover effects in other clinical areas, suggesting that innovation can diffuse throughout the healthcare ecosystem. University-industry interactions and medical research institutions are central to facilitating these spillovers and supporting innovation (Mao and Chen, 2025).

2.3 Regional innovation systems and geographic proximity

Regional innovation systems (RIS) provide the framework within which spillovers are generated and absorbed (Cooke et al., 1997). Geographic proximity facilitates formal and informal knowledge exchange, which is critical for learning and the diffusion of complex knowledge (Wilkinson and Arcaute, 2023). However, while proximity remains vital, digitalisation is transforming these dynamics. Cuvero et al. (2025) highlight that the absorption of knowledge spillovers relies on entrepreneurs' interactive learning and their ability to establish social and cognitive proximity within innovation networks. With the growing integration of digital tools and social media, these forms of proximity are increasingly reproduced in virtual environments, enabling knowledge exchange and spillover absorption beyond physical boundaries.

2.4 Digital platforms and social media as catalysts for knowledge spillovers

Social media and digital platforms have become crucial catalysts for open innovation in healthcare, enabling HCPs and MedTech companies to exchange professional insights, discuss new technologies, and foster innovation communities (Ventola, 2014). This creates a symbiotic relationship between knowledge management and digital tools. A recent bibliometric analysis by Stoumpos et al. (2024) asserts that "knowledge management and digital innovation are symbiotic in healthcare. Digital tools provide platforms for capturing, storing, and analysing knowledge". This underscores the growing importance of interdisciplinary collaboration between healthcare providers, technologists, and policymakers in fostering innovation and resilience in modern healthcare systems (Zhang and Sung, 2023).

3 Hypothesis development

The existing literature demonstrates that knowledge spillover effects arising between two populations with complementary expertise can drive innovation. In this case, HCPs contribute practical and clinical insights, whereas MedTechs provide technological expertise and innovative capabilities (Kwon et al., 2022).

The interrelationship between geographical factors, knowledge spillover, and innovation performance in healthcare is complex. This study analyses knowledge

economy regions characterised by high levels of knowledge-intensive activities, strong research institutions, and supportive innovation ecosystems (Cooke, 2001). The European Spatial Planning Observation Network (ESPON) classification (Szendrei et al., 2020) provides the analytical framework for examining geographical differences in shaping innovation patterns and knowledge exchange. However, the specific influence of these regional dynamics on knowledge spillover remains insufficiently explored (Bathelt et al., 2004).

Therefore, we hypothesise:

H1.1.1 There is a significant difference between knowledge economy regions with regard to the knowledge spillover effect.

The effects of knowledge spillover may vary substantially across regions, as suggested by region-based typologies (Szendrei et al., 2020). For instance, Vienna, Austria, exemplifies a science-based knowledge region due to its high concentration of scientific activity and highly educated human capital. In contrast, adjacent regions exhibit varying degrees of innovation intensity, reflecting differences in urbanisation and concentration of knowledge-based activities.

H1.1.2 There is a significant difference between HCPs and MedTechs with regard to the knowledge spillover effect.

This hypothesis builds upon prior research on knowledge spillover and innovation in healthcare. The two study groups represent distinct nodes within the healthcare innovation ecosystem, each with unique knowledge bases and interaction patterns. The variation in knowledge spillover effects between these groups can be interpreted through the concept of absorptive capacity (Cohen and Levinthal, 1990). HCPs may have a different capacity to recognise, assimilate, and apply external knowledge compared to MedTechs, who are focused on technological innovation. Understanding these structural and dynamic networks properties are crucial for improving the information diffusion and innovations (Tasselli, 2014).

H1.1.3 There is a significant interaction effect between HCPs and MedTechs and the knowledge economy region.

This hypothesis implies a complex interdependence between the two groups and the regional innovation environment in which they operate. Knowledge economy regions can be differentiated by their innovation performance, scientific output, human capital, and the strength of their knowledge exchange ecosystems, aligning with the concept of the RIS. An RIS comprises the network of institutions, actors, and interactions within a specific geographical area that collectively facilitate the creation, diffusion, and utilisation of knowledge and innovation. It emphasises the importance of regional proximity, institutional collaboration, and localised learning in fostering innovation-driven development (Asheim and Gertler, 2016).

The interaction effect implied is influenced by the degree of urbanisation and concentration of knowledge-intensive activities in different regions. In areas that encompass major urban centres and second-tier cities, the proximity and density of healthcare institutions, research centres, and medical technology companies may facilitate intense knowledge sharing and spillover. According to innovation diffusion theory, Rogers (1969) suggests that the rate at which new ideas and technologies spread varies in different social systems.

