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**Thinking Innovation beyond Agglomeration:
Opportunities and Challenges for Innovative Firms in the Periphery**

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Jakob Eder

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List of acronyms

CCI	Complex and Combined Mode of Innovation
CIS	Community Innovation Survey
DUI	Doing, Using, and Interacting Mode of Innovation
EU	European Union
EUROSTAT	European Statistical Office
GREMI	Groupe de Recherche Européen sur les Milieux Innovateurs
FFG	Austrian Research Promotion Agency [<i>Österreichische Forschungsförderungsgesellschaft</i>]
IT	Information Technology
JAC	Jacobs Externalities
MAR	Marshall-Arrow-Romer Externalities
MLP	Multi-Level Perspective
NIS(s)	National Innovation System(s)
NUTS	Nomenclature of Territorial Units for Statistics [<i>Nomenclature des unités territoriales statistiques</i>]
OECD	Organisation for Economic Co-operation and Development
POR	Porter Externalities
REG	Relational Economic Geography
RIS(s)	Regional Innovation System(s)
R&D	Research & Development
RQ	Research Question
S3s	Smart Specialization Strategies
SMEs	Small and medium sized enterprises
STI	Science, Technology, and Innovation Mode of Innovation
TIM(s)	Territorial Innovation Model(s)

List of publications

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2. Eder, Jakob (2019b): "Peripheralization and knowledge bases in Austria: towards a new regional typology", In: European Planning Studies 27(1): 42-67. doi: [10.1080/09654313.2018.1541966](https://doi.org/10.1080/09654313.2018.1541966)
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Abstract

Keywords

Innovation; Periphery;
Peripheralization; Regional
Development; Austria

JEL classifications

D83; O31; R11

The relationship between innovation and space lies at the core of the research agenda in economic geography. Especially the observation that innovative activities and therefore prosperity are spatially clustered, has led to an impressive body of work on the determinants of innovation in such clustered and mostly urban environments. The famous examples of Silicon Valley and Baden-Württemberg have inspired policies all around the world, which aim to achieve innovation through agglomeration. The basic idea is that innovation in core areas will eventually benefit the whole economy and therefore everyone.

However, there is increasing discontent with at least three issues. First, innovation occurs also in peripheral and rural areas, which has been often overlooked in innovation studies so far. Second, central and peripheral innovations are often treated exclusively and there is little work investigating urban-rural relationships towards innovation. Third, growing regional disparities suggest that innovation in clusters tends to aggravate these developments, rather than mitigate them.

Against this background, this dissertation aims to contribute to contemporary debates within the discipline. It explicitly addresses innovation in peripheral regions and provides theoretical advancements as well as empirical evidence. In doing so, it reviews research on innovation in the periphery, elaborates on the periphery concept, and sheds light on the innovation process of peripheral firms. Hence, it also suggests recommendations for a spatially sensitive innovation policy, which might aim to decrease uneven regional development.

The results display that research on innovation in the periphery is increasing, but more efforts are necessary regarding the periphery concept and the comparability of case studies. This dissertation therefore suggests a framework that highlights the strengths and weaknesses of regions towards innovation in detail. Such an understanding that goes beyond the strict poles of the urban and the rural is more appropriate for studying innovation in space. Finally, the case study provides evidence that peripheral innovators have developed a diverse portfolio of strategies for dealing with large distances.

In addition to presenting the main findings of the three scientific articles that constitute this dissertation, the framing text at hand includes the overarching research questions, discusses the role of innovation and provides the theoretical background. Furthermore, it introduces the study area, namely Austria, and identifies critical realism as the underlying paradigm. These ontological and epistemological perspectives lead to a methodology that combines both quantitative and qualitative approaches. A summary, conclusions, policy recommendations, and avenues for future research conclude this framing text.

Kurzfassung

Schlüsselwörter

Innovation; Peripherie;
Peripherisierung;
Regionalentwicklung;
Österreich

JEL-Klassifizierung

D83; O31; R11

Wie sich Innovation im Raum verteilt, ist eine der Schlüsselfragen der wirtschaftsgeographischen Forschung. Vor allem die Tatsache, dass Innovation und damit auch Wohlstand räumlich konzentriert sind, hat zu einer Vielzahl an Publikationen geführt, die sich mit den Determinanten von Innovation in erfolgreichen und meist urbanen Regionen beschäftigen. Die berühmten Beispiele Silicon Valley und Baden-Württemberg sind Inspiration für Maßnahmen auf der ganzen Welt, die Innovation durch Agglomeration stärken möchten. Die zugrunde liegende Idee ist dabei, dass Innovation in den Zentren der gesamten Wirtschaft nützt und damit schlussendlich allen zugutekommt.

Allerdings zeigt sich eine zunehmende Unzufriedenheit mit diesen Annahmen. Erstens lässt sich Innovation auch in peripheren und ländlichen Gebieten beobachten, die oftmals in der räumlichen Innovationsforschung übersehen werden. Zweitens werden Innovationsprozesse in Stadt und Land häufig als streng voneinander getrennt betrachtet. Es gibt kaum Forschung, die die Beziehung zwischen urbanen und ländlichen Regionen in Innovationsprozessen untersucht. Drittens nehmen regionale Disparitäten derzeit zu und es scheint, als würde Innovation in urbanen Clustern diese Entwicklung eher verschärfen, anstatt sie abzumildern.

Vor diesem Hintergrund zielt die vorliegende Dissertation darauf ab, einen Beitrag zu aktuellen Debatten innerhalb der Disziplin zu leisten. So werden explizit Innovationen in peripheren Regionen berücksichtigt und theoretische Weiterentwicklungen sowie empirische Ergebnisse vorgestellt. Schließlich werden auch Handlungsempfehlungen für eine raumsensible Innovationspolitik diskutiert, die einen Beitrag dazu leisten könnten, der ungleichen räumlichen Entwicklung entgegenzuwirken.

Die Ergebnisse zeigen, dass die Forschung zu Innovation in der Peripherie zunimmt. Allerdings ist die Präzisierung des Peripheriekonzepts notwendig, auch um die Vergleichbarkeit der vielen Fallstudien zu gewährleisten. Folglich schlägt die vorliegende Dissertation ein Framework vor, das detailliert die Stärken und Schwächen von Regionen hinsichtlich Innovation verdeut-

licht. Ein solches Raumverständnis, das über die starren Pole von Kern und Peripherie hinausgeht, ist zielführender, um Innovation im Raum zu untersuchen. Abschließend zeigt die Fallstudie, dass innovative Unternehmen in der Peripherie vielfältige Strategien entwickelt haben, um mit großen Distanzen umzugehen.

Die vorliegende Rahmenschrift stellt einerseits die Hauptergebnisse der drei wissenschaftlichen Aufsätze vor, die das Kernstück dieser Dissertation bilden. Andererseits behandelt sie die übergreifenden Forschungsfragen, diskutiert die Rolle von Innovation in der Wirtschaftsgeographie und die theoretischen Grundlagen. Darüber hinaus werden aktuelle räumliche Trends im Untersuchungsgebiet Österreich beleuchtet. Zusätzlich geht die Rahmenschrift auf das zugrunde liegende Paradigma des Kritischen Realismus ein. Diese ontologischen und epistemologischen Perspektiven sind die Grundlage für eine Methodologie, die quantitative und qualitative Ansätze kombiniert. Eine Zusammenfassung, Schlussfolgerungen, Handlungsempfehlungen und Möglichkeiten für zukünftige Forschung bilden den Abschluss.

1 Introduction

The interplay between agglomeration and innovation has been one of the main interests of the discipline of economic geography and scholars have produced an impressive body of work on this issue (Shearmur [2012](#)). Since Marshall ([1919](#), p. 284) introduced the notion of industrial atmosphere in his seminal work on Sheffield (United Kingdom) and Solingen (Germany), the question concerning the ways in which innovations are brought forward through the spatial proximity of the relevant actors became a focal point. The strong performance in the 1980s and 1990s of regions like the Third Italy (Bagnasco [1977](#); Piore and Sabel [1984](#); Scott [1993](#)), Silicon Valley (Saxenian [1991, 1994](#)) and Baden-Württemberg (Cooke and Morgan [1994](#); Strambach et al. [2001](#)) have spurred the interest in such spatially concentrated clusters. Consequently, these three regions have become the most famous examples for the idea that economic prosperity might be linked to short distances and the clustering of certain industries.

In subsequent years, these instances served as blueprints for a group of theoretical frameworks, the so-called Territorial Innovation Models (TIMs) (Moulaert and Sekia [2003](#)). Clusters (Porter [1998, 2008](#)), Regional Innovation Systems (RISs) (Braczyk et al. [1998](#); Cooke et al. [2004](#)) and Innovative Milieus (Maillat and Lecoq [1992](#); Maillat [1998](#)) belong to this theoretical family and have been influential also in economic policy. However, policies based on these concepts have not always led to prosperity (Martin and Sunley [2003](#); Cooke [2012](#)). In addition, the definitions of

clusters and RISs are blurry and some scholars are suggesting that a strict reading of the literature would mean that there are no true clusters or RISs beyond the three examples mentioned above (Doloreux and Parto [2005](#), p. 142).

Economic geography has subsequently produced a deep understanding of the dynamics of urban and regional innovation systems all around the globe, focusing largely on best-practice examples. In this “world of regions” – as denoted by Scott ([2000](#), p. 492) – questions of uneven regional development have faded into the background of scientific interest since the heydays of polarisation theories in the 1950s (Myrdal [1957](#); Hirschman [1958](#)) and the work of Harvey ([1982](#)) and Massey ([1984](#)). This is linked to the pro-innovation bias in the public perception but also in the scientific debate (Godin and Vinck [2017](#)), which implies that innovation in core areas will benefit everyone. The result was regional policies based on the migration of people towards economic centres, rather than place-based approaches, leaving the periphery behind (Rodríguez-Pose [2018](#)).

Hence, some scholars are advocating a shift of interest in economic geography. Martin ([2016](#), p. 436) for example sees the transition “from ‘winner take all’ to ‘fairness for all’” as one of 20 challenges for innovation studies. In a similar vein, Phelps et al. ([2018](#), p. 237) argue for a deeper interest in uneven development and what they call “the dark side of economic geography”. In a globalized and knowledge-based economy, peripheral regions are indeed obliged to pursue innovative activities to counter depopulation and ageing.

However, there is an “innovation paradox” in the periphery: On a systemic level, public funds to stimulate innovation are usually high in these regions, but the capacity to translate them into new products and services is relatively low (Oughton et al. 2002, p. 98). On the individual level, this means that the actors in these areas are supposed to be innovative, but they often lack the relevant qualifications (Andersson 2009, p. 198).

However, beside the dominant focus on innovation in core areas and the numerous challenges peripheries face towards innovation, there is a growing interest within economic geography in innovative behaviour off the beaten track. Research on entrepreneurship (Baumgartner et al. 2013; Müller 2016) and innovation (Eder 2019a) in peripheral regions has therefore been accumulating in the recent years, leading to theoretical advances and empirical evidence. This work has helped to challenge the “urban bias” (Shearmur 2017, p. 440) in innovation studies and acknowledges that innovation processes in remote areas differ from those in urban environments (Davies et al. 2012; Isaksen 2015; Shearmur 2015; Isaksen and Karlsen 2016; Shearmur and Doloreux 2016). It has furthermore shown that innovation is not inherent to urban areas, but that it can also be observed in remote locations. The question remains, however, why so many peripheries then struggle to enter more promising economic paths (Shearmur 2017).

Against this background, the dissertation at hand draws on recent debates within economic geography. It provides an overview of the research on innovation in the periphery, proposes a more nuanced understanding of advantaged and disadvantaged regions in conceptual terms, and provides empirical evidence on the innovation process in peripheral regions. As such, it contributes to a detailed understanding of the geography of innovation and informs spatially sensitive innovation policies, which aim to overcome one-size-fits-all-approaches (Tödtling and Trippel 2005). An example for such modern policies are Smart

Specialisation Strategies (S3s), which have been implemented in current EU policies (Foray 2014, 2018).

1.1 Introduction

The overall aim of the dissertation is to contribute to a more nuanced understanding of innovation in peripheral regions, both theoretically and empirically. As such, the overall research question (RQ) reads as follows:

What are the characteristics of innovation in peripheral areas and what are the preconditions for and the characteristics of innovation processes in the periphery?

Answering this overarching RQ is achieved with the three scientific articles that constitute the dissertation. These papers address different desiderata in the existing literature, which are outlined below based on the state of the art.

1.1.1 Innovation and space: the predominance of core regions

The relationship of agglomeration and innovation is a key question of economic geography (Simmie 2005). In classical location theory (Weber 1909; Thünen 1910), cost advantages concerning land prices and transport constituted the most important factor for explaining economic activity. However, since Marshall's (1919, p. 284) notion of “industrial atmosphere”, it has become consensus that the centrality of places provides more than savings alone. Scale, localization, and urbanization economies allow firms to enhance their efficiency and to benefit from local knowledge spillovers, labour pooling, and urban diversity. These ideas have later been incorporat-

ed into endogenous growth models (Arrow 1962; Romer 1986, 1990), in order to test the influence of economic clustering on economic performance. Paying tribute to Marshall, Arrow, and Romer, these externalities have been labelled MAR externalities (Glaeser et al. 1992; Beaudry and Schiffauerova 2009; Caragliu et al. 2016).

A second set of externalities stems from the seminal work of Porter (1990), who later emphasized a regional perspective in his influential cluster theory (Porter 1998, 2003, 2008). This approach highlights the role of fierce competition amongst firms specialised in the same industry, which is expected to spur innovation. In other words, firms that are not innovative will not survive (Beaudry and Schiffauerova 2009). These POR externalities therefore have much in common with MAR externalities, as they focus on positive spillovers from specialised and clustered expertise in certain industries (Glaeser et al. 1992; Caragliu et al. 2016).

In contrast to specialization, the importance of diversity as another precondition for innovation has been advocated in the work by Jacobs (1969). The emphasis lies on cities and the concentration of creativity and different industries, allowing for cross-fertilization of ideas not only in formal, but also in informal settings. In contrast to scale economies, this underlines the role of spillovers from unrelated industries for innovation. The more diverse a city, the more potential it therefore possesses for experimentation and innovation. Consequently, they are coined JAC externalities (Beaudry and Schiffauerova 2009; Caragliu et al. 2016).

JAC externalities have more recently gained influence again through the popularity of the “creative class” concept (Florida 2004) and the (un)related variety approach (Frenken et al. 2007). The latter distinguishes between related variety, which means diversity between related industries, increasing the likelihood of knowledge spillovers, and unrelated variety, which encompasses diversity between different, unrelated sectors. This more

fine-grained view on diversity suggests that regions with unrelated variety and therefore a larger portfolio of sectors should be relatively well protected against external shocks and unemployment, while related variety provides the greatest potential for knowledge spillovers and thus for economic growth. As such, the approach also suggests that job creation based on innovation is more likely in agglomerations, scoring high on both related and unrelated variety, while less-densely populated areas could benefit through higher productivity by saving labour-costs (Frenken et al. 2007). In a recent review of studies based on this concept, Content and Frenken (2016) find that empirical work indeed confirms the relationship between related variety and economic growth.

MAR, POR, and JAC externalities have been widely adopted in economic geography, regional studies, and the public and political debate. They convincingly underline why innovation has been conceptualised in the last decades as a regional and urban phenomenon (Maillat and Lecoq 1992; Florida 1995; Morgan 1997; Braczyk et al. 1998; Maillat 1998; Moulaert and Sekia 2003). As Shearmur (2012, p. 9) points out, there now is a plethora of books and papers on the relationship of cities and innovation. For example, in his influential book the “Triumph of the City”, Glaeser (2011) proclaims that cities are believed to provide the solutions for the challenges of mankind. Similarly, Florida et al. (2017, p. 93) conclude that “innovation and entrepreneurship do not simply take place in but *require* cities” (original emphasis).

In contrast to this extensive work, research on innovation in the periphery is in its infancy: clusters and agglomerations have by far received more scientific attention (Shearmur 2012) and as demonstrated above, theories of innovation rely almost exclusively on urban experiences. This focus on research and development (R&D), high tech, radical innovations, and patents as the most common indicator for innovation has been labelled “urban bias” in innovation studies (Shearmur 2017,

p. 440). However, as regional disparities are increasing (Iammarino et al. 2019) and populism is prevalent in struggling regions (Essletzbichler et al. 2018; Rodríguez-Pose 2018), place-based innovation policies for peripheral areas are in demand, leading to an increased attention by academia, policy makers, and the general public.