This section discusses the conceptual path model developed for this study (Figure 1), that shows the interplay between knowledge spillover and innovation performance among the two study groups within specific geographical settings. It illustrates the assumed relationships between knowledge spillover effect (independent variable) and innovation performance (dependent variable), incorporating innovation performance (moderator) and knowledge economy region (second-level moderator). The model reflects the theoretical assumptions guiding the moderated moderation analysis, displaying the core relationship in this model between knowledge spillover effects and innovation performance, which is essential for understanding knowledge diffusion.

$H2_{Moderation}$ A positive correlation exists between knowledge spillover effects and innovation performance within the healthcare and medical technology sectors.

This hypothesis is consistent with Tasselli (2014), which underlines the role of professional networks in disseminating information and innovations. Studies on spatial clustering of economic activity and its relation to knowledge creation in interactive learning processes. It has been found that a combination of strong local buzz, defined as the spontaneous, ongoing exchange of information, ideas, and knowledge that occurs through face-to-face interactions, social proximity, and informal networks within a specific geographic region. It facilitates trust-building, rapid knowledge diffusion, and collective learning, particularly in innovation-driven environments and densely clustered companies provides advantages (Bathelt et al., 2004). Such environments promote innovation particularly in dense, knowledge-driven regions.

$H3a_{Moderation}$ Knowledge spillover effects in healthcare and medical technology sectors are moderated by knowledge economy regions.

$H3b_{Moderation}$ Knowledge spillover effects in healthcare and medical technology sector are moderated by professional group.

These hypotheses are grounded in research highlighting the influence of diverse knowledge bases on innovation and the expectation that interactions between HCPs and MedTechs enhance innovation performance through knowledge spillover. The moderation model (Figure 1) integrates knowledge economy regions as a contextual moderator a novel approach in the study of regional innovation systems and the geography of innovation (Asheim and Gertler, 2016; Cooke, 2001).

$H4a_{Moderation}$ Knowledge economy regions moderate the relationship between the two study groups and knowledge spillover effects.

$H4b_{Moderation}$ Knowledge economy regions moderate the relationship between the two study groups and innovation performance.

These hypotheses reflect the understanding that regional characteristics substantially shape innovation dynamics. Certain knowledge economy regions possess more advanced physical and digital infrastructures, enabling efficient knowledge exchange and higher concentrations of skilled professionals and research institutions (Bathelt et al., 2004). The model's emphasis on the interaction between professional group and regional context aligns with innovation diffusion theory (Rogers, 1969). The interaction between the two groups is expected to be moderated by these regional characteristics. Furthermore,

organisations often face a trade-off between exploration and exploitation. Medical technology companies may be inclined to pursue exploratory innovation, whereas HCPs might focus on best practise innovation (March, 1991). The interaction between these groups, moderated by the characteristics of knowledge economy regions, can lead to a balanced innovation strategy that combines exploratory and exploitative elements.

4 Materials and methods

4.1 Research design

This study employs a quantitative, cross-sectional research design to investigate the moderating effects of professional group and geographic region on the relationship between knowledge spillovers and innovation in the Austrian healthcare sector.

A 2 × 2 factorial design was implemented for the systematic examination of the main effects and interactions between independent variables. Two groups (HCPs and MedTechs) and knowledge economy regions (competitive knowledge-based economies and highly competitive knowledge-based economies) are considered. Additionally, a moderation analysis was conducted to examine the conditional effects of various moderators on the relationship.

4.2 Data collection

Data were collected via an online survey conducted in Austria using the SoSci Survey platform between 13 April and 13 May 2024. The initial outreach, conducted through systematic mailing campaigns, included 1,063 HCPs and 554 MedTech representatives. The final sample for analysis comprised 97 participants (45 HCPs and 52 MedTechs).

4.3 Measurements and variables

All constructs were measured using multi-item scales adapted from established literature to fit the healthcare context. The concept of knowledge spillover was operationalised using six adapted items from Wang and Jiang (2020). Construct measurement involved adaptation of the scale items to the specific target groups in healthcare. The responses given on a Likert scale from 1 (no implementation) to 7 (very intensive implementation), which allowed for an assessment of the degree of knowledge spillover (Cheng and Shiu, 2019; Wang and Jiang, 2020).

Innovation performance was assessed using a scale consisting of three items, adapted from the Song et al.'s (2019) scale as modified by Cheng and Shiu (2019). This scale ranges from 1 (performance much lower than targeted) to 5 (performance much higher than targeted) and allows a detailed assessment of innovation outcomes relative to predetermined targets.

Knowledge economy regions were conceptualised as geographic areas displaying varying concentrations of knowledge-intensive industries, research infrastructure, and a highly educated workforce. Vienna, Austria, is considered a highly competitive knowledge-based region, in comparison to the other eight regions of Austria. Vienna has a focus on science-based activities and applied sciences, an availability of skilled labour,

and where technological advances are made (Szendrei et al., 2020). In this study, the regions were categorised into two levels:

1 competitive knowledge-based economies

2 highly competitive knowledge-based economies.

4.4 Data analysis

Data analysis was conducted using IBM SPSS version 28 and JASP version 0.18. The descriptive statistics included measures of dispersion and geographic parameters.

A multidimensional approach was chosen to assess the normality of the data distribution. This included the Shapiro-Wilk test, supplemented by visual inspection of histograms, QQ diagrams, and box plots. In cases where the normality test yielded ambiguous results, both parametric and non-parametric tests were performed to ensure robustness of the results.

Inferential statistics were calculated through two-way parametric analysis of variance (ANOVA), preceded by a Levene's test to ensure the homogeneity of variances. Where parametric assumptions were not met, the non-parametric Kruskal-Wallis test was used instead. In addition, chi-square tests were conducted for categorical data analysis.

To examine complex relationships between variables, a moderated moderation analysis was conducted, to allow the investigation of how the effect of an independent variable (knowledge spillover effect) on a dependent variable (innovation performance) is moderated by two interacting variables (Two groups and knowledge economy regions).

5 Results

5.1 Hypothesis 1

A two-way ANOVA was conducted to examine the effect of two groups and knowledge economy regions on knowledge spillover values. The results showed that there were no statistically significant main effects between the two groups, F (1, 79) = 0.198, p =.757, $\eta^2 p$ = 0.001 or knowledge economy regions, F (1, 79) = 2.951, p = 0.090, $\eta^2 p$ = 0.036 on the knowledge spillover effect scores. Additionally, there was no statistically significant interaction between the two groups and the knowledge economy regions, F (1, 79) = 0.096, p = 0.758, $\eta^2 p$ = 0.001.

5.2 Hypothesis 2 moderated moderation analysis

A moderated moderation regression analysis was conducted to examine the relationship between the knowledge spillover effect and innovation performance. The analysis included innovation performance groups as a moderator, and this moderation was further influenced by knowledge economy regions. The R^2 value for the model was 0.501, indicating that the model explained 50.1% of the variance in the dependent variable. This suggests a moderately strong relationship between the independent and dependent variables, moderated by the two groups. The result highlights the significance of the two groups in moderating the relationship between KSE and the outcome variable, offering insights into the variance explained by the model.

Figure 1 presents a conceptual path plot model.

Figure 1 Conceptual path plot model of relationships between knowledge spillover and innovation performance

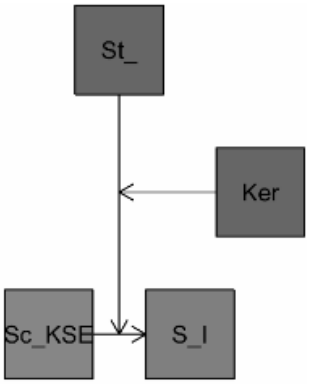

Table 1 presents the results of a *path analysis*, showing how different variables and their interactions predictions *innovation performance (Scale_IP)*.

The path coefficients from the regression analysis are summarised in Table 1. The relationship between the knowledge spillover effect and the outcome variable innovation performance was significant ($b = 0.654$, $SE = 0.086$, $z = 7.579$, $p < 0.001$, 95% CI [0.485, 0.823]). The interaction between knowledge spillover effect and knowledge economy regions also showed a significant positive effect on innovation performance ($b = 0.242$, $SE = 0.087$, $z = 2.778$, 95% CI [0.071, 0.412]).

Additionally, the three-way interaction of knowledge spillover effect, two groups, and knowledge economy regions was significant ($b = –0.172$, $SE = 0.086$, $z = –1.997$, $p = 0.046$, 95% CI [−0.342, −0.003]. Other paths, including the direct effect of the two groups on innovation performance and the interactions involving the two groups and the two knowledge economy regions, were not statistically significant (all p-values > 0.05). These findings imply that knowledge spillover significantly influenced innovation performance. The influence was particularly marked when considering the interaction with the knowledge economy regions and the three-way interaction involving the two groups.