Obscured by striking examples such as that of Silicon Valley (Saxenian 1991, 1994) and by the political acclaim for theoretical ideas such as clusters (Martin and Sunley 2003), scepticism towards the idea that regional attributes spur innovation has remained rare and often barely noticed. Kleinknecht and Poot (1992) for example investigate the spatial distribution of R&D by firms in the Netherlands and find no differences in R&D spending between urban and rural firms, the exception being service industries in the largest cities of the country. More recently, Tödtling et al. (2009) have shown that central and remote firms in Austria display similar levels of collaboration with universities and business organizations as well as similar levels of R&D. In the United Kingdom, original innovation also occurs to the same degree in central and more peripheral areas (Lee and Rodríguez-Pose 2013).

Scholarly criticism focuses on the indicators used to measure innovation (Davies et al. 2012; Shearmur 2015; Isaksen and Karlsen 2016) and on the bias towards high-tech industries, overlooking innovation in more traditional sectors (Alderman 1998) and low- and medium-tech industries (Hirsch-Kreinsen 2008; Hirsch-Kreinsen and Jacobson 2008; Robertson and Smith 2008; Robertson et al. 2009). Also, most theoretical ideas such as the (un)related variety approach stem from the urban experience and are unsuitable to explain innovation in peripheral areas. In this regard, other recent theoretical concepts are more helpful (for a detailed discussion see Section 2). For instance, the proximities approach (Rallet and Torre 1999; Boschma 2005; Torre and Rallet 2005; Knoblen and Oerlemans 2006) has highlighted that geographical proximity is no prerequisite for

collaboration and that too much proximity might even increase the danger of lock-in. As such, Boschma (2005) argues that it can be substituted by cognitive, organizational, social, or institutional proximity.

Other concepts like innovation modes (Jensen et al. 2007; Isaksen and Karlsen 2012) and knowledge bases (Laestadius 1998; Asheim and Gertler 2005; Asheim and Coenen 2006; Asheim 2007; Asheim, Coenen, Moodysson, et al. 2007) emphasize the different origins and outcomes of innovations. The Doing, Using, and Interacting mode (DUI) and the synthetic knowledge base describe innovations that are not primarily science driven and are therefore not spatially bound to agglomerations. In addition, the idea of global pipelines underlines the importance of trans-regional and international connections (Bathelt et al. 2004). As the knowledge economy becomes more and more specialised in niches, partners for collaboration are spread around the globe and are rarely found within the same region or city (Howells 2012).

However, in comparison to the study of innovation in agglomerations, the research on innovation in the periphery lacks similarly influential and acknowledged frameworks as the readily available concepts for the research on agglomerations. Although there are first attempts to theorize on the specifics of peripheral innovation processes (Shearmur 2015; Shearmur and Doloreux 2016; Eder and Trippel 2019), more theoretical and empirical efforts are needed. Therefore, the dissertation at hand relates to these debates through the first sub-question (RQ 1):

What are the challenges for innovation in the periphery and what are the characteristics of non-core innovation processes?

By doing so, this dissertation provides a critical survey on the state of research on innovation in peripheral areas (Eder 2019a). This systematic literature review also contributes to the discipline by structuring and guiding

this emerging strand of research and by identifying avenues for future work. Some of these desiderata in the literature are addressed in further parts of the dissertation.

1.1.2 Innovation and peripheralization: the regional preconditions

As pointed out above, the majority of the literature attributes innovation to agglomeration effects. However, the definition of what qualifies as a central and what as a peripheral region is still often based on static and simplistic indicators like accessibility and population density, which are changing only gradually over time, if at all (Kühn and Weck [2012](#); Eder [2019a](#)). One of the most common delimitations is the one defined by the OECD, which applies a threshold of 150 inhabitants/km² to distinguish urban from rural municipalities and regions (OECD [2011](#)). More recent approaches based on grid cells overcome the issue of often arbitrary administrative borders, but are still emphasizing population density (EUROSTAT [2010](#)).

Scholars have increasingly expressed their discontent with such a simplistic periphery concept and have argued for the incorporation of functional indicators (Eder [2019a](#)). Consequently, ideas from neighbouring disciplines such as demography, sociology, and political science have been incorporated into economic geography to investigate the regional preconditions for innovation in a more nuanced way. In this regard, the peripheralization discourse has been influential (Crone [2012](#); Kühn [2015](#)). It highlights a process perspective (peripheries are not given, but constructed) and the various dimensions of this process, namely political, economic, social, and communicative factors (Kühn [2015](#), p. 369).

Relating to JAC externalities, one stream of the literature focuses on demographic factors and the diversity of the workforce. Hunt and Gauthier-Loiselle ([2010](#)) show for the

US that the many scientists and engineers amongst immigrants display higher patenting rates than the domestic population. At the firm level, above-average diversity also contributes to higher innovation rates (Lee [2014](#); Ozgen et al. [2014](#)). This relationship is furthermore found at the regional level, where areas with a higher share of immigrants tend also to be those with the highest innovative output (Poot [2008](#); Niebuhr [2010](#); Maré et al. [2014](#); Ozgen et al. [2015](#)). This emphasizes the advantages of urban environments for innovation, but recent work has shown that firms in the periphery are also able to create diversity and to reap its benefits (Solheim [2016](#); Meili and Shearmur [2019](#)).

Another factor is demographic ageing, one of the main demographic trends in developed nations. Research confirms that younger individuals are usually more likely to found firms and to introduce new products (Bönte et al. [2009](#)). However, although most studies assume the peak of innovativeness between 30 and 50, the evidence is inconclusive and depends on the industry and qualification of each individual (Frosch [2011](#)). Again, rural and remote areas are often those where demographic ageing is most pronounced and firms in such regions need to develop concepts to counteract these developments (Leick and Ströhl [2013](#); Leick [2019](#)).

Human capital is one additional demographic dimension that is discussed in the literature. As most scholars in economic geography emphasize the importance of R&D for innovation, a tertiary educated workforce is often seen as crucial. Nevertheless, theoretical concepts such as that of differentiated knowledge bases highlight that on-the-job training and experience are also an important factor (Asheim and Gertler [2005](#); Asheim [2007](#)). Empirical work confirms that if vocational education systems have been successfully modernized, they indeed convey crucial qualifications to their alumni (Moodie [2006](#); Bosch and Charest [2008](#)). Inhabitants of peripheral regions often have gone through such vocational training programmes. Accord-

ingly, in more traditional sectors or in cases where work experience is crucial, conditions for innovation might be favourable (Davies et al. [2012](#); Isaksen and Karlsen [2016](#); Shearmur [2017](#)).

Beside the demographic dimension, other elements of peripheralization have been investigated, although to a lesser degree. For example, Rodríguez-Pose and Di Cataldo ([2015](#)) have addressed the political dimension, analysing the influence of the quality of government on regional innovation practices. They find that corrupt governments and weak support are limiting innovation in peripheral regions. Additionally, Gherhes et al. ([2017](#)) focus on the communicative dimension and stigmatization, by showing how negative perceptions of a region suppress entrepreneurial ambition across generations. So far, it has mainly been Kühn and his colleagues that have attempted to analyse the various dimensions simultaneously (Kühn and Weck [2012](#); Kühn and Miltrey [2015](#); Kühn et al. [2017](#)).

This research has provided insights into the regional preconditions for innovation and into the specific challenges in peripheral regions. It also moved beyond the classical understanding of the core-periphery dichotomy based on accessibility and population density. As such, it suggests manifold dimensions and indicators along which the degree of peripheralization and/or centralization can be analysed in order to arrive at a more nuanced picture of the geography of innovation. In other words, it is a toolbox for the detailed analysis of the strengths and weaknesses of a region. However, a more detailed understanding of the periphery also entails a certain complexity, making it difficult for scholars and policy makers to work with the concept. Markusen ([1999](#), p. 870) has labelled such approaches “fuzzy concepts” and this critique is acknowledged by the proponents of peripheralization (Crone [2012](#); Kühn [2015](#)). Nevertheless, Kühn ([2015](#)) argues that there is common ground in geographic, economic, social, and political conceptualizations of the term “pe-

riphery”. Consequently, there is a foundation for further exploring the promising potential of the peripheralization discourse.

Against this background, this dissertation aims to contribute to this emerging field and to provide a detailed assessment of peripheralization in Austria, going beyond population density and accessibility. Hence, this analysis is also a step towards a more comprehensible and fine-grained periphery concept in innovation studies, which highlights the diversity of peripheries, but also of urban areas. The next sub-question therefore focuses on the detailed spatial pattern for innovation in Austria (RQ 2):

What are the key dimensions of capturing the preconditions for innovation in the periphery, and which roles do geographic, demographic, and economic factors as well as knowledge bases play?

Hence, this analysis contributes to the peripheralization literature and provides the basis for the subsequent empirical case studies of the dissertation.

1.1.3 Innovation and spatial proximity: the actual usefulness of local buzz

Marshall ([1919](#), p. 271) described “mysteries in the air” about trade, which every child would learn about unconsciously when growing up in an industrial district, giving residents of such areas a distinct advantage for pursuing economic activities. Since then, the idea that economic actors benefit from being located in certain places has been present in economic geography. This assumption gained further momentum in the 1980s with the formation of the Groupe de Recherche Européen sur les Milieux Innovateurs (GREMI), a research group of French sociologists and regional scientists. GREMI advocated the idea of the “innovative milieu”, which has been

influential in theory building and policy making. Similar to Marshall's mysteries, it focuses on informal social relationships that facilitate innovation and therefore economic activity, which is illustrated by Camagni's definition (1991, p. 3):

"An innovative 'milieu' may be defined as the set, or the complex network of mainly informal social relationships on a limited geographical area, often determining a specific external 'image' and a specific internal 'representation' and sense of belonging, which enhance the local innovative capability through synergetic and collective learning processes."

More recently, other scholars have labelled such phenomena as "noise" (Grabher 2002, p. 254) or "local buzz" (Bathelt et al. 2004, p. 36).

However, the proposition that the spatial proximity of competitors, suppliers, customers, service providers and a specialized labour market are the main preconditions for innovation has been challenged over the last years. Gordon and McCann (2005) as well as Huber (2012) find that innovative behaviour in London and in the Cambridge information technology (IT) cluster has little to do with co-location and short distances. Similarly, Aarstad et al. (2016) provide inconclusive evidence regarding local buzz and trans-regional knowledge sources, so-called global pipelines (Bathelt et al. 2004). While small enterprises (below 50 employees) show no differences in innovative output relying either on local buzz or global pipelines, there is a positive effect for bigger small and medium sized enterprises (SMEs), i.e. those with more than 50 employees. Seemingly, only major enterprises possess the resources necessary to harvest the potential of regional and trans-regional collaboration. Fitjar and Rodríguez-Pose (2017, p. 37) even reject Marshall's mysteries entirely, concluding that "little" or "nothing is in the air", but that collaboration nowadays rests on purpose-built searches.

This challenges the still dominant paradigm of TIMs, such as the cluster theory and its assumption of increasing competitiveness through co-location with relevant competitors, as suggested by Porter (1998, 2008). It also supports the hypothesis of the "death of geography" (Morgan 2004, p. 4) and hints at the global distribution of expertise in niches. In a specialised knowledge economy, firms and workers are increasingly specialised and therefore become more isolated at their location. Consequently, there is a growing need for trans-regional and international collaboration (Howells 2012). In a similar vein, theoretical concepts such as the proximities approach highlight that geographical proximity is not necessarily beneficial for innovation. Collaboration in innovation projects can also be built upon cognitive, organizational, social, and institutional proximity. Additionally, being too close to partners along these dimensions even bears the danger of lock-in and eventually economic decline (Boschma 2005).

These empirical observations and theoretical underpinnings might explain the occurrence of innovation in peripheral regions, which is highlighted by a growing number of scholars (Eder 2019a). Since this obviously is a contested field, the dissertation also aims to focus on the ways in which firms deal with the lack of geographic proximity in peripheral contexts, which is addressed with a further sub-question (RQ 3):

How do innovative firms deal with location advantages and disadvantages in organizationally as well as institutionally thin environments?

1.1.4 Innovation and policy: the need for place sensitivity

As pointed out above, the analysis of economic phenomena in space lies at the core of economic geography. This analysis often provides insights into the underlying causes

for regional well-being or decline. Therefore, the discipline also aims to inform policy makers with theoretical concepts and empirical evidence to initiate, strengthen, or adjust regional development. Innovation policies are therefore increasingly seen as an option towards addressing market failures which for instance result in uneven spatial development (McCann and Ortega-Argilés 2013). In this regard, concepts such as clusters (Porter 1998, 2008) or RISs (Braczyk et al. 1998; Cooke et al. 2004) have successfully entered the policy arena. However, these older often broadly defined concepts did not always yield the intended outcomes, since one approach might work in one region and fail in the other. Furthermore, there is widespread consensus now that successful clusters and RISs can hardly be constructed from scratch (Martin and Sunley 2003; Cooke 2012). One reason is that policies have often been derived from best practice examples in central and high-tech regions (Tödtling and Trippel 2005).

Hence, in their frequently cited paper, Tödtling and Trippel (2005) argue for overcoming “one-size-fits-all” solutions in favour of place-based approaches, outlining directions for central, peripheral, and old-industrial regions. As a result, the paradigm of place-based policies has entered the policy discourse over the last years and is favoured over place-neutral approaches (Barca et al. 2012). In this vein, Rodríguez-Pose (2018) argues that they are especially important for regions in which people feel left behind, making them prone to populist ideas. Nevertheless, the evident need for place-based policies also increases the complexity of innovation policy, as even central, peripheral and old-industrial regions are far from uniform. Although areas falling in these common and frequent categories share some similarities, Morisson and Doussineau (2019, p. 102) highlight additional dimensions by stating that

“regions are, however, highly unequal when designing and implementing place-based policies due to differences in

the quality of their governments (Charon et al. 2014), their capacities to absorb funds (Oughton et al. 2002), and their institutional capabilities (Farole et al. 2011).”

This leads to the question whether, in a world with extremely diverse regions, recommendations for innovation policy are even possible or whether every region requires tailor-made concepts based on a detailed analysis of the strengths and weaknesses of the region in question. As such, scholars have become careful when formulating policy recommendations based on their research by including disclaimers that the findings are highly place-specific and must not be transferred uncritically to other places. Certainly, some things can be learned from case studies, and thus it appears that a middle ground might be most promising. A sound knowledge of general policy approaches should form the basis for translating these into place-based policies. S3s represent a major attempt to foster various kinds of innovation both in strong and weak regions and to develop place-based solutions (Foray 2014, 2018).

In addition to the shift from place-neutral to place-based policies, another general transition in the principles of innovation policy can be observed. While TIMs did focus on the benefits of spatial clustering, more modern approaches tend to highlight the importance of trans-regional knowledge networks (Bathelt et al. 2004). This is underpinned by empirical work, which highlights that firms with more international partners tend to be more innovative (Rodríguez-Pose and Fitjar 2013; Fitjar and Huber 2015). In this regard, platform policies have become more frequent, in which policy makers try to spread new knowledge (e.g. about innovation also from outside the region and from industries in unrelated sectors) within the region. Highlighting new technologies and potential partners from abroad then provides potential for the local development of new products and ser-

vices (Asheim et al. [2011](#); Cooke [2012](#)). As such, platform policies incorporate ideas from the (un)related variety literature and are in opposition to traditional cluster policies based on spatial concentration and specialisation.

Although progress has been made in modernizing innovation policy, further insights can still contribute to a better design of place-based policies, especially in peripheral areas where there often is a mismatch between intended and actual results (Eder [2019a](#)). As such, in addition to providing answers to the RQs introduced above, the empirical findings of the dissertation have potential to inform a spatially aware innovation and regional policy, such as S3s.

1.2 Overview of the articles

This section briefly introduces the main findings of the three papers that constitute this dissertation. As such, it highlights the theoretical underpinnings, the empirical approaches, and the relation to the research questions and gaps introduced above.

[Paper I](#), titled *Innovation in the Periphery: A Critical Survey and Research Agenda*, published in *International Regional Science Review* (Eder [2019a](#)), provides a thorough analysis of the state of the research of innovation in peripheral regions. Methodically, it constitutes a systematic literature review of the work on the subject conducted between 1960 and 2016. Theoretically, it highlights the approaches that have helped to explain innovative behaviour in peripheral areas in the aftermath of TIMs: the proximities approach (Boschma [2005](#); Torre and Rallet [2005](#); Knobens and Oerlemans [2006](#)), global pipelines (Bathelt et al. [2004](#)), innovation modes (Jensen et al. [2007](#); Isaksen and Karlsson [2012](#)), knowledge bases (Asheim and Coenen [2005](#); Asheim [2007](#); Asheim, Coenen, and Vang [2007](#)), and thin RISs (Trippel et al.