Table 2 demonstrates how the two groups and knowledge economy regions influence *innovation performance*.

The analysis in Table 2 shows a significant positive relationship between the knowledge spillover effect and innovation performance, particularly in higher knowledge economy regions. The impact for the more highly developed region was significant across both groups ($\beta = 0.799$ to 0.983, $p < 0.001$). The pronounced effect was also seen in the MedTechs in highly developed knowledge economy regions ($\beta = 0.799$, $SE = 0.185$, $z = 4.319$, $p < 0.001$, 95% CI [0.436, 1.162]). In contrast, no significant relationship was found in lower knowledge economy regions within the two groups ($\beta = 0.182$, $SE = 0.169$, $z = 1.079$, $p = 0.280$, 95% CI [–0.148, 0.512]). The results underscore how intricate the relationship is between the knowledge spillover effect and the outcome variable. The contextual factors must be considered in understanding this relationship.

Table 1 Path coefficients

Scales and variables			*Estimate*	*Std. error*	*z-value*	*p*	*95% confidence interval*	
							Lower	*Upper*
Scale_KSE	→	Scale_IP	0.654	0.086	7.579	<.001	0.485	0.823
Two_groups	→	Scale_IP	–0.007	0.079	–0.088	0.930	–0.163	0.149
Scale_KSE: Two_group	→	Scale_IP	0.081	0.086	0.946	0.344	–0.087	0.249
Knowledge economy regions	→	Scale_IP	–0.054	0.080	–0.682	0.495	–0.210	0.102
Scale_KSE: Knowledge economy regions	→	Scale_IP	0.242	0.087	2.778	0.005	0.071	0.412
Scale_KSE: Two_group: Knowledge economy regions	→	Scale_IP	–0.172	0.086	–1.997	0.046	–0.342	–0.003
Two_groups: Knowledge economy regions	→	Scale_IP	–0.085	0.080	–1.060	0.289	–0.241	0.072

Note: Standard errors, test statistics, and confidence intervals based on standardised estimates.

Table 2 Mediation effects of two groups and knowledge economy regions on innovation performance (Scale_IP)

			Two_groups	*Knowledge economy regions (KE)*	*Estimate*	*Std. Error*	*z-value*	*p*	*95% confidence interval*	
									Lower	*Upper*
Scale_KSE	→	Scale_IP	HCP	CKE	0.182	0.169	1.079	0.280	–0.148	0.512
Scale_KSE	→	Scale_IP	Both	CKE	0.182	0.169	1.079	0.280	–0.148	0.512
Scale_KSE	→	Scale_IP	MT	CKE	0.680	0.119	5.718	<.001	0.447	0.914
Scale_KSE	→	Scale_IP	HCP	KE	0.182	0.169	1.079	0.280	–0.148	0.512
Scale_KSE	→	Scale_IP	Both	KE	0.182	0.169	1.079	0.280	–0.148	0.512
Scale_KSE	→	Scale_IP	MT	KE	0.680	0.119	5.718	<.001	0.447	0.914
Scale_KSE	→	Scale_IP	HCP	HKE	0.983	0.200	4.912	<.001	0.591	1.376
Scale_KSE	→	Scale_IP	Both	HKE	0.983	0.200	4.912	<.001	0.591	1.376
Scale_KSE	→	Scale_IP	MT	HKE	0.799	0.185	4.319	<.001	0.436	1.162

Note: Standard errors, test statistics, and confidence intervals are based on standardised estimates. Competitive knowledge-based economies – CKE and highly competitive knowledge-based economies – HKE.

6 Discussion

The two study groups (HCPs and MedTechs) are similar in terms of knowledge spillover. This proves group differences exerted less influence than anticipated. One explanation could be the increasing integration of the healthcare and medical technology sectors, whereby interdisciplinary innovation processes become more interdisciplinary, the traditionally separate areas of the two groups begin to overlap. The concept of absorptive capacity may explain why both sectors show similar abilities in capturing spillovers (Cohen and Levinthal, 1990), with both groups may have the sufficient capacity to effectively identify, assimilate, and apply external knowledge.

There was no significant main effect of the two groups or knowledge economy regions on the KSE scale scores and no interaction between these two factors. This lack of significance may reflect complexity of the relationships, which may be influenced by contextual and institutional conditions characteristics. This finding was unexpected. A possible explanation is that the healthcare sector is characterised by high levels of uncertainty and complexity, which may constrain it difficult for knowledge spillovers to occur. Additionally, healthcare is often subject to strict regulations and standards, which limit companies' ability to innovate and adopt new technologies.