[2016](#); Isaksen and Trippel [2017b](#); Trippel et al. [2018](#)). Some of these approaches relate to the ideas of the Relational Economic Geography (REG), which emphasizes networks for economic activities (Bathelt and Glückler [2003](#)).

The review documents the increasing theoretical and empirical interest in innovation processes in peripheral areas and highlights a geographical bias towards Western and Northern Europe. It then turns to the preconditions for innovation in peripheral areas, their specific innovation processes, and the characteristics peripheral innovations exhibit. It further investigates the various periphery concepts, highlighting the many factors and scales that are applied. In addition, it critically questions the imperative towards innovation for peripheral areas and based on this discussion, the paper outlines directions for further research. By doing so, it relates mainly to RQ 1 and outlines a comprehensive picture of innovation in the periphery, providing guidance for other scholars and for the dissertation at hand.

[Paper II](#), titled *Peripheralization and knowledge bases in Austria: towards a new regional typology*, published in *European Planning Studies* (Eder [2019b](#)), introduces a framework for analysing the diversity of regions. This framework is based on the theoretical concepts of knowledge bases (Asheim and Gertler [2005](#); Asheim [2007](#); Asheim, Coenen, and Vang [2007](#)) and peripheralization (Crone [2012](#); Kühn [2015](#)). The core-periphery dichotomy is not approached by simplistic indicators such as accessibility and population density, but by combining geographic, demographic, and economic dimensions as well as knowledge intensity. The latter is conceptualised via regional knowledge bases, highlighting the foundation for innovation in the region. The framework is then applied to the 95 districts in Austria, using a weighted, additive index as suggested by Heintel et al. ([2017](#)).

The results demonstrate that an in-depth analysis of peripheralization and centralization provides a detailed picture of the

strengths and weaknesses of a region. Additionally, very few regions are either central or peripheral in all dimensions. Rather than emphasizing the poles of urban cores and peripheries, the discussion should acknowledge their multi-dimensional character, the process perspective, and the multi-scalarity of the peripheralization discourse. A detailed analysis following these principles provides a sound basis for policy makers trying to strengthen regions. It also facilitates the comparison of case studies, if the challenges of a region are made explicit in a transparent way. These questions lie at the heart of RQ 2, but also consider the policy dimension by providing insights on regional diversity. The first two papers provide the basis for the empirical case studies from peripheral regions. As such, they relate to RQ 1 and to questions of spatial proximity, which again informs place-based innovation policies.

Paper III, titled *Innovation in the periphery: Compensation and exploitation strategies*, published in *Growth and Change* ([Eder and Trippel 2019](#)), aims to provide insights in the characteristics of innovation processes in peripheral regions by adopting a novel perspective. As such, it not only focuses on the negative location factors innovative firms need to compensate for, but develops a framework including peripheral assets that firms can exploit. Theoretically, the paper draws on the proximities approach ([Boschma 2005](#); [Torre and Rallet 2005](#); [Knoben and Oerlemans 2006](#)), global pipelines ([Bathelt et al. 2004](#)), virtual and temporal buzz ([Bathelt and Henn 2014](#); [Maskell 2014](#); [Bathelt and Gibson 2015](#); [Bathelt 2017](#)), and the Multi-Level Perspective (MLP) ([Markard et al. 2012](#); [Smith and Raven 2012](#)). The empirical evidence is provided by 20 in-depth interviews with innovative firms in the Austrian periphery.

The qualitative data reveal that such firms indeed need to compensate disadvantages, mainly by strengthening the internal knowledge base and by maintaining external knowledge networks. In addition to these well-

known strategies, firms also establish branch offices in central regions to tap into diverse labour markets and increase their employer branding efforts in order to attract talent to remote regions. However, these firms also value their secluded environment, especially in terms of protection from labour poaching and undesirable knowledge spillovers. Another asset is the high institutional leeway innovators often experience in peripheries. For both compensation and exploitation strategies, firm size seems to be the determining factor. These insights into the innovation process followed by innovators in peripheral areas also highlight the potential for developing place-based policies which are not derived from urban experiences.

1.3 Structure of the thesis

The main part of this dissertation is constituted by three scientific articles that have already been published, either online and in print or online ahead of print. These articles are preceded by a framing text, which pieces together the separate parts and puts them into perspective. As such, this text is concerned with the overall contribution of the thesis, with theoretical as well as methodological issues, and with providing a synthesis of and conclusions regarding the main findings.

Following this introduction to the aims, the contribution, and the underlying research questions of the dissertation ([Section 1](#)), the remainder of the paper is organised as follows: [Section 2](#) adds the underlying theoretical foundation and discusses the theoretical concepts that informed the empirical analysis. It deals with the nature of innovation and its consequences for (uneven) regional development, thin RISs, innovation networks, and different routes for novelty. [Section 3](#) highlights some regional trends in Austria, as the country serves as the empirical example for this dissertation. [Section 4](#) focuses on the research

design by outlining epistemological and ontological perspectives, as well as on the methodology, the data, and the methods used in the dissertation. [Section 5](#) concludes the framing text and summarizes the main findings with regard to the research questions. Furthermore, it provides conclusions, policy recommendations and avenues for future research.

Afterwards, the three academic papers are presented. They have been written over a three-year period (i.e. between 2016 and 2019) and are either single-authored ([Paper I](#) and [Paper II](#)) or co-authored with a supervisor ([Paper III](#)). The articles are in chronological

order and follow a certain logic. [Paper I](#) provides an overview of the state of the art on the issue, identifying avenues for further research. Of these, two are taken up in the subsequent work. As such, [Paper II](#) proposes a new framework, going beyond simplistic periphery concepts, while [Paper III](#) provides insights into innovation processes of peripheral firms, also taking benefits of such locations into account. Consequently, this dissertation offers a comprehensive picture of innovation in the periphery of Austria. However, the results are also of relevance to the wider scientific and theoretical debates within the discipline.

2 Theoretical background: innovation and uneven space

This section aims to provide the theoretical underpinning for the overarching theme of this dissertation, which can be summarized as innovation and uneven space. Hence, it complements the more narrow theoretical discussions in the scientific articles, which focus on specific questions, with a broader perspective on uneven regional development. It introduces the notion of innovation and subsequently reflects on the way in which spatial unevenness is conceptualised in economic geography and on the role played by innovation in aggravating or mitigating these tendencies. Thereafter, the section turns to theoretical concepts that shed light on the preconditions for innovation in peripheral areas. As such, it highlights the systemic character of innovation and the differences of thick and thin RISs, the former usually found in strong, the latter in weak regions. Networks are an integral part of such innovation systems, and as innovation increasingly occurs in niches, trans-regional collaborations are becoming more important. Moreover, these networks might lead to different innovations, based on diverging knowledge sources, norms, and habits in the various sectors that are also unevenly distributed across space. By reviewing these issues, this section provides an overview of the theoretical assumptions regarding the reasons for, means of, and places in which innovation occurs, and why this varies across regions. Thus, it grounds the dissertation in historical and recent discourse.

2.1 Economic geography: innovation in regional contexts

Innovation currently ranks high on the policy agenda, but this has not always been the case. Until World War II, research focused mainly on the allocation of resources necessary for innovation, while the innovation process itself remained obscure. This so-called “black box” of innovation remained largely untouched, as social scientists assumed that an explanation of the ways in which innovation occurs was too complicated and therefore impossible (Fagerberg 2005). This has obviously changed in the last decades. Today, innovation studies represent an interdisciplinary field with a vast number of publications.

Under these circumstances, it is not surprising that there is no single definition for innovation. Nevertheless, reviewing 60 definitions of innovation from various disciplines, Baregheh et al. (2009, p. 1334) suggest that

“innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace.”

This concise definition reflects important achievements in the theoretical discussion on innovation. First, it includes the fundamental distinction between invention (“ideas”) and innovation (“new/improved products, services or processes”). Here, invention describes

ideas that appear for the first time, sometimes lacking their immediate application. In contrast, innovation can be seen as the first attempt that is made to bring an idea to market maturity and to harness the rewards of the long development process. As such, invention and innovation are often linked, but the time span between the two instances varies greatly (Fagerberg 2005), often leading to a lag between the first occurrence and the economic significance of an idea (Edquist 1997).

Second, the definition by Baregheh et al. (2009) displays that research has come a far way. The *linear model of innovation*, which dominated the discourse after World War II, describes only four consecutive steps: (1) research, (2) development, (3) production, and (4) marketing. This neglects the incremental character of innovation, ignores the various feedback loops, and overemphasizes research (Kline and Rosenberg 1986; Fagerberg 2005). In contrast, the *chain-linked model of innovation* redefines and expands the steps to five: (1) identifying the potential market, (2) inventing and/or producing the analytic design, (3) detailed designing and testing, (4) redesigning and production, as well as (5) distribution and marketing. In addition, it acknowledges the many connections with research institutes, the available knowledge, and the iterative character of each step. Accordingly, this model relates to the “multi-stage process” mentioned in the definition, which can lead to a complete reset of the innovation process (Kline and Rosenberg 1986).

Similarly, Chesbrough (2003) introduced the paradigm of “open innovation”, which has largely replaced the paradigm of “closed innovation”. In a world of closed innovation, firms are conducting research, development, and marketing on their own and in isolation. In contrast, open innovation includes many sources of information in the innovation process, amongst others universities, competitors, suppliers, and customers. As such, the paradigm of open innovation describes modern innovation processes appropriately and has become highly influential in research,

policy making, and for the innovation strategies of firms (Huizingh 2011).

Third, Baregheh et al. (2009) underline that innovations are diverse and can relate to new products, services, or processes. In addition, organizational innovations can play a crucial role in gaining a competitive advantage (Fagerberg 2005). This diversity has already been taken up in the European Community Innovation Survey (CIS), which is based on the Oslo Manual and in which firms are asked whether they had recently introduced product (goods and services) or process innovations new to the firm or new to the market (OECD and EUROSTAT 2018). Such innovation surveys have therefore significantly improved the quality of available data over the last decades. Accordingly, these data sets created the opportunities for researchers to expand innovation studies.

As pointed out above, innovation studies today represent a multidisciplinary field and as such, each discipline contributes its specific angle to investigate different phenomena. Since the late 1970s and the mid-1980s, economic geography has added the “regional lens” and has focused on differences in space concerning innovation issues (Scott 2000). Geographers started to note the success of some specific regions like the Third Italy (Bagnasco 1977; Piore and Sabel 1984; Scott 1993), Silicon Valley (Saxenian 1991, 1994), and Baden-Württemberg (Cooke and Morgan 1994; Strambach et al. 2001) and have essentially put two questions on the research agenda: Why are some regions more innovative than others? How can innovation be fostered on a regional scale?

Along with this renewed interest in the spatial dimension of innovation in academia, (regional) policy makers became aware of the importance of innovation for economic well-being. As Shearmur (2012, p. 10) points out, this can be attributed to three decisive developments. First, the move from Fordism to post-Fordism shifted the attention of role players from state organization and major enterprises to innovation, competition, and

SMEs. Local and regional institutions became more important for achieving or maintaining prosperity in a global economy. Second, well-paying manufacturing jobs started to shift overseas. To stay competitive, Western countries felt increasing pressure to upgrade their economies by fostering innovation. Third, technological change has been incorporated in mathematical models, which resulted in the endogenous growth theory (see [Section 1.1.1](#)). This influential work once again underscored the importance of knowledge, information exchange, and learning processes for technological change, or in other words, innovation.

In the wake of these developments, academic concepts like RISs and their policy implications have been influential. They added a systemic perspective on innovation and strengthened the idea that the regional level is crucial for competitiveness in the global knowledge economy (Braczyk et al. [1998](#); Cooke et al. [2004](#)). As classical TIMs have not always yielded the intended results (Martin and Sunley [2003](#); Cooke [2012](#)), economic geographers are frequently emphasizing the importance of place-based approaches (Barca et al. [2012](#)). In this vein, the geography of innovation has produced an impressive body of case studies on innovation in spatially concentrated clusters and RISs (Shearmur [2012](#)). In addition, there are constant theoretical efforts to understand the diversity of RISs (Cooke [1998, 2004](#); Doloreux and Parto [2005](#); Asheim and Coenen [2006](#); Trippl et al. [2016](#); Isaksen and Trippl [2017b](#)) and to add a spatial dimension to concepts such as open innovation (Shearmur [2015](#); Shearmur and Doloreux [2016](#)).

Hence, the geography of innovation has successfully entered the field of innovation studies and questions of innovation performance and prosperity are increasingly discussed from a regional or spatial perspective. Against this background, this dissertation aims to contribute to current debates within the discipline, both theoretically and empirically. To achieve this, it identifies new avenues

for research ([Paper I](#), [Paper II](#), and [Paper III](#)), aims to provide a more nuanced understanding of regional preconditions of innovation ([Paper II](#)), and investigates the nature of peripheral innovation processes ([Paper III](#)).

2.2 Uneven regional development in economic geography

Seemingly, the discipline of economic geography is bound intrinsically to uneven space, as it has always been interested in the question why some places thrive while others struggle. As mentioned above, some argue that this regional lens is the distinct contribution of geography to innovation studies. In this regard, it deviates fundamentally from the neoclassical view in orthodox economics, which sees spatial disparities as transitory state, with market forces restoring the equilibrium over time. In the mainstream “regional orthodoxy”, the competitiveness of firms and regions stands above all; societal and spatial challenges are hardly acknowledged (Zeller [2003](#)). In contrast, economic geography proper, in relation to political economy, emphasizes the effects of capitalism on the diverging development of regions (Peck [2016, 2017](#)). In fact,

“in economic geography (...), the idea that political-economic transformations, capitalist and otherwise, are necessarily and inescapably characterized by uneven spatial development would later acquire something approaching foundational status, even if this was (sometimes) observed no more than implicitly, as a condition of existence for studies of localized economic formations, processes, and practices.” (Peck [2017](#), p. 2)

One of the first important theoretical contributions was the regional adaption of Perroux’s ([1950](#)) growth pole theory by Myrdal ([1957](#))

and Hirschman (1958). In contrast to focusing on the dominance of a certain economic sector, these authors emphasize the differences between regions. They distinguish between positive and negative feedback effects, arguing that these forces can tighten regional disparities over time, especially if some regions or countries experience a negative spiral caused by many factors reinforcing each other. Regional policy makers should therefore explicitly try to tackle these negative forces by actively engaging with these market failures. As such, the focus lies not on maximising efficiency as it does in neoclassical approaches, but on territorial cohesion (Maier et al. 2012).

Following these first theoretical efforts, the 1980s witnessed the publication of two other seminal books deeply concerned with uneven development. The first was *The Limits to Capital* by Harvey (1982), which can be seen as an attempt to radicalise human geography and to spread Marxist ideas within the discipline. As such, he emphasizes the inherent tendency for crisis in capitalism, which cannot be prevented by so-called “temporary” and “spatial” fixes. In other words, “uneven geographical development is an intrinsic, non-accidental part of capitalist life” (Castree 2008, p. 60). Second, Massey’s (1984) *Spatial Divisions of Labour* gained even broader attention, as it had more influence outside academia. Written at the time of profound capitalist restructuring in the UK in the 1970s and 1980s, it combines theoretical advances with empirical case studies to investigate uneven development in a comprehensive way (Phelps 2008).

This specific perspective of economic geography on regional disparities was at odds with the spread of neoliberalism in the political discourse of that time (Castree 2008). And as scholars rediscovered the virtues of industrial districts and agglomerations in the 1980s and 1990s (Scott 2000), some argue that this critical perspective on capitalism and spatial unevenness was lost in subsequent work. In the years to come, uneven development was increasingly taken for granted and did not rank high on the research agenda, neither

theoretically nor empirically (Peck 2016). As such, economic geographers have tended to ignore that the success of some regions comes at the expense of others that are disadvantaged. With regard to this observation, Phelps et al. (2018, p. 238) issue an “invitation to the dark side of economic geography”, encouraging scholars again to engage more explicitly with uneven regional development. In other words, struggling regions on all scales should feature more prominently in economic geographical research.

A certain renewed interest in these issues in fact has become evident in economic geography over the last years. There is a growing consensus that disparities are increasing on many scales and that this divergence is indeed hindering economic development, social and territorial cohesion, as well as political stability (Iammarino et al. 2019). For many years, people-based policies have focused on facilitating the move to economically prosperous regions, while place-based approaches were largely neglected. However, this focus on economic powerhouses has led to a “revenge of the places that don’t matter” (Rodríguez-Pose 2018, p. 190) through a rise of populism, underlining the need for a more intensive and renewed debate about uneven development (Peck 2016; Phelps et al. 2018).

One recent theoretical advancement is the introduction of the notion and the concept of peripheralization. It rejects the static idea of periphery, which rests on geographical distances and population density, in favour of a dynamic understanding. Additionally, it moves beyond rural as well as border regions and suggests that these processes can lead to a peripheral position on many scales (for example regional vs. national). Finally, by conceptualizing peripheries as socially constructed and as process-centered, peripheralization acknowledges the potential that a region might become central over time, although a manifestation of undesirable developments is also possible (Kühn 2015; Kühn et al. 2017).

In this regard and similar to the arguments of Myrdal (1957), modern conceptualizations

Periphery Pre-given spaces—with social implications Fringes, edges, outskirts, borders	Peripheralization Social relations—with spatial implications “Production” of peripheries
Status: static <ul style="list-style-type: none"> Distance to centres Remote location Sparse population 	Processes: dynamic <ul style="list-style-type: none"> Political Economic Social Communicative
Fields of application: non-urban <ul style="list-style-type: none"> Rural regions Border regions Suburban fringes 	Fields of application: open <ul style="list-style-type: none"> Developing countries Urban regions and cities Rural (non-metropolitan) regions Urban neighbourhoods
Conditions for actors: fixed <ul style="list-style-type: none"> Determined by structural deficits Periphery as “destiny” 	Conditions for actors: changeable <ul style="list-style-type: none"> Role of periphery in a system changes Actor networks matter

advocate policy interventions towards territorial cohesion. Innovation policy has therefore entered mainstream politics as a means of addressing market failures such as increasing regional disparities on various scales (McCann and Ortega-Argilés 2013). Although the concepts and contributions of economic geography proper are often overlooked (Peck and Sheppard 2010), the interest of economic geographers in innovation processes in peripheral regions is on the rise again. This incorporation of “the dark side of economic geography” (Phelps et al. 2018) contributes to accumulating the necessary knowledge for tailor-made and place-based policies (Eder 2019a).

2.3 Thick and thin regional innovation systems

Differentiated RISs represent one way to approach the different preconditions for innovation and thus for economic prosperity in bright and dark regions. This approach builds on the interactive model of innovation and emphasizes that innovation emerges not in isolation, but in a system that consists of a network of all relevant actors: customers, suppliers, competitors, educational institutions, organisations,

and policies (Cooke 1992; Cooke and Morgan 1994; Cooke et al. 1997; Autio 1998). While this approach was originally developed on the national scale and termed National Innovation Systems (NISs) (Freeman 1988; Lundvall 1992; Edquist 1997), the regional perspective became dominant in the 1990s. Nevertheless, it is acknowledged that RISs do not operate in isolation, but that national and supranational bodies as well as trans-regional collaboration are crucial (Cooke et al. 1997; Braczyk et al. 1998). The empirical analysis of the concept has shown that due to these complex networks and differences in the organizational and institutional setting, RISs come in many shapes (Braczyk et al. 1998; Cooke et al. 2004; Zukauskaitė et al. 2017).

This might not come as a surprise, since one distinctive feature of RISs in comparison to other TIMs is that this variety already exists in the theoretical foundation. Cooke (1992, p. 370), as one of the earliest proponents of this concept, for example distinguishes between grassroots (predominately local), network (multi-level), and dirigiste (top-down) forms of governance support for firms. He later adds the dimension of business innovation, which can be localist, interactive, or globalised. As such, Cooke (2004, p. 15) provides a matrix and examples of nine different RISs. However, the empirical basis for this framework mainly comprises best practice examples such as that

Table 1: Periphery vs. Peripheralization (Source: Kühn 2015, p. 369)

of Baden-Württemberg. While this demonstrates that the concept is open to plurality, it also illustrates the focus on core regions.

Since this dissertation investigates innovation in remote environments, other typologies highlighting the challenges between the RISs of central and more disadvantaged regions are also helpful. Tödtling and Tripl (2005) for instance distinguish three broad types: First, metropolitan regions are those which often possess a well-functioning RIS. However, some might experience fragmentation, for instance due to the lack of specialisation and due to absent networks. Second, old industrial regions usually suffer from a predominance of declining sectors like heavy industry. Innovation networks are therefore limited by functional, cognitive, and political lock-ins, which hinders renewal. Third, by definition, the necessary foundations of a RIS are absent in peripheral regions. These include the lack of a critical mass of firms and weak support organisations. In other words, so-called “organizationally thin” regions often experience a less intense circulation of knowledge.

This organizational thinness has recently been complemented by the notion of institutional thinness, providing a more detailed picture (Zukauskaitė et al. 2017). In conjunction, both can be used to further specify the weaknesses of a RIS:

“Organizational thickness (thinness) refers to the presence (absence) of a critical mass of firms, universities, research bodies, support organizations, unions, associations, and so on. Institutional thickness (thinness) is defined as the presence (absence) of both formal institutions (laws, rules regulations) and informal institutions (such as an innovation and cooperation culture, norms, and values) that promote collective learning and knowledge exchange.” (Tripl et al. 2016, p. 26)

Hence, both central and peripheral regions can suffer from different forms of thinness,

but in the latter, both dimensions are usually only developed weakly. However, these typologies suffer from several inconsistencies of the RIS concept that are similar to those of other TIMs; for example, they are lacking a comprehensive framework and shared definitions. As summarized by Doloreux and Parto (2005, pp. 141-147), first, the borders between the types of RISs are opaque and overlapping, as there are no detailed guidelines for classification. Second, there is the implicit assumption that RISs can be found everywhere, indicating a certain fuzziness of the concept. Third, RISs are described on various scales, from inner-urban to NUTS-II regions. As such, it remains unresolved where the borders of a RIS should be drawn, especially if it is increasingly integrated into international networks.

Notwithstanding this criticism, RISs offer an acknowledged theoretical perspective that informed this dissertation and constituted one of the criteria for selecting the case studies. The outlined issues of scale and delimitation were amongst the reasons for not explicitly addressing RISs in the papers. Nevertheless, this dissertation relates to the discussion above regarding the empirical work (Paper III), as innovators in the Austrian periphery have to deal with underdeveloped RISs, or in other words, organizationally and institutionally thin RISs. In this way, the organizational and institutional implications of the RIS literature have been taken into account in the interpretation of the results.

2.4 Innovation networks: buzz, pipelines, and proximities

The critique of the unresolved question of the borders of a RIS is partially rooted in recent insights on innovation networks. While older studies emphasize the importance of geographical proximity, face-to-face contacts, and tacit knowledge (Storper and Venables 2004), more recent work questions the actual

importance of spatially bound clusters (Huber 2012; Fitjar and Rodríguez-Pose 2017). One reason might be an increasing specialisation in niches and the dispersion of knowledge, which makes it necessary for both firms and researchers to collaborate with the few relevant partners that can be identified globally (Howells 2012).

The proposition of REG (Bathelt and Glückler 2003) has therefore lead to a growing interest in the nature of today's innovation networks. In their seminal paper, Bathelt et al. (2004) complement local buzz (i.e. place-specific exchange in a localised innovation system) with global pipelines (i.e. trans-regional knowledge networks). While the former leads to a common set of values and attitudes that allows actors to engage in collective learning, the latter connects the cluster to the outside world and to external knowledge. Both local buzz and global pipelines are important and are mutually dependent, as a high degree of connectedness to international partners also increases the quality of local knowledge exchange.

Accordingly, the most innovative regions are those that harbour the critical mass of actors for a fruitful local buzz and hold the capacity and resources to maintain beneficial global pipelines. In fact, international networks and exchange with strangers might already contribute more to innovation than the regional environment does (Fitjar and Huber 2015). By definition, such a critical mass is usually absent in peripheral regions. However, the increasing importance of global pipelines and therefore trans-regional knowledge networks also highlights a potential for remote innovators. The basic idea is that these networks are an alternative which compensates for the absence of local buzz. However, empirical analyses have yielded mixed results, highlighting that remote firms do not have more but actually fewer global pipelines than those in urban areas (Rodríguez-Pose and Fitjar 2013) and that they do not always lead to more innovation (Aarstad et al. 2016). Nevertheless, this concept offers an explanation

for the presence of successful innovators also in peripheral areas, as it emphasizes not only agglomeration effects for innovation, but also purpose-built networks, which can be maintained from a remote location. The success of these pipelines depends, amongst others, on the absorptive capacity (Cohen and Levinthal 1990) of innovators in peripheral regions (Virkkala 2007; Fitjar and Rodríguez-Pose 2011; Grillitsch and Nilsson 2015).

This idea is related to another influential concept in economic geography, namely the proximities approach. Rallet and Torre (1999) have already concluded that in addition to geographical proximity, organisational proximity (belonging to the same professional community) can spur informal interactions over longer distances. As such, both are equally important and strengthening local as well as extra-regional collaboration should rank high on policy agendas. However, the defining publication within economic geography is the paper by Boschma (2005). Building on the French School of Proximity Dynamics (Torre and Gilly 2000), he goes beyond the geographical dimension and distinguishes a total of five relevant dimensions, emphasizing problems of too little and too much proximity (see Table 2).

First, cognitive proximity first introduced by Nooteboom in the 1990s (Nooteboom 1992) relates to a common knowledge base and expertise, meaning that people can work together by exchanging knowledge if they have a common background. However, being too close on this dimension might also limit the diffusion of external knowledge and increase the danger of undesirable knowledge spillovers. Second, organizational proximity describes the need for a certain coordination of collective learning, which is facilitated if organizational arrangements are similar. Again, improper forms of governance and too little flexibility can lead to a lock-in. Third, social proximity is rooted in social relations such as friendship or shared experiences, which promote trust and the exchange of tacit knowledge. If a firm is too deeply embedded in such

Proximity	Key dimension	Too little proximity	Too much proximity	Possible solution
Cognitive	Knowledge gap	Misunderstanding	Lack of sources of novelty	Common knowledge base with diverse but complementary capabilities
Organizational	Control	Opportunism	Bureaucracy	Loosely coupled system
Social	Trust (based on social relations)	Opportunism	No economic rationale	Mixture of embedded and market relations
Institutional	Trust (based on common institutions)	Opportunism	Lock-in and inertia	Institutional checks and balances
Geographical	Distance	No spatial externalities	Lack of geographical openness	Mix of local buzz and extra-local linkages

Table 2: Proximity

Dimensions in
Innovation Networks
(Source: Boschma
[2005](#), p. 71)

a social system however, this might lead to a cautious attitude towards outsiders and therefore also towards new ideas. Fourth, institutional proximity encompasses issues like a shared language, norms, or laws that enable collaboration. Nevertheless, being preoccupied with the institutional arrangement can hamper necessary adjustments. Finally, geographical proximity means the physical distance between relevant actors. Although there are situations in which knowledge exchange is purely based on agglomeration, geographical proximity often needs a combination with other proximities to unravel its real benefits (Boschma [2005](#)).

Geographical proximity alone is therefore not enough to spur interactive learning and knowledge creation, or in other words, innovation. As Boschma ([2005](#), p. 71) concludes, especially the right amount of cognitive proximity is of key importance, with the other dimensions rather being complementary than absolutely necessary. This discussion has important implications for both central and peripheral regions. For agglomerations with their dense environment, it is crucial to raise awareness that too much proximity might be harmful. For peripheries, the limited importance of geographical proximity highlights that these regions are not isolated from innovation processes and collective learning. Remote innovators can build their interactive innovation processes on the cognitive, organizational, social, and institutional dimensions of proximity (Eder [2019a](#)).

These dimensions also are the foundation for temporal clusters like trade fairs or conferences, which are an important source for spontaneous exchange (Maskell et al. [2006](#); Bathelt and Henn [2014](#); Maskell [2014](#); Bathelt and Gibson [2015](#); Bathelt [2017](#)), especially for peripheral innovators. In addition, virtual buzz utilising modern IT technologies such as video conferences or webinars is common today (Bathelt and Turi [2011](#); Grabher and Ibert [2014](#)). If a peripheral region has reached a certain level of accessibility through transport infrastructure and broadband connections, innovators are able to participate in innovation processes not based on geographical proximity. However, there is an ongoing debate whether proximity dimensions can be substituted as indicated by Boschma ([2005](#)). Contrasting this view, Malmberg and Maskell ([2006](#), p. 11) emphasize the benefits of spatial proximity for the other dimensions. So-called “neighbourhood effects” will almost automatically lead to closer cognitive, organizational, social, and institutional proximity. Recent evidence shows that the relationship of geographical proximity and the other dimensions is indeed complex and that a substitution mechanism as well as an overlap mechanism can be observed (Hansen [2015](#)).

2.5 Different routes for novelty: innovation modes and knowledge bases

At least two more theoretical approaches have spatial implications for central and peripheral regions, as they emphasize the different preconditions for innovation. In other words, they acknowledge that there are different types of knowledge that can lead to new products, processes, and services. First, Jensen et al. (2007) distinguish between the STI and the DUI mode of innovation. Innovations based on the STI mode have their foundation in codified scientific knowledge, which is usually available through publications or patents. In contrast, the DUI mode emphasizes the importance of tacit knowledge, informal learning, and experience-based expertise, all of which require frequent face-to-face contacts.

Jensen et al. (2007) already argue that firms combining both modes tend to be the most innovative. This finding is further emphasized by Isaksen and Karlsen (2012, p. 115), who introduce the notion of the Combined and Complex mode of innovation (CCI). Concerning the spatial pattern, it is suggested that with the reliance of the STI mode on research institutions, innovation in research-intensive fields is more common in urban areas. Concerning the DUI mode, the picture is more diverse. Workplace learning often occurs also in manufacturing, which traditionally extends to rural areas. It can therefore be expected that DUI innovations should be more evenly spread across space.

Second, the similar approach of differentiated knowledge bases is even more influential. Martin and Moodysson (2013, p. 172) consider differentiated knowledge bases to be the third important knowledge taxonomy in economic geography, in addition to codified versus tacit knowledge and the concept of know-what, know-why, know-how, and know-who. Furthermore, knowledge bases can be seen as a generic industry classification, as they group

together firms from different industries displaying similar innovation practices. For certain analyses, this might be more helpful than other, often arbitrary, industry classifications. Introduced by Laestadius (1998) and later taken up and extended by Asheim and Gertler (2005), three bases may be distinguished.

First, the analytical knowledge base is found in sectors such as Life Sciences or IT, i.e. industries where scientific knowledge is fundamental and learning processes follow standardized procedures. This parallels the STI mode and highlights the importance of scientific qualifications. Basic research is crucial, which is why firms usually have their own R&D staff and collaborate with research institutions. This emphasis on research frequently leads to radical innovations and consequently to the establishment of new firms, start-ups and spin-offs (Asheim and Gertler 2005; Asheim and Coenen 2006; Asheim, Coenen, Moodysson, et al. 2007; Asheim, Coenen, and Vang 2007).

Second, the synthetic knowledge base is more frequently observed in manufacturing, for instance in industrial machinery engineering or plant engineering. The core of innovation processes in these sectors is the novel combination of existing knowledge, which is why experimental development is preferred over basic research. Tacit knowledge is of higher importance and a greater number of informal learning processes, such as on-the-job training, can be observed, which underlines the similarities to the DUI mode. Qualifications obtained through vocational schools are therefore more frequent than academic degrees. However, although these innovations are often marketable as they are developed in close cooperation with customers and suppliers, they are usually also rather incremental (Asheim and Gertler 2005; Asheim and Coenen 2006; Asheim, Coenen, Moodysson, et al. 2007; Asheim, Coenen, and Vang 2007).

Third, the symbolic knowledge base was introduced later in reaction to the rise of creative industries such as design, marketing, and publishing. In urban milieus with specif-

ic norms and habits, a tacit knowledge about this institutional context is central. In these often temporal settings, experience, skills, and personal networks are more important than academic degrees (Asheim, Coenen, Moodysson, et al. 2007; Asheim, Coenen, and Vang 2007). The orientation of the analytical knowledge base, and the need for a milieu in which the symbolic knowledge base can develop, link these two knowledge bases to cities, which is also the case for the STI mode. In contrast, the synthetic knowledge base shares not only conceptual ideas, but also its spatial pattern with the DUI mode.

However, the innovation process requires different knowledge bases in different phases of product development (Strambach and Klement 2012; Manniche et al. 2017). Firms and regions that are able to combine all knowledge bases will therefore display the highest degrees of innovation (Grillitsch et al. 2017). Nevertheless, the central conclusion concerning both innovation modes and knowledge bases is that innovation must not be conflated with R&D and high-tech. Especially peripheral regions are frequently characterized by the DUI mode or by the synthetic knowledge base, which is why they are often overlooked in innovation studies (Davies et al. 2012; Isaksen and Karlsen 2016; Trippel et al. 2016; Shearmur 2017).