The following hypothesis tested whether the knowledge economy moderates the relationship between the two study groups on one side, healthcare professionals (HCPs), and on the other side, medical technology companies (MedTechs) and knowledge spillover effects (KSE). Results demonstrate a significant positive association between regional knowledge-economy strength and innovation performance, confirming that knowledge spillovers exert a favourable influence on innovation within the healthcare sector. This observation accords with OECD evidence that knowledge-based economies are distinguished by intensive innovation dynamics and entrepreneurial capacity (OECD, 2019). Nevertheless, the diffusion of knowledge through social media is highly context-dependent, influenced by geographical disparities in digital access, network density, and technological opportunity. Regions with well-developed digital infrastructures experience more efficient knowledge exchange, underscoring the necessity of investing in digital connectivity. OECD evidence underscoring the significance of local innovation systems and their part in regional performance through network mediated spillovers (OECD, 2019).

A significant interaction occurs between knowledge spillover effects and knowledge economy regions as variables that influence innovation performance. The findings suggest that the relationship between KSE and innovation performance is moderated by knowledge economy region. This tendency is in line with the first hypothesis, confirmed by prior literature that indicates that knowledge economy regions can influence innovation capacity (Cooke, 2001). The further results of the moderation analysis showed a significant moderating effect, showing that regions strong knowledge economy regions play a role in amplifying the positive effects of knowledge spillovers on innovation performance. The finding is consistent with RIS perspective (Cooke, 2001) and conceptualisation of knowledge economy (Foray, 2004).

The absence of a significant direct effect of professional group on innovation performance was unexpected. This pattern implies that group differences influence innovation indirectly primarily through their contribution to the regional knowledge economy. Hence, the impact of healthcare professionals and MedTech companies on

innovation appears to be mediated by the broader knowledge infrastructure that facilitates spillover utilisation.

A significant three-way interaction among KSE, professional group, and knowledge-economy region is identified, demonstrating that the strength of the KSE innovation relationship depends simultaneously on organisational and regional context. Specifically, the positive effect of KSE on innovation performance is amplified in regions with a strong MedTech presence and mature knowledge ecosystems.

The mediation analysis confirmed that KSE exerts a significant positive influence on innovation performance, particularly within regions characterised by high knowledge-economy intensity. This finding supports the proposed hypothesis and aligns with the theoretical perspectives of absorptive capacity (Cohen and Levinthal, 1990) and RIS (Cooke, 2001; Foray, 2004). Collectively, these results underscore the pivotal role of contextual and multi-level interactions in converting knowledge spillovers into tangible innovation outcomes.

7 Theoretical and practical implications

The findings extend theoretical understanding of knowledge spillovers and offer practical guidance for strengthening innovation practices across heterogeneous geographic and institutional settings.

7.1 Theoretical implications

This study enriches the literature on knowledge spillovers by elucidating the critical role of geographic context in shaping innovation outcomes. The results reinforce the premise that geographic proximity enhances knowledge transfer, consistent with the RIS perspective (Cooke, 2001).

In healthcare, regions characterised by a dense concentration of MedTech companies and healthcare professionals exhibit stronger spillover effects than less knowledge-intensive regions. This pattern supports theories of agglomeration (Glaeser et al., 1992), and spatial clustering of knowledge-intensive activities (Feldman, 2004), while emphasising the significance of localised knowledge economies. In particular, innovation hubs with dense professional networks and institutional support mechanisms foster accelerated knowledge dissemination, aligning with RIS theory (Cooke, 2001) and research on regional clustering of knowledge-based industries (Asheim and Gertler, 2016) confirm our findings.

The findings also add nuance to existing conceptualisations of knowledge spillover by revealing professional-group differences and geographical mediation effects. They suggest that the open innovation paradigm requires contextual adaptation to account for regional heterogeneity in regulation, institutional density, and professional network structures.

7.2 Practical implications

The results provide actionable insights for policymakers aiming to strengthen healthcare innovation within knowledge-economy regions. Although the theoretical model anticipated a pronounced direct influence of geography on knowledge spillover, the

empirical analysis revealed only a modest main effect. However, the presence of significant interactions effects particularly the three-way interaction among knowledge spillover, professional group, and knowledge-economy region demonstrates that regional attributes condition innovation performance in nuanced and context-specific ways.