2.6 Synthesis and implications

The discussion of uneven regional development and selected theoretical approaches has demonstrated three important lessons for this dissertation. First, the increasing awareness of the diverging trajectories of urban and rural places and striking regional disparities have led to a growing interest on the part of researchers, policy makers, and the general public. Recommendations for place-based approaches are in demand, which underlines that engaging with these issues is a promis-

ing avenue for economic geography towards highlighting its societal relevance. Rather than picking winners and studying best-practice examples, the discipline should extend its focus to struggling regions. Accepting the invitation by Phelps et al. (2018), it is therefore the aim of this dissertation to study the challenges and opportunities of innovation at this “dark side” (i.e. peripheral regions).

Second, the focus on spatial proximity and agglomeration economies inherent in the TIM family, which dominated the discourse in the 1990s and early 2000s, resulted in an “urban bias” in innovation studies (Shearmur 2017). By focusing on high-tech industries and patents as the prime indicator, innovations in peripheral regions have often been overlooked. In fact, studies that specifically address this issue find that original innovations are more evenly spread across regions than is often assumed (Lee and Rodríguez-Pose 2013). Research on the geography of innovation should therefore not only focus on geographical proximity, but also on the other dimensions suggested by the proximities approach.

Third, innovation processes rely on different preconditions, namely on various innovation modes and knowledge bases. Urban and rural areas have their specific strengths and weaknesses, resulting in varying innovation processes. Furthermore, innovation is also possible in relative geographical isolation. However, whereas this is acknowledged by some scholars (Isaksen 2015; Shearmur and Doloreux 2016), more insights into the actual characteristics of peripheral innovators are necessary to inform researchers and policy makers alike.

One attempt to explicitly theorize on the similarities and differences of urban and peripheral innovation processes is suggested by Shearmur (2015), who distinguishes between slow and fast innovators. In this vein, he assumes that certain innovation requires the immediate knowledge of recent developments and therefore a high frequency of interaction, often face-to-face. In contrast, some new products and services combine knowl-

edge that has been around for a while and is available through publications or patents. The conclusion is that innovation of the first kind occur mainly in cities (fast innovators) and that the second kind is more likely in rural areas (slow innovators). Although there are first empirical attempts to approach these assumptions (Shearmur and Doloreux [2016](#)), further research is necessary to generalize the results, as well as more theoretical work towards a comprehensive framework of innovation in an uneven space.

With regard to the theoretical discussion, the relevance of place-based approaches, the need to understand innovation more broadly than in terms of high-tech and patents, and the awareness of differentiated innovation processes are therefore the key messages and the theoretical background for this disser-

tation. As such, it also considers the few attempts that have already been made towards bridging some of the concepts mentioned above. Isaksen and Trippel ([2017b](#), p. 127) for instance combine thick and thin RISs with innovation modes to develop a more nuanced typology of the expected industry structure in central and peripheral regions. Another example is the work by Mattes ([2012](#), p. 1094), who highlights which proximity dimensions are fundamental or negligible for the analytical, synthetic, and symbolic knowledge base.

Considering this theoretical background ensures that this dissertation is grounded in contemporary and relevant debates in economic geography. Furthermore, it is the basis for the empirical work and thus for the ontological and epistemological considerations as well as for the methodology outlined in [Section 4](#).

3 Innovation and regional disparities in Austria

Before turning to questions of the philosophy of science, the following section introduces the study area for the empirical contributions of this dissertation, namely Austria. First, it puts Austria's regions into a European perspective by discussing the results of the most recent Regional Innovation Scoreboard 2019. Second, as NUTS-1-Regions encompass both central and peripheral regions, a more fine-grained view on regional disparities and recent developments is provided. Third, it highlights Austria's federal system and some of the challenges this entails for innovation policy. To conclude, this section briefly reviews former work on the geography of innovation of Austria.

3.1 Austrian regions as strong innovators

As an EU-member, Austria partakes in international surveys and is therefore included in cross-country comparisons regarding innovation performance. For example, [Figure 1](#) displays the Regional Innovation Scoreboard 2019. Although this scoreboard has been criticised for its broad indicators, which are often not available at the same geographical scale (Tripl et al. [2016](#)), it provides interesting insights in the innovation activities in Europe and puts Austria into context. Accordingly, the three NUTS-1-Regions of Austria, namely *Ostösterreich* (Eastern Austria – AT1 – Score: 114.8%), *Südösterreich* (Southern Austria – AT2 – Score: 116.2%), and *Westösterreich*

(Western Austria – AT3 – Score: 119.9%) are all classified as “Strong Innovators +”. As their score indicates, they nearly fall into the strongest set of regions with a performance above 120% of EU average, mainly found in western and northern Europe. A comparison over time shows that Austria's regions have occupied this category since 2009, when the first Regional Innovation Scoreboard was drawn up. This means that although the country exhibits an above-average performance, it has not been able to close the gap to leading regions of innovation, which has been a political goal for many years (European Commission [2009](#), [2012](#), [2014](#), [2016](#), [2017](#), [2019](#)).

Again, one could argue that this classifies Austria's regions as central – and on a continental scale, they definitely are. However, all three NUTS regions combine the cores with some of the most peripheral regions of the country, implying that there are profound regional disparities within the NUTS-1 regions (Lichtenberger [2000](#)). One example is *Ostösterreich*, which includes Vienna and therefore the economic core of Austria, but also regions along the Czech and the Hungarian border, which are some of the most peripheral areas of the country. This on the one hand illustrates the problem of analyses following administrative borders. On the other hand, innovation and economic data in Austria are often only published on the national scale or on the NUTS-1 level, which prohibits a more fine-grained analysis. Dealing with the regional preconditions for innovation and regional disparities therefore requires the combination of various data sources and methods.

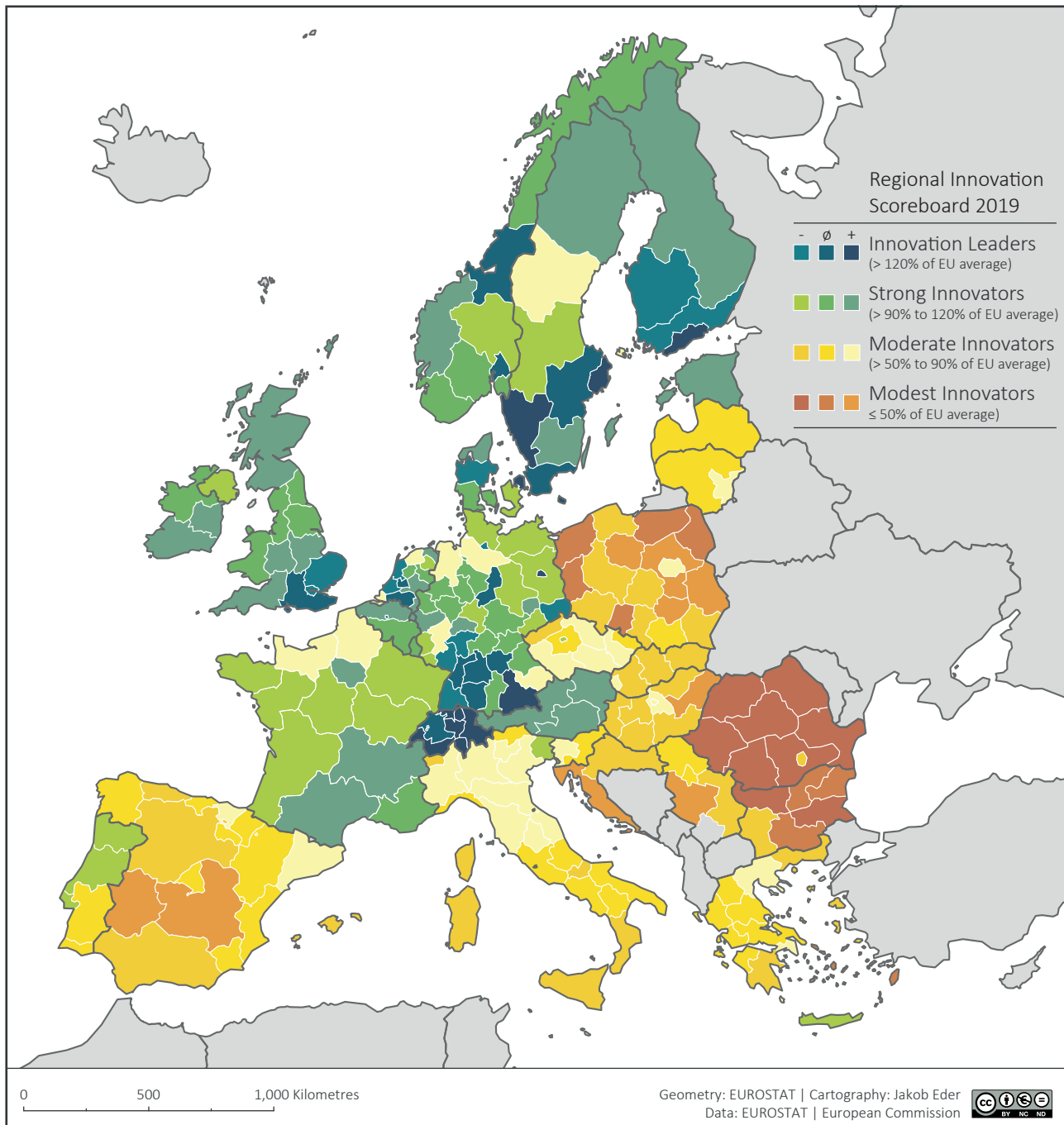


Figure 1: Regional Innovation Scoreboard 2019 (Data: EUROSTAT and European Commission)

3.2 Regional disparities and recent developments

With the fall of the iron curtain and the accession to the European Union (EU) in 1995, Austria's position in Europe has changed substantially. After World War II, it was an outpost of the Western World, with closed

borders to the Czech Republic, Hungary, Slovakia, and Slovenia. Meanwhile, these countries have joined the EU and are close partners along with its western neighbours, i.e. Germany, Italy, Liechtenstein, and Switzerland. Today, it is a well-integrated country in the European single market, with Germany being the most important trading partner (Lichtenberger [2000](#)).

However, the iron curtain closed historically important transport routes and cut off traditional trans-border economic areas. These events played a decisive role in the development of Austria's economic landscape today. The eastern, northern, and southern border regions have been struggling for many decades and have not entered growth paths yet. In addition, the western parts of the country are dominated by the Alps, which historically constitute another peripheral area. In these latter regions, however, winter tourism today is the main pillar of the local economy and has enabled a certain level of regional development (Lichtenberger 2000). Hence, although distances in Austria are not comparable to those found in the peripheries of Scandinavia or North America, the country exhibits a distinct urban-rural typology.

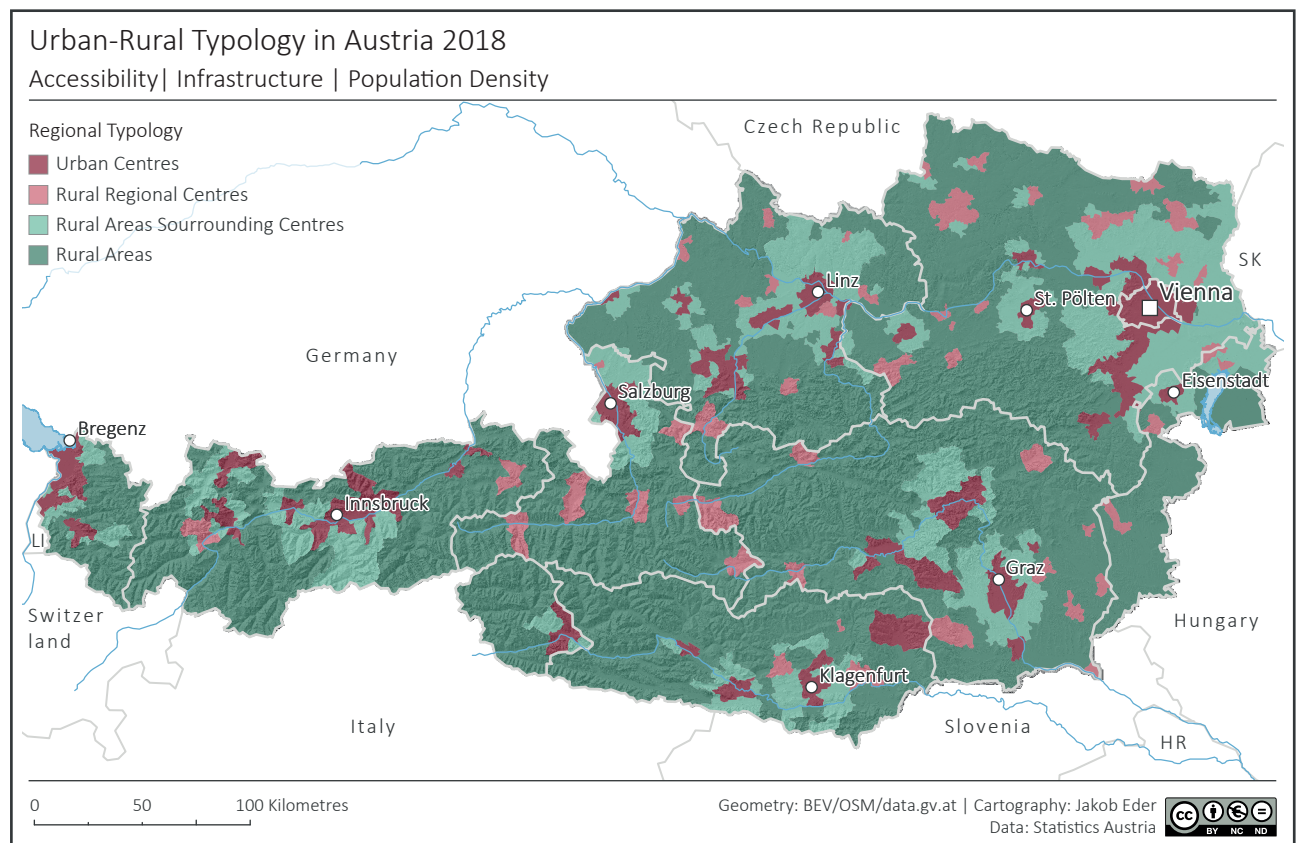
The only metropolitan area is the Vienna urban region with approximately three

million inhabitants in 2018, which constitutes one third of the country's population. Other important cities with a population above 100,000 inhabitants are Graz (290,000), Linz (200,000), Salzburg (150,000), Innsbruck (130,000), and Klagenfurt (100,000).¹ As trans-border cooperation is becoming increasingly important, cities like Passau/Germany and Bratislava/Slovakia, as well as regions like the Rhine Valley are gaining importance for the country's economic landscape. Smaller urban and regional centres are found mainly along transport axes, while the vast majority of Austria's state territory can be described as rural (see Figure 2).

Although Austria's peripheries can be considered central in an international comparison, regional disparities have been increasing since the 1970s and 1980s, as it has done in many European countries (Iammarino et al. 2019). Although there is economic

Figure 2: Urban-Rural Typology in Austria
(Data: Statistics Austria)

¹ Population numbers retrieved from Statistic Austria's STATcube: <http://statcube.at> [last visited: 01.08.2019]



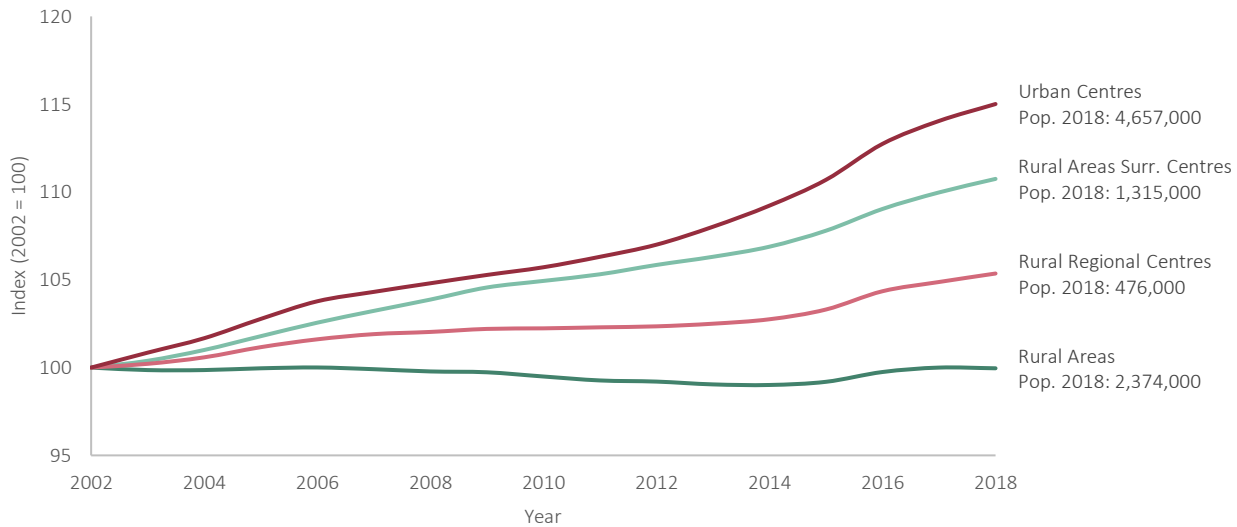


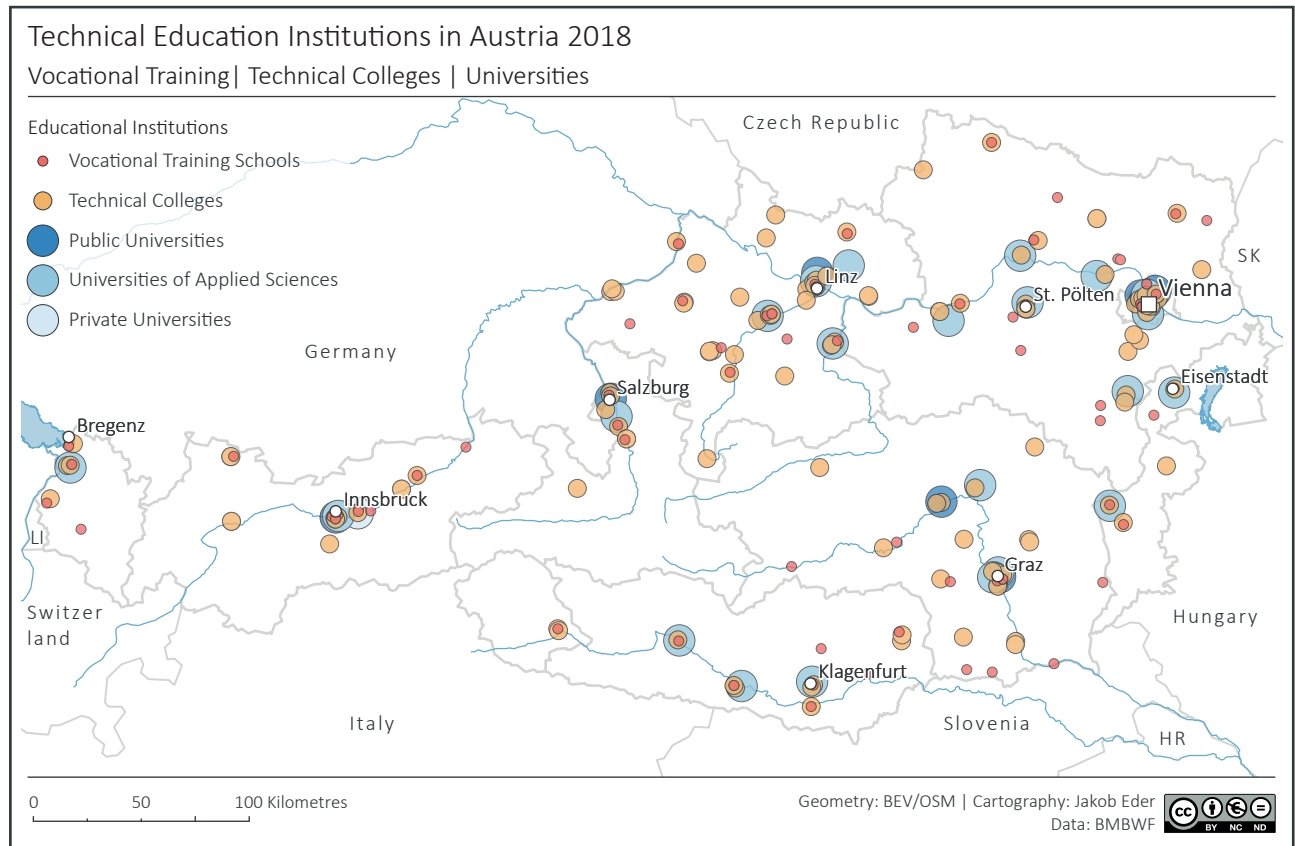
Figure 3: Population Development in Austria 2002 to 2018 (Data: Statistics Austria)

convergence at the level of the nine federal states (*Bundesländer*) (OECD 2016), there is an increasing polarisation between urban and rural areas, both economically and demographically. Looking at data from 2002 onwards, rural areas have for example been experiencing a stagnating demographic development, resulting in an ageing population, and rural regional centres have witnessed only marginal population growth. In contrast, urban centres and their rural hinterland are the main drivers of Austria's population growth of 800,000 individuals during the period of 2002 to 2018 (see Figure 3). As in other countries in Europe, these regional disparities are also visible in election results, with rural areas being more prone to the influence of populist candidates (Rodríguez-Pose 2018). However, Austria displays this phenomenon to a lesser degree than is the case in the US and the UK as Essletzbichler et al. 2018 demonstrate.

Additionally, the prevalence of higher education institutions can also be seen as a proxy to approach the knowledge intensity of regions and therefore regional disparities. Hence, Figure 4 provides an insight into the landscape of educational institutions, as the skills of the workforce are often seen as crucial for regional development. It focuses on the technical educational institutions of Aus-

tria, as they convey qualifications that are frequently considered as fundamental for innovation. Tertiary education and therefore institutions that convey qualifications attributed to the analytical knowledge base are mostly limited to the main cities, although universities of applied sciences can be found in areas that are more rural.

In contrast, vocational training schools and technical colleges are located both in central and peripheral areas, although to a very different degree. Such schools combine theoretical education with on-the-job training, leading to qualifications that are more common in the synthetic knowledge base. Their density is particularly striking in Upper Austria, one of the industrial centres of the country, whereas such educational institutions are scarce in Alpine regions. The prevalence of higher education institutions fosters bigger cities like Graz, Linz and Vienna as the main innovation hubs. Hence, innovative firms in the periphery often need to recruit highly skilled people from these urban cores or from abroad.



3.3 Multi-level governance and a fragmented innovation policy

The developments mentioned above have increased the awareness of policy makers concerning issues of spatial inequality and divergent trajectories of urban and rural areas, underlining the importance of innovation policy to address market failures causing uneven development (McCann and Ortega-Arriaga 2013). However, because Austria is a federal state, innovation and regional policy involves many actors: national policy makers, the nine federal states (*Bundesländer*), regions, and municipalities have different competences and pursue different goals (Lichtenberger 2000). This multi-level governance allows regions to set their own priorities, but comes at the cost of overarching strategies. For example, at the federal level, the Austrian Conference on Spatial Planning serves as a

strategic platform, but has very limited power. It develops long-term spatial development concepts every ten years, but the legislative authority in questions regarding this matter lies with the nine federal states (*Bundesländer*), which results in nine different spatial planning laws (Faludi 1998; Humer 2018).

With this in mind, it is not surprising that cluster and innovation strategies as well as subsidy schemes also exist on various levels. At the national level, Austria issued its latest strategy on research, innovation, and technology in 2011 (BKA et al. 2011) and more recently its open innovation strategy (BMFWF and BMVIT 2016). One of the most important funding bodies at this level is the Austrian Research Promotion Agency (FFG), which promotes innovation and collaboration between the private sector and research institutions. This is complemented by nine strategies on research, innovation, and technology at the level of the federal states (*Bundesländer*), which also

Figure 4: Technical Education Institutions in Austria 2018 (Data: BMBWF)

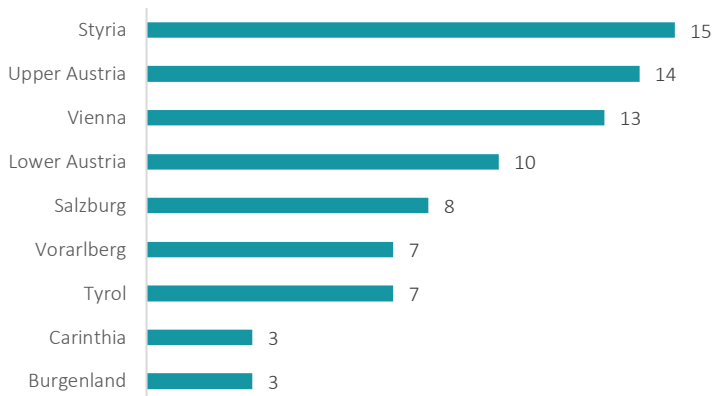


Figure 5: Clusters by Federal State (*Bundesländer*) 2019 (Data: BMDW)

have their independent economic subsidies. For example, currently (2019), 80 economic clusters are registered at the Ministry for Digital and Economic Affairs at the federal state level (*Bundesländer*), famous examples being the Automotive Cluster in Upper Austria and the Life Sciences Cluster in Vienna (see [Figure 5](#)).² However, cluster members are not limited to the administrative borders of these federal states (*Bundesländer*), but come from all over Austria or even from abroad. This suggests that a territorial definition of clusters is obsolete, laying greater importance on the idea of trans-regional, specialised networks.

The importance of place-based policies is not explicitly visible in current overarching planning documents. For instance, the “Master Plan for Rural Areas” proposes general solutions, treating non-core regions as rather uniform (BMLFUW 2017). Similarly, the national innovation strategies mentioned above do not distinguish between urban and rural areas. Nevertheless, due to the federal system in Austria and strong competences at the level of the nine federal states (*Bundesländer*), specific strengths and weaknesses are taken into account in subnational planning documents and in cluster management.

3.4 Former research on the geography of innovation in Austria

Beside this overview on innovation performance, regional disparities, and multi-level governance in Austria, this dissertation builds on manifold scientific publications that have analysed the geography of innovation of Austria. In the 1980s, Tödtling (1983, 1989) started to investigate innovation processes in different regions in Austria, both in central and peripheral environments. More or less contemporaneously, Gebhardt (1990) researched innovation and industrial development in the Alps. Beside results from France, Switzerland, and Italy, he also included evidence from Vorarlberg and Tyrol and therefore from mountainous and often marginalised regions in western Austria. To arrive at a more systematic picture of Austria’s economic landscape, Palme (1995) applied cluster analysis to distinguish between knowledge-intensive, industrial, tourism-intensive, and rural areas.

In the wake of the increased interest in innovation studies worldwide (see [Section 2.1](#)), the 2000s witnessed a significant increase in questions raised about regional innovation also in Austria. These include processes of renewal in old industrial areas in Styria (Tödtling and Sedlacek 1997; Tödtling and Trippel 2004; Trippel 2004), collaboration between Austria’s firms and its universities (Schartinger et al. 2001; Schartinger et al. 2002; Fischer and Varga 2003), the effect of public subsidies on innovation (Kaufmann and Tödtling 2002; Tödtling and Kaufmann 2002; Falk 2007), the importance of national and international knowledge networks (Tödtling et al. 2009; Grillitsch and Trippel 2014), and urban innovation clusters (Trippel and Tödtling 2007; Tödtling et al. 2009; Trippel et al. 2009; Musil and Eder 2016).

² Clusters by State, Ministry for Digital and Economic Affairs: <https://www.bmdw.gv.at/WirtschaftsstandortInnovationInternationalisierung/ClusterplattformOesterreich/ClusterNetzwerkeOesterreich/Seiten/Cluster-nach-Regionen.aspx> [last visited 01.08.2019]

In addition, Kramar (2005) has analysed the location factors for knowledge production, Tripl et al. (2013) investigated the spatial pattern of creative industries, and Kaufmann (2015) looked at the development of innovation and employment between 2006 and 2012. Recently, Isaksen and Tripl (2017a) have demonstrated the importance of the university of applied sciences in the *Mühlviertel*/Upper Austria with a specialisation in IT. After the establishment of the university, this peripheral region was able to enter a development path based on the analytical knowledge base.

With this in mind, this dissertation aims to contribute to the research on regional dis-

parities and the role of innovation for regional development. As such, it relates to the literature on the geography of innovation in Austria, but also to the wider debates in the field of economic geography. It first reviews the literature on innovation in the periphery including examples from Austria and from international sources (Paper I). Second, it discusses periphery concepts within the discipline and proposes a new typology for the analysis of regions, which allows for the nuanced analysis of urban and rural areas also in a country with limited data availability such as Austria is (Paper II). Third, it provides recent empirical evidence in relation to the existing literature on peripheral innovation processes (Paper III).

4 Towards a critical realist research design

The nature of a research design is deeply rooted in the underlying paradigm that constitutes how and under which propositions research is conducted. First, this relates to questions of the philosophy of science and to specific perspectives, both ontological (concerning existence) and epistemological (concerning the ways and means of attaining knowledge). Second, these ontological and epistemological considerations define not only the methodology researchers build upon, but also their specific portfolio of methods (Johnston 1986). While the former describes the theoretical foundations as well as the set of rules and the procedures of the scientific process, the latter specifies the actual tools that are applied to arrive at scientific results.

Together, ontology, epistemology, and methodology form a paradigm. Kuhn (1970) assumed that in a phase of “normal science”, most scholars of a discipline carry out research under a shared paradigm. The arrival of new perspectives on ontological and epistemological issues is usually not welcome. Representatives of the old paradigm will show resistance, delaying or even preventing a transition. However, in reality and especially in geography, various often-competing paradigms exist simultaneously. Hence, with regard to this plethora of paradigms, reflection on these issues seem especially important for a geographical dissertation.

On the one hand, one reason for its importance lies in the humanist and naturalist traditions of geography and the fundamental differences in the methodology of social

and natural sciences. As such, the discipline as a whole is impossible to classify as either nomothetic (searching for universal laws) or idiographic (documenting singularity), since various strands pursue different directions (Johnston 1986; Blotevogel 2015). On the other hand, matters are not clear-cut within human geography, which is the umbrella discipline of this dissertation, either. Social science research in geography has witnessed the quantitative revolution and many “turns” in the 20th century through the incorporation of ideas from neighbouring disciplines, which often implied different methodological directions (Sayer 1985; Johnston 1986; Scott 2000).

With this in mind, the following section frames the dissertation by identifying the underlying paradigm, namely critical realism, which was introduced in the 1970s (Bhaskar 1975, 1979). It provides ontological and epistemological perspectives and discusses the methodology, which was the foundation in choosing the toolkit of methods for this research endeavour.

4.1 Ontological and epistemological background

Every discipline has its specific view of the world and, often unconsciously, its students are socialized according to that view (Johnston 1986). However, as Kuhn (1970) has clarified, an old paradigm is not instantly replaced by a new one, it rather takes quite some

	Ontology	Epistemology	Methodology
Empiricist approaches	The things humans experience are the reality	Humans know through experience	The presentation of experienced facts
Positivist approaches	The provable facts that humans experience are the reality and absolute truth	Humans know through verifiable and reproducible experience	The “Scientific Method”, i.e. testing of hypotheses by statistical analysis
Humanistic approaches	That which humans perceive to exist, constitutes the reality	Humans know subjectively in a socially constructed world	The investigation of individual worlds
Structuralist approaches	The reality cannot be observed directly, but only through thought	Humans know appearances, which are not necessarily the causal and covered mechanisms	The construction of theories that guide empirical research, while direct testing is impossible
Postmodern approaches	Spatial, social, and historical dimensions equally constitute reality	Humans know subjectively, influenced by discourse, language, gender, race, and class	The investigation of various individual perspectives, tolerating relativism

Table 3: The ontology, epistemology, and methodology of the main philosophies in geography (own elaboration, based on Johnston 1986, p. 5 and Soja 2001, pp. 11860-11864)

time for old ideas to fade and new ideas to spread, often against open resistance (Chalmers 2013). This usually leads to a plurality of paradigms existing simultaneously. Hence, the paradigm someone relates to is rooted in the time of study and in his or her teacher’s perspective.

Providing a rough outline, Table 3 displays the ontological and epistemological perspectives of the four main philosophies in geography identified by Johnston (1986, p. 5): empiricist, positivist, humanist, and structuralist approaches. Postmodernist approaches have been added due to their increasing importance since the 1990s, although some scholars reject the idea of postmodernism being a paradigm, but rather deem it to be a set of ideas and concepts of great influence:

“...there may be no other time in its existence as a distinct discipline when geography has been so paradigm-free and yet so critically engaged with the major issues and events of our times. While these developments are not entirely due to the impact of postmodernism, it has certainly played a stimulating role.” (Soja 2001, p. 11864)

As the divide between human and physical geography grows, paradigms also begin to differ increasingly. Positivism has long been

dominant, advocated again by the quantitative revolution. Although it is rarely found today, further developments such as Popper’s critical rationalism (1959) are still the foundation for physical geographical and for human geographical research that is based on statistical testing and regression models. However, humanistic, structuralistic, and postmodern approaches have been subsequently introduced, primarily to human geography, and form the basis for the modernization of the social sciences branch of the discipline that has taken place since the 1960s (Johnston 1986; Johnston and Sidaway 2016). While positivism assumes that there is an objective and absolute truth that can be reached by thorough observation and experimentation, recent philosophies are more cautious. As such, they emphasize the influence of subjectivity and acknowledge that the world is socially and culturally constructed (Sayer 2000; Chalmers 2013).