Anchored in institutional theory, these findings imply that regional innovation policies should be differentiated according to local structural and competitive dynamics. Policy instruments such as innovation hubs, network intermediation, and adaptive regulatory frameworks are especially effective in urban clusters with concentrated professional networks and advanced infrastructural capacity (Porter, 1998). By elucidating the spatial contingencies of open innovation, this study extends the discourse on the geography of innovation, reinforces the knowledge-based view of the firm, and refines the theoretical scope of the open innovation paradigm.

8 Limitations

The study provides meaningful insights into how knowledge economy regions shape open innovation dynamics; however, several limitations merit consideration. First, the healthcare sector's inherent complexity stemming from its diverse stakeholders, regulatory intensity, and technological volatility renders it difficult to capture the full scope of regional innovation processes. Second, the study's focus on MedTech companies and healthcare professionals excludes other subsectors such as pharmaceuticals, biotechnology, and digital health, which may operate under different innovation logics. Third, the cross-sectional design limits causal inference regarding the interplay between geography, knowledge spillovers, and innovation performance. Fourth, regional heterogeneity in technological infrastructure and unobserved contextual moderators, including organisational culture, may have influenced spillover effects (Wang et al., 2021). Finally, consistent with Buzard et al. (2020), the inherent difficulties of measuring and quantifying knowledge spillovers constrain the precision with which their magnitude can be assessed.

9 Future research directions

Future research should address these limitations. Longitudinal studies are needed to track innovation processes over time and enable stronger causal inferences. Comparative studies across different countries could help identify which institutional factors are most critical for success. Furthermore, future work should conduct sector-specific analyses and employ qualitative methods, such as case studies or in-depth interviews to explore the underlying mechanisms and lived experiences behind the quantitative interactions identified in this study.

10 Conclusions

The present research examines three major contributions to the literature on healthcare innovation and knowledge spillovers. This study examined how open innovation in the

Austrian healthcare sector is shaped by geographic context and the characteristics of knowledge economy regions. The analysis provides empirical evidence that the relationship between knowledge spillovers and innovation performance is both positive and highly context-dependent.

The most salient finding is the significant three-way interaction: the positive effect of knowledge spillovers on innovation performance depends jointly on the professional group (healthcare professionals vs. MedTech companies) and the type of knowledge economy region. These finding challenges one-dimensional models and shows that a 'one-size-fits-all' approach to fostering healthcare innovation is unlikely to be effective.

This finding also advances RIS concept (Cooke, 2001) by demonstrating that who the actors are and where they operate jointly determine innovation outcomes. The collaboration between MedTech companies and highly competitive knowledge economies appears particularly potent in generating innovation outcomes.

While the study anticipates a strong direct effect of geographic region and professional group on knowledge spillovers, these main effects were not significant. This result may reflect the increasing integration of the healthcare sector, where baseline opportunities for knowledge exchange are becoming more homogeneous. However, the significant interaction effects indicate that the translation of spillovers into tangible innovation outcomes is where professional and regional differences become decisive. This observation supports the concept of absorptive capacity (Cohen and Levinthal, 1990), suggesting that different actors in distinct environments vary not only in their access to knowledge but also in their ability to recognise, assimilate, and exploit it effectively.

The findings further contribute to the debate on the relative importance of local versus global knowledge flows in innovation processes. While regional factors were shown to be critical, healthcare innovation also appears to depend on a complex interplay between local and global knowledge networks, consistent with the concepts of local buzz and global pipelines (Bathelt et al., 2004). The results underscore those regions with strong knowledge economies characterised by dense professional ecosystems, advanced infrastructure, and a high concentration of MedTech activity amplify the positive effects of knowledge spillovers on innovation performance. This supports agglomeration theory (Glaeser et al., 1992) and the notion of geographically clustered, knowledge-intensive activities (Asheim and Gertler, 2016; Feldman, 2004).

Further it advances the understanding of context-specific innovation policy. For policymakers, the findings highlight that promoting general knowledge sharing is insufficient; instead, policy instruments should focus on strengthening targeted collaborative links particularly between MedTech companies and urban research hubs that yield the highest innovation returns.

From an institutional perspective, the results imply that regional innovation policies must be tailored to the specific structural and competitive conditions of each region. Measures such as the establishment of innovation hubs, facilitation of professional networks, and adaptive regulatory frameworks are most effective in urban clusters with dense knowledge ecosystems and advanced technological infrastructures (Porter, 1998). By foregrounding the spatial dimension of open innovation, this study contributes to the broader discourse on the geography of innovation, the knowledge-based view of the company, and the open innovation paradigm.