Critical realism belongs to the set of structuralist approaches and emerged in the 1970s, its main proponent being Bhaskar (1975, 1979). This thinking assumes that underlying general structures determine the causal factors for observations, but that these structures cannot be identified by studying through observation alone. In fact, it is necessary to combine theory with observation and analysis in order to achieve scientific knowledge (John-

ston 1986). In this vein, critical realism was developed as a critique of positivist approaches and had gained influence especially in human geography since the 1980s (Yeung 1997). As highlighted by Pratt (1995, p. 62), the work by Andrew Sayer (e.g. 1981; 1982, 1985, 1992, 1993, 2000) was central in this regard. While positivism assumes that the social world can be condensed into behavioural regularities and social laws similar to phenomena in the natural sciences, realism is more concerned with the actual nature of open social systems (Sayer 2000).

As such, its ontology can be further specified. Bhaskar (1975) distinguishes between two dimensions of knowledge: the intransitive and the transitive. The former refers to the actual object of research, while the latter relates to the theories and the resources of a discipline. If, for example, the theory on a subject changes, this does not necessarily mean that reality changes as well. Consequently, the world should not be reduced to experience alone (Sayer 2000). Therefore, Sayer (2000, pp. 11-13) points out that the ontology of critical realism is stratified and not flat, as it distinguishes between “the real”, “the actual”, and “the empirical”. First, “the real” relates to that which exists and can be researched, also encompassing underlying structures and powers. Second, “the actual” is concerned with the mechanisms that are activated, should these powers engage. Third, “the empirical” is the domain of experience, which depends on the knowledge of “the real” and “the actual”.

Regarding epistemology (“the empirical”), Sayer (2000, pp. 14-15) highlights the specific view of critical realism on causality. The focus of research under this paradigm lies on the identification of causal mechanisms, while acknowledging that some may be active and some may be dormant. Whether a mechanism has causal influence depends on specific temporal and local conditions. As such, the observed outcome is contingent and can be different from similar instances. Causal factors can also lead to different outcomes in open systems like social systems, which are

usually researched in human geography (Sayer 1985, 2000).

Therefore, critical realism rejects the testing of hypotheses on the relationship of two variables by quantitative methods, first, because the necessary conditions for such tests are only met in closed and not in open systems. Secondly, it is rejected because if a regularity is found and such behaviour can be modelled and predicted, it remains unclear why this is the case. Critical realism is much more concerned with actual causal mechanisms, of which some are well known and others are still hidden (Sayer 1985). As Figure 6 illustrates, critical realism therefore differs fundamentally from positivism and its focus on regularity, as it emphasizes complexity and fallibility.

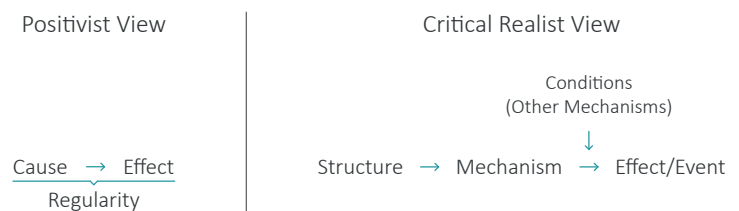


Figure 6: Positivist and critical realist view on causation (own elaboration, based on Sayer 2000, pp. 14-15)

In addition to positivist and realist views, postmodernism (sometimes labelled post-structuralism) has entered human geography in the 1980s and gained influence, challenging the popularity of critical realism (Sayer 1993; Pratt 1995). These newer approaches focus on language, discourse, and place, but have been criticized for evoking relativism, since they question truth, empirical testing, and the progressive development of knowledge. Together with the focus on subjectivity, the defeatist strain of postmodernism questions whether researchers can really compile reliable knowledge (Sayer 1993, 2000). According to this view, truth can only be local, as humans know subjectively and perception depends heavily on gender, race, and class. Postmodernists not only advocate subjectivity, but also the diversity of regions, neglecting universal spatial laws (Warf 1993; Soja 2001).

Critical realists are open to these propositions; however, their conclusions looking at these phenomena are different. Consequently, they especially neglect inherent relativism and position themselves in-between the two poles of positivism and postmodernism. They are acknowledging diversity, but

“argue for a different conclusion: that notwithstanding the daunting complexity of the world and the fallible and situated character of knowledge, it is possible to develop reliable knowledge and for there to be progress in understanding.” (Sayer 2000, p. 30)

As such, postmodernist ideas have influenced the view of critical realist geographers and some argue towards incorporating this thinking in critical realism rather than shying away from the debate (Sayer 1993; Pratt 1995). In fact, many key concepts and research themes of postmodernism have been absorbed in geography today, which also influences the conceptualization and abstraction of critical realists (Soja 2001).

In this tradition, critical realism serves as the underlying paradigm of this dissertation, while recent developments within the discipline are not ignored. During my studies, I have been unknowingly socialized to the scientific principles introduced above. I am aware of the importance of a sound theoretical foundation, the careful choice of the right methods, and the constant scrutinizing of results. Hence, I share the view of critical realists that reality can be approached through a deliberate application of theory, aiming to identify the relevant underlying structures, which will not follow societal laws as proposed by positivism.

As such, this dissertation focuses on these underlying structures and mechanisms of social systems, namely innovation processes in peripheral settings. It acknowledges complexity, singularity and is aware that knowledge is fallible. In doing so, it on the one hand rejects the intrinsic motivation of positivism,

which is generalization and the search for universal laws through quantitative methods. On the other hand, it also diverges from the postmodernist view, as it assumes that reliable knowledge can be achieved through the application of theory and thorough empirical analysis. Therefore, this dissertation also dismisses the relativism inherent in postmodernist approaches.

Finally, as the proponents of critical realism have not been explicit about how they understand the term “critical”, I approach this issue as follows. This dissertation aims to be relevant and to contribute to the knowledge of grand societal challenges. Therefore, an engaged, committed, and emancipatory scientific self-conception is applied, trying to better understand the nature and underlying processes of uneven regional development. Furthermore, the focus on peripheral regions aims to challenge implicit assumptions and dominating systems of thought within the geography of innovation, especially considering the predominant negative perception of peripheries. Accordingly, for this dissertation “critical” means conducting research in a careful manner, engaging with society, and challenging dominant schools of thought.

4.2 Methodology: conceptualization, abstraction, and triangulation

As outlined above, ontology and epistemology are the foundation for methodological considerations. Although the theoretical basis of critical realism was developed in the 1970s and 1980s, geographers struggled to define the characteristics of a critical realist methodology (Pratt 1995; Yeung 1997). One reason is that realists do not see social science as either nomothetic or idiographic (Sayer 2000), although there is a tendency towards idiographic research among critical realist geographers (Sayer 1985). However, propo-

nents of critical realism have outlined guiding principles on how researchers should proceed under this paradigm.

First, research should rest on sound theoretical assumptions. However, rather than providing ordering frameworks for regularities, critical realist theories are more concerned with conceptualization. As such, the influence of the properties of an object on causation is emphasized. These connections require constant questioning to sharpen conceptualization and therefore theories, which indicates the dynamic understanding of science. Critical realist theories should describe real-world connections and will claim a certain level of generality, but will not expect to find predictive behaviour of empirical cases (Sayer 1985; Pratt 1995; Sayer 2000).

Second, rather than aiming towards generalization as positivists do, critical realists should strive for abstraction. In this regard, to abstract means to isolate specific aspects of the object of research. Sayer (1981, 1982, 1992) distinguishes between two kinds of abstraction: “Rational abstraction” refers to specific elements of a real-world phenomenon, which is defined consistently. “Chaotic conception”, on the other hand, combines unrelated dimensions in broad categories or overlooks important factors. In this vein, critical realist research should be based on “rational abstraction”, allowing for the identification of relevant mechanisms. Such abstractions of empirical material are then used to validate and, if necessary, to adapt theoretical assumptions (Yeung 1997).

Third, given the complexity of critical realist problems, methodological triangulation is recommended to analyse phenomena from different angles in order to increase the validity and reliability of results. Based on Denzin (1970), Yeung (1997, p. 64) distinguishes between four kinds of triangulation: data triangulation (time, place, person, geographical level), investigator triangulation (multiple researchers), theoretical triangulation (consideration of different concepts and frameworks), and methodological triangulation

(extensive methods/quantitative data and intensive methods/qualitative data). As such, critical realism explicitly supports the combination of quantitative and qualitative methods (Downward and Mearman 2007). However, ideally, the methods applied should be embedded in the ontology and epistemology of critical realism. If the results are complementing, this indicates a high robustness of the findings at hand. Should they be diverging, it is necessary to proceed with caution and to critically review the outcomes (Sayer 1992; Yeung 1997).

Accordingly, critical realists will draw mainly on intensive research, carried out through qualitative methods such as interviews and qualitative analysis. They do not fully reject extensive research either, characterized by the quantitative analysis of large and representative samples (Sayer 1992). However, extensive research is seen as the basis to reveal interesting connections and conditions, the research of the several underlying relevant mechanisms is therefore delegated to in-depth intensive research (Sayer 1985; Yeung 1997). Hence, critical realists are less concerned with sample size and representativeness, but emphasize intensive research to grasp as many relevant mechanisms as possible. Another contrast to positivism is that hypothetical and conditional statements are accepted (Yeung 1997). This indicates that critical realism believes it is viable to reach knowledge through interpretative understanding (i.e. through the hermeneutic dimension) (Sayer 2000).

However, these propositions have not been translated into guidelines for conducting critical realist research. As the approach allows numerous research designs, various scholars have provided examples of their research under this paradigm. These illustrations are also guiding the choice of a methodology for this dissertation. For instance, Sayer (2000, p. 24) describes work on firm performance of the same industry between regions, using the case of South Wales (Sayer and Morgan 1985; Morgan and Sayer 1988). The

necessary categorisation of firms for an extensive research design could only be achieved through “chaotic conception” as described above. Consequently, quantitative analysis did not reveal regularities or causalities. A switch to an intensive approach was then necessary, which increased the information load but facilitated explanation. Context was crucial and by interviewing the most relevant firms in the case study region, the main trends could be revealed. Similarly, Pratt (1995, pp. 70-72) reflects on his research concerning the development of the form and the location of firms (Pratt 1994). While positivism views agglomeration economies as causal, critical realism suggested the importance of place and time specific factors. Interviews with a range of actors revealed issues with the conceptualization of property development, resulting in a more fine-grained causal explanation.

This dissertation relates to this methodological discussion in various ways. First, the research is guided by state of the art theories in economic geography, but it sees the necessity for (re)conceptualization of existing concepts, especially in relation to innovation in peripheral areas. Second, rather than identifying universal laws through generalization, it aims to make meaningful “rational abstractions” in order to analyse (some of) the underlying mechanisms concerning the case studies. Third, it uses triangulation to validate and to compare the qualitative results. The quantitative analyses included in this dissertation are therefore largely descriptive and are not the basis for explanation. Fourth, empirical results are used to constantly adjust the theoretical assumptions and conceptual frameworks throughout the thesis. The next section discusses the data sources and methods of the three scientific articles in detail.

4.3 Data and methods

This section elaborates on the data sources and the specific methods applied for each of

the three academic articles in this dissertation. Overall, the principles of critical realism have guided the entire research project. Abstraction was particularly necessary for the conceptualization of the underlying research questions and the choice of theoretical underpinnings. Preliminary work focused on the thorough study of literature on the geography of innovation, including both classical concepts and seminal empirical work, as well as recent theoretical and empirical advancements. Additionally, reading exercises were an essential part of the ongoing research process, as it was necessary to frame the articles differently and to consider recently-published results.

With regard to the overall research questions introduced in [Section 1](#), triangulation is used not only within, but also across the articles (Yeung 1997). As such, data and investigator triangulation, but especially theoretical triangulation and methodological triangulation were used to interpret the general results, inspired by the importance of triangulation in critical realism. Furthermore, as often suggested, this dissertation combines extensive and intensive methods (Downward and Mearman 2007). In the tradition of critical realism, the former were used mainly in a descriptive way, while the latter aimed at explanation.

As such, this dissertation relates to the discontent with positivism and the methods pushed by the quantitative revolution, which led to a renewed interest in alternatives especially in the early 1990s (Yeung 1997). Semi-structured interviews with business owners have since then been seen as fruitful to investigate individual perceptions and the locational behaviour of firms. Information on these issues is usually not available through general large-scale surveys, but is essential for uncovering the underlying mechanisms, which are expected to be causal. While a qualitative approach sometimes raises questions about validity and the relation between interviewer and respondent, the advocates of such a research design also highlight the explana-

tory power and the suitability for critical realist research (Healey 1991; Schoenberger 1991; McDowell 1992; Schoenberger 1992; Healey and Rawlinson 1993).

Hence, while acknowledging that quantitative research provides interesting insights, the selection of specific methods for this dissertation follows a different direction, capitalising on the potential of the combination of quantitative and qualitative approaches. Although this dissertation expresses full awareness of the difficulties and challenges inherent in qualitative research, it is believed that a multi-method approach is suitable for addressing the overarching research questions (see [Section 1](#)). Hereinafter, details for the data sources and the methods applied are provided for each paper. However, the consideration of all three papers in relation to each other is necessary to retrace the implementation of the underlying critical realist methodology, since the individual papers do not fulfil their propositions in isolation.

4.3.1 Systematic literature review

[Paper I](#) (Eder 2019a) conducts a systematic literature review on innovation in the periphery, following an approach outlined by Wee and Banister (2016). As such, it made use of scientific databases such as Elsevier's Scopus and Google Scholar to gain an overview of the state of research. The review also pays attention to the importance of theory, by identifying the dominant theoretical concepts which the empirical analyses built upon. As such, it not only discusses the relevant theoretical concepts, but also shows that many empirical works do not relate to a theoretical framework at all.

Abstraction was then applied to the data set to narrow the field and to code the remaining publications. As such, this literature review relies on many forms of triangulation. First, data triangulation was part of the en-

deavour, as studies from different periods, regions and geographical levels were considered. Second, publications from various authors on the same subject were collected, as suggested by investigator triangulation. Third, it was kept in mind that these papers have different theoretical foundations, highlighting theoretical triangulation. Finally, publications with both extensive and intensive research designs were included for review. Although this does not fulfil the criterion of methodological triangulation in a strict sense, as the review itself did not combine methods, taking into account different research designs did ensure that results were comprehensive.

For the subsequent analysis, descriptive statistics (extensive methods) were applied to present the thematic and geographic scope of the existing literature, as well as the theoretical underpinnings and the underlying periphery concepts. The interpretation of the results revealed desiderata in the literature, indicating the necessity of reconceptualization of, for example, the periphery concept. Based on this analysis and the evident need for reconceptualization, avenues for further research on innovation in the periphery are outlined, some of which are taken up by subsequent papers in this dissertation.

4.3.2 Additive index

[Paper II](#) (Eder 2019b) aims similarly to provide a descriptive foundation for the intensive methods in [Paper III](#). It builds upon one of the main findings of [Paper I](#), which is the inadequateness of simplistic periphery concepts based on accessibility and population density. Using abstraction and the peripheralization literature, it identifies a set of indicators for analysing the regional preconditions for innovation in Austria. In other words, it focuses on the degree of peripheralization and its implications for regional well-being. This analysis relates the districts of Austria to each other, which is a necessary precondition for region-

al case studies. As such, they are not isolated, but embedded in a broader perspective.

Again, theoretical triangulation is evident, as different views on the core-periphery dichotomy are discussed. Abstraction and reconceptualization based on this review are central for the proposal of a framework combining peripheralization literature and the approach of variegated knowledge bases. As such, this paper is highly theory-driven. The resulting framework does not intend to predict or generalize a regional typology; it rather aims at a more detailed conceptualization and therefore introduces a more nuanced explanation of the regional preconditions for innovation. An additive index is used as extensive method (as outlined by Heintel et al. 2017), combining data from the Austrian Conference on Spatial Planning, the Austrian Patent Office, and Statistics Austria. The results for the 95 districts of Austria are critically discussed with regard to the framework. The need for further (re)conceptualization is again highlighted in the directions for further research.

4.3.3 Semi-structured interviews

[Paper III](#) (Eder and Trippel 2019) builds on the descriptive analysis in [Paper II](#), which provided the basis for the selection of case study regions in Austria. While the extensive analysis with quantitative data in [Paper II](#) contributed to the frame of this dissertation, [Paper III](#) adds the in-depth investigation of innovation processes. In doing so, it analy-

ses both the role of locational disadvantages and advantages in peripheral regions. It thus relies on the explanatory power of narrative and interactive interviews to identify some of the reasons for the spatial pattern observed in [Paper II](#). To achieve this, 20 interviews were conducted with innovative firms in remote regions in Austria. Based on a review of the literature on challenges and benefits encountered in such regions, a framework for a better understanding of innovation in the periphery was developed. Hence, the interviews were later fully transcribed and coded deductively according to this framework, applying qualitative content analysis (Mayring 2015). This step was necessary in order to conduct a systematic and valid investigation, minimizing the challenges for the gathering of reliable knowledge with qualitative methods.

Theoretical triangulation and investigator triangulation to a certain extent played a role in the development of the underlying framework, considering, for example, the proximities literature, the approach of global pipelines, and the MLP. In addition, abstraction and reconceptualization were crucial for defining the research gap and for the identification of the major themes of the semi-structured questionnaire. The results allow for a deeper understanding of innovation processes in peripheral areas, which would not have been possible with a quantitative approach – on the one hand, because of the lack of quantitative survey data on the individual scale, and on the other, because of the complexity of this issue. As such, an intensive approach offers a better opportunity to uncover relevant mechanisms, which may later be translated into more robust policy recommendations.

5 Main findings, conclusions, and outlook

To conclude, this final section summarizes the main findings of the dissertation by drawing conclusions, providing policy recommendations, and highlighting avenues for further research. To recapitulate, [Table 4](#) provides an overview of the three scientific articles that constitute this dissertation. It lists the central research question of each specific paper and the contribution to the overall research questions (see [Section 1.1](#)), the theoretical background (see [Section 2](#)), the geographical scope (see [Section 3](#)), the methods (see [Section 4](#)), and briefly summarizes the main findings. In doing so, it relates the single papers to the various sections of the framing text. While a summary of these papers is included in the introduction (see [Section 1.2](#)), the following concluding remarks focus on the overarching research questions

and display the main findings with a slightly different emphasis.

5.1 Summing up: innovation in the periphery

This dissertation provides manifold insights in the geography of innovation in various peripheries. It thus contributes to ongoing debates in economic geography and aims to provide an interesting contribution and inspiration for further research. Departing from a discussion on agglomeration effects, the nature of innovation, and its potential to alleviate regional disparities, a critical realist research design was adopted in order to

Table 4: Overview of the three articles constituting this dissertation (own elaboration)

Paper	Research questions		Theoretical background	Geographic scope	Method(s)	Main findings
	Specific Paper	Overall Thesis				
I (Eder 2019a)	What are the challenges for innovation in the periphery and what are the outcomes?	RQ 1	Proximities, Buzz/Pipelines, Innovation Modes, Knowledge Bases, RISs	International (37 countries)	Systematic Literature Review	There is an increasing interest in innovation in the periphery. However, more conceptual clarity and comparative research designs are necessary.
II (Eder 2019b)	How do various dimensions of peripheralization vary across regions?	RQ 2	Peripheralization, Knowledge Bases	National (Austria – 95 districts)	Additive Index	Few regions are either clearly central or clearly peripheral. The regional preconditions for innovation are highly diverse.
III (Eder and Trippel 2019)	What is the portfolio of compensation and exploitation strategies of peripheral firms?	RQ 3	Proximities, Buzz/Pipelines, Multi-Level Perspective	Regional (Austria – three peripheral regions)	Semi-structured interviews	Peripheral innovators need to compensate their location, but also see potential for exploitation, which leads to specific innovation processes.

provide answers to the overarching research questions. The main findings of this research endeavour are summarized below.

RQ 1 (*What are the challenges for innovation in the periphery and what are the characteristics of non-core innovation processes?*) was inspired by the fact that research of the geography of innovation has mainly focused on best-practice examples in urban areas and agglomerations. While this is still true, this dissertation has shown that since 2000, there is also an increasing interest in innovation in peripheral areas. There is more and more awareness that policies based on experiences from urban environments will hardly work in such areas. Hence, as innovation is often seen to be key for regional development of peripheries, more research is necessary that investigates innovation through a peripheral lens. This sheds light on the preconditions for peripheral innovation, peripheral innovation processes, and peripheral innovations itself.

The literature highlights frequent challenges such as low accessibility and therefore high transport costs, a low population density, and a lack of support infrastructure. Many other issues are mentioned, although to a lesser extent. Overall, most research applies a negative perception of peripheral locations towards innovation. Consequently, the common thinking is that firms need to adapt to this environment and have to internalise certain functions. Another characteristic of peripheral innovation is that it is often not captured by standard indicators such as patents, since it occurs in other sectors than high-tech.

As such, these findings are key for understanding the peculiarities of struggling regions. In order to make research results more comparable, the periphery concept has to be further developed. Basic distinctions on centre and periphery based on accessibility and population density are too simplistic and researchers have to be more explicit on their rationales for choosing case studies. It also remains largely unclear, which peripheral regions qualify as innovative. This dissertation

has also highlighted, that innovation can contribute to decrease uneven regional development, but that most peripheries do not have the necessary resources to enter growth paths based on innovation. The innovation imperative might therefore be sometimes ill-fated. In many regions, innovation can contribute to a more positive regional development, but it is not the solution to all difficulties.

RQ 2 (*What are the key dimensions of capturing the preconditions for innovation in the periphery, and which roles do geographic, demographic, and economic factors as well as knowledge bases play?*) addressed another desideratum in the literature. Too often, case studies are investigated without providing the necessary information on the actual strengths and weaknesses of a region. In addition, it sometimes remains unclear which core a region is defined as peripheral to. This dissertation aims to be explicit on these issues and proposes a framework based on the peripheralization discourse and regional knowledge bases. This framework goes beyond accessibility, population density, and a static understanding of periphery, as it also incorporates changes over time. The consideration of geographic, demographic, economic, and political indicators leads to a much more detailed picture of regional strengths and weaknesses. It also provides insights concerning the question why the same policy leads to a promising trajectory in one region and fails in another.

With regard to the empirical case of Austria, this dissertation has shown that when a more sophisticated approach is applied on a fine-grained scale, very few regions are either clearly central or clearly peripheral. While the overall assumption holds true that agglomeration has a more promising point of departure, some peripheries are doing surprisingly well, while some cities are struggling. Border and alpine regions are those that are challenged in most dimensions, but many regions have certain preconditions a regional innovation policy could build on. Especially the synthet-

ic knowledge base is above average in some rural areas.

The analysis has also revealed that demographic and economic prosperity do not always go hand in hand. In some peripheral regions, the regional economic performance is quite robust, but rates of outmigration are elevated. In addition, in the biggest cities of Austria, unemployment rates are usually higher than in rural areas. Still, they are the paramount destinations of internal and international migration. Although such a multifaceted approach bears the danger of fuzziness, it seems necessary to analyse the core-periphery-dichotomy in a more comprehensive way.

RQ 3 (*How do innovative firms deal with location advantages and disadvantages in organizationally as well as institutionally thin environments?*) is concerned with the actual relevance of geographical proximity for innovation processes of the 21st century. Innovators in peripheral locations have learned to deal with the absence of spatial proximity to research institutions, customers, suppliers, and markets. Larger distances are sometimes inconvenient, but partners for collaboration are chosen on grounds of expertise and sympathy, rather than on the principle of traveling distances. As such, firms in the periphery apply compensation strategies, allowing them to tap into global innovation networks. These strategies include building up a strong internal expertise, fostering formal cooperation, participating in temporal and virtual buzz, and maintaining urban branch offices. However, these firms have also reported various exploitation strategies that are useful in the innovation process. The high loyalty of the workforce, which limits unwanted knowledge spillovers, was frequently mentioned. In addition, the examples of a high institutional leeway in the region, a tranquil environment, and lower factor costs were given. The latter also has relevance for the innovation process, as lower wages and cheaper plots allow firms to maintain R&D and production at the same location in high-wage countries.

In a nutshell, whereas spatial proximity has not become irrelevant, the results confirm the proximities approach which states that being close physically on a daily basis is not necessary for innovation processes, as long as there are other foundations that firms can build upon. Dimensions like cognitive and social proximity were frequently highlighted. Some innovators even deliberately chose a remote location to decouple from the constant buzz in cities. As such, this dissertation provides detailed insights into innovation processes of different industries, but also of firms in urban and rural environments. Cities with their agglomeration effects provide the necessary foundations for certain innovations, but it is also demonstrated that peripheries possess particular advantages which innovators can utilise. By highlighting exploitation strategies such as harnessing the protective environment or capitalising on institutional leeway, the dissertation emphasizes that a predominant negative perception of peripheries is too simplistic.

5.2 Conclusions and policy recommendations

This dissertation has clearly highlighted the importance of place-based approaches, as it has shown that urban and rural areas do not represent extreme poles, but that many regions experience processes of centralization and peripheralization simultaneously. The diversity of regions and innovations implies that a sound innovation policy has to consider this pluralism. This recommendation has become quite common amongst economic geographers (Barca et al. [2012](#)).

As such, the dissertation highlights that focusing on spatial proximity might make sense in an urban environment and in a sector such as Life Sciences, in which access to costly infrastructure is crucial. Otherwise, understanding clusters as spatially bound on

a regional scale seems increasingly questionable. As the example of Austria illustrates, cluster networks at the level of states (*Bundesländer*) are open to firms from other parts of the country and even from abroad. Consequently, firms in the periphery are members of the relevant clusters, although they are located remotely. These networks are, accordingly, more of a sectoral nature, based on cognitive rather than on spatial proximity. As such, it appears that reality has already gone beyond the strict interpretation of TIMs.

Another important conclusion is that the analysis of the urban and the rural should go beyond this clear-cut dichotomy. Although it is convenient to focus on accessibility and population density, as these data are often easily accessible, such an understanding is also simplistic. As the peripheralization discourse implies (Kühn 2015), urban areas can be peripheral and peripheries can perform surprisingly well. Furthermore, not all regions are central or peripheral in all dimensions and these dimensions are in constant flux. Frequent monitoring of these trends therefore is crucial.

Finally, this dissertation has also demonstrated that looking not only at innovation in an urban and thriving region, but also considering the “dark side of economic geography” (Phelps et al. 2018) is insightful and deepens our understanding of uneven space. Considering the present-day rise of populism (Rodríguez-Pose 2018) and in the wake of increasing regional disparities (Iammarino et al. 2019), a renewed interest of economic geographers in spatial inequality might further increase the societal relevance of the discipline.

Against this background, this dissertation has highlighted the importance of successful and accurate regional and innovation policy for peripheral regions. This is true not only for reasons of economic well-being, but also in a broader societal and political perspective, relating to current debates on the “places that don’t matter” (Rodríguez-Pose 2018). To respond to these trends, place-based policies are in demand and this recommendation has

already successfully entered the policy arena via the concept of S3s. These so-called mission-orientated policies are fundamental in the most recent generation of EU regional policy and are even a precondition for receiving funding (Foray 2014, 2018).

As such, this dissertation underlines that S3s need to consider the diversity of regions, should not only focus on high-tech sectors alone, and should emphasize relations to international partners. As Trippl et al. (2019) find, S3s display a degree of positive impact in so-called less-developed regions, suggesting that they are a promising policy tool for peripheries. Hence, the following policy recommendations could inform policy makers who are interested in providing tailor-made policies for such regions. One issue is that innovators are scattered and highly diverse in peripheral regions and it might be challenging to define a specialisation in such un-specialised regions. Therefore, the following points focus on a number of challenges and characteristics usually found in such areas.

First, innovation policy can serve as a means of making lagging regions more attractive, but only on the long run and only if regional needs are taken into account. Rather than constructing a new office building by chance, policies need to carefully consider the specific needs of the addressed innovators. Targeting them explicitly is more likely to lead ultimately to the intended favourable regional development.

Second, as the literature suggests and as this dissertation has further confirmed, innovation policies should focus on the relevant proximity dimensions, which are highly place-specific. While some regions might benefit from a better physical infrastructure, which results in decreasing travel times (Meili and Shearmur 2019), other approaches such as platform policies highlight that trans-regional collaboration and innovation are also spurred by distributing ideas from outside within a region, which challenges traditional cluster policies (Cooke 2012). Especially in peripheral areas, a focus on spatial agglomeration seems

ill-fated and more emphasis should be put on fostering trans-regional knowledge networks. This should benefit firms under the umbrella of the defined S3s, but even more so, highly specialised firms that are operating in a niche outside the scope of the S3 of a peripheral region.

Third, as the empirical results have displayed, both central and peripheral regions have different configurations of knowledge bases. However, as all three knowledge bases are considered important in innovation processes (Strambach and Klement [2012](#)), such an analysis could provide the basis for introducing the know-how of currently less-developed knowledge bases to a region. Complementing knowledge bases could therefore increase the innovativeness of a region, as this additional knowledge sources could be used to upgrade the products and services of local firms substantially. S3s could take this into account to further strengthen the selected industries.

Fourth, policy makers should help firms to keep track of regional trends and develop concepts to tackle these changes together (Vonnahme et al. [2018](#)). Few peripheral regions will enter growth paths again, but it lies at the core of regional policy to provide the basic preconditions to run a business and to alleviate current developments. Especially in peripheral regions, trends like out-migration and ageing can only be addressed by a comprehensive approach, which brings together policy makers, firms, and the civil society, i.e. the key individuals of regional development (Sotarauta [2010](#); Leick [2019](#)). S3s will therefore need constant adaption to developments inside and outside the region.

5.3 Avenues for future research

The three scientific articles have different implications for future research and provide some directions for interested scholars, re-

garding their specific topic. Hence, this closing section provides some overarching reflections on suggestions for subsequent work. This dissertation has aimed to put innovation in peripheral regions on the research agenda of economic geography more prominently, as research on innovation in peripheral areas is still poorly understood (Eder [2019a](#)). Further research on this highly relevant topic might contribute to one of the great societal challenges ahead, namely reducing or managing regional disparities.

Both theoretically and empirically, this dissertation has aimed to reduce the lack of concepts and empirical evidence for innovation in peripheral areas, both by providing a framework for the analysis of the degree of peripheralization of regions and by conceptualising peripheral innovation processes. However, theories of the geography of innovation have to be developed further and tested empirically, incorporating the specific perspective of peripheral regions. First, more work is necessary to address the diversity of peripheries, which has important implications for place-based policies going beyond the poles of urban and rural (Leick and Lang [2018](#)). While this dissertation has mainly considered inputs for innovation towards developing a typology, considering outputs such as actual innovations should also provide important insights. The focus could lie on the dimensions of centralization or peripheralization favouring or hindering innovation the most in practice. This could lead to a better understanding of the proxies for innovation, going beyond mere agglomeration effects.

Second, a more dynamic perspective on spatial processes is needed. Most work to date has investigated the status quo, often in case studies (for an exception see Doloreux et al. [2007](#)). However, quantitative analyses are also often limited to a single year or short periods of time because of data limitations. An evolutionary and comparative perspective should provide more insights concerning pertinent questions, including: Why do some

peripheral regions decline while others enter growth paths, although the preconditions had been similar? How sustainable are emerging paths? And what makes the actual difference: tailor-made policy, key individuals, or – after all – pure coincidence?

Third, while innovation processes in urban areas are well researched, this dissertation has attempted to open the black box of peripheral innovation processes. However, more work is needed to conceptualize the specific characteristics of peripheral innovators, also in comparison to their urban counterparts (Vonnahme and Lang 2019). Innovative firms might be surprisingly similar, regardless of their location. Another important question in terms of regional development concerns the kind of innovations that are found in peripheral regions, other than high-tech innovations. Low-tech or social innovation might possess even more potential for regional resilience in such environments.

Fourth, further methodological developments are in demand for analysing the spatial pattern of the geography of innovation. While the problem with patents are well documented, they are still widely used, as patent data are usually readily available on a fine-grained geographical scale (Kleinknecht et al. 2002).

Therefore, a future challenge is that of mapping urban and rural innovation in a comprehensive way, also capturing peripheral innovations that might be overlooked by a focus on patents. This could be achieved either by developing new indicators and data sources, or by more comparative research.

Finally, innovation is often exclusively conceptualized in a positive way. Consequently, it is seen as a key for peripheral regions in terms of regional development. However, peripheral regions often have limited capacities for innovation (Oughton