In conclusion, this study provides compelling evidence that geographic region plays a decisive but context-dependent role in shaping open innovation within the healthcare

sector. By examining the interplay among spatial factors, knowledge economy characteristics, and professional group dynamics, the study offers a nuanced understanding of how innovation emerges from the interaction of local ecosystems and actor networks. As the healthcare sector continues to evolve in response to technological change and global challenges, these insights can inform more adaptive, regionally tailored innovation strategies and policies that strengthen both the competitiveness and resilience of healthcare systems.

Declarations

All participants provided written informed consent previous to participation in the study. They were informed about the purpose of the study, the procedures elaborated, their right to withdraw at any time, and the measures taken to ensure disclosure and data protection. Furthermore, participation was intentional.

The authors declare usage of text-generating AI tools (DeepL, Writefull, ChatGPT 4.0) exclusively for the purpose of enhancing the linguistic clarity and grammatical accuracy of the text.

The author declares that there are no conflicts of interest related to the research, authorship and publication of this work.

References

Asheim, B.T. and Gertler, M.S. (2016) *The Geography of Innovation: Regional Innovation Systems*, Oxford Academic [online] https://academic.oup.com/edited-volume/38667/chapter/335805297 (accessed 24 June 2024).

Audretsch, D.B. and Keilbach, M. (2007) 'The theory of knowledge spillover entrepreneurship', *Journal of Management Studies*, Vol. 44, No. 7, pp.1242–54, DOI: 10.1111/j.1467-6486.2007.00722.x.

Audretsch, D.B., Belitski, M. and Fiedler, A. (2025) 'The knowledge spillover theory of entrepreneurship and innovation: taking stock and new directions', *Journal of Technology Transfer*, DOI: 10.1007/s10961-025-10215-9.

Bathelt, H., Malmberg, A. and Maskell, P. (2004) 'Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation', *Progress in Human Geography*, Vol. 28, No. 1, pp.31–56, DOI: 10.1191/0309132504ph469oa.

Buzard, K., Carlino, G.A., Hunt, R.M. et al. (2020) 'Localized knowledge spillovers: evidence from the spatial clustering of R&D labs and patent citations', *Regional Science and Urban Economics*, Vol. 81, p.103490, DOI: 10.1016/j.regsciurbeco.2019.103490.

Cheng, C.C. and Shiu, E.C. (2019) 'Acquisition and use of customer information', *International Small Business Journal*, Vol. 37, No. 1, pp.22–42, DOI: 10.1177/0266242618774831.

Chesbrough, H.W. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business Press, Boston, MA.

Cohen, W.M. and Levinthal, D.A. (1990) 'Absorptive capacity: a new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35, No. 1, pp.128–152, DOI: 10.2307/2393553.

Cooke, P. (2001) 'Regional innovation systems, clusters, and the knowledge economy', *Industrial and Corporate Change*, Vol. 10, No. 4, pp.945–974, DOI: 10.1093/icc/10.4.945.

Cooke, P., Uranga, M.G. and Etxebarria, G. (1997) 'Regional innovation systems: Institutional and organisational dimensions', *Research Policy*, Vol. 26, Nos. 4–5, pp.475–91.

Cuvero, M., Granados, M., Pilkington, A., Evans, R., Ko, W.W., Bortnovskaya, M. and Wang, C. (2025) 'How entrepreneurs absorb knowledge spillovers during innovative product development: evidence from UK start-ups', *R&D Management*, DOI: 10.1111/radm.12768.

Feldman, M.P. (2004) 'Knowledge spillovers and the geography of innovation', in Henderson, J.V. and Thisse, J.F. (Eds.): *Cities and Geography*, pp.2713–2739, Elsevier, DOI: 10.1016/S1574-0080(04)80018-X.

Foray, D. (2004) *New Models of Innovation and the Role of Information Technologies in the Knowledge Economy* [online] https://direct.mit.edu/books/edited-volume/chapter-pdf/2290711/9780262272070_caf.pdf.

Glaeser, E.L., Kallal, H.D., Scheinkman, J.A. and Shleifer, A. (1992) 'Growth in cities', *Journal of Political Economy*, Vol. 100, No. 6, pp.1126–1152, DOI: 10.1086/261856.

Griliches, Z. (1998) *Patent Statistics as Economic Indicators: A Survey*.

Jaffe, A.B., Trajtenberg, M. and Henderson, R. (1993) 'Geographic localization of knowledge spillovers as evidenced by patent citations', *Quarterly Journal of Economics*, Vol. 108, No. 3, pp.577–598, DOI: 10.2307/2118401.

Kwon, H.S., Lee, J., Lee, S. et al. (2022) 'Knowledge spillovers and patent citations: trends in geographic localization, 1976–2015', *Economics of Innovation and New Technology*, Vol. 31, No. 3, pp.123–147, DOI: 10.1080/10438599.2020.1787001.

Li, Z., Guo, L. and Ping, Y. (2024) 'Revolutionizing pharmaceutical innovation: unveiling the impact of endogenous knowledge spillover in China', *PLoS ONE*, Vol. 19, No. 9, p.e0307171, DOI: 10.1371/journal.pone.0307171.

Mao, D. and Chen, J. (2025) 'Does the university knowledge spillover promote common prosperity? Empirical evidence from China', *Humanities and Social Sciences Communications*, Vol. 12, No. 1, p.532, DOI: 10.1057/s41599-025-04858-0.

March, J.G. (1991) 'Exploration and exploitation in organizational learning', *Organization Science*, Vol. 2, No. 1, pp.71–87, DOI: 10.1287/orsc.2.1.71.

OECD (2019) 'An OECD learning framework 2030', in Bast, G., Carayannis, E.G. and Campbell, F.J. (Eds.): *The Future of Education and Labor*, pp.23–35, Springer International Publishing, Cham, DOI: 10.1007/978-3-030-26068-2_3.

Porter, M.E. (1998) 'Clusters and the new economics of competition', *Harvard Business Review*, Vol. 76, No. 6, pp.77–90 [online] http://biblioteca.fundacionicbc.edu.ar/images/d/de/Clusters_1.pdf (accessed 1 October 2024).

Rogers, E.M. (1969) *Diffusion of Innovations: Educational Change in Thai Government Secondary Schools*, ERIC, Ann Arbor, MI.

Sakakibara, M. (2002) 'Formation of R&D consortia: industry and company effects', *Strategic Management Journal*, Vol. 23, No. 11, pp.1033–1050, DOI: 10.1002/smj.272.

Soltani, M., Batt, R.J. and Bavafa, H. (2025) 'Quality improvement spillovers: evidence from the hospital readmissions reduction program', *Management Science*, Vol. 71, No. 7, pp.6112–6130, DOI: 10.1287/mnsc.2023.01062.

Song, H., Lu, Q., Yu, K. et al. (2019) 'How do knowledge spillover and access in supply chain networks enhance SMEs' credit quality?', *Industrial Management and Data Systems*, Vol. 119, No. 2, pp.274–291, DOI: 10.1108/IMDS-01-2018-0049.

Stoumpos, A.I., Talias, M.A., Ntais, C., Kitsios, F. and Jakovljevic, M. (2024) 'Knowledge management and digital innovation in healthcare: a bibliometric analysis', *Healthcare*, Vol. 12, No. 24, p.2525, DOI: 10.3390/healthcare12242525.

Szendrei, G., Evrard, E., Goosse, T. et al. (2020) *Territorial Patterns and Relations in Austria*, ESPON Report [online] https://biblio.ugent.be/publication/8736978/file/8736979 (accessed 8 April 2025).

Tasselli, S. (2014) 'Social networks of professionals in health care organizations: a review', *Medical Care Research and Review*, Vol. 71, No. 6, pp.619–660, DOI: 10.1177/1077558714557079.

Ventola, C.L. (2014) 'Social media and health care professionals: benefits, risks, and best practices', *Pharmacy and Therapeutics*, Vol. 39, No. 7, pp.491–520.

Wang, C., Brunswicker, S. and Majchrzak, A. (2021) 'Knowledge search breadth and depth and OI projects performance: a moderated mediation model of control mechanism', *Journal of Knowledge Management*, Vol. 25, No. 4, pp.847–870, DOI: 10.1108/JKM-03-2020-0222.

Wang, Z. and Jiang, Z. (2020) 'How R&D originality affects open innovation under knowledge spillovers', *European Journal of Innovation Management*, Vol. 23, No. 4, DOI: 10.1108/EJIM-xx-xxxx-xxxx.

Wilkinson, P. and Arcaute, E. (2023) *Revealing the Spatial Extent of Patent Citations in the UK: How Far Does Knowledge Really Spillover?*, arXiv preprint, DOI: 10.48550/arXiv.2306.17412.

Zhang, X.A. and Sung, Y.H. (2023) 'Communities going virtual: examining the roles of online and offline social capital in pandemic perceived community resilience-building', *Mass Communication and Society*, Vol. 26, No. 4, pp.539–565, DOI: 10.1080/15205436.2021.1974046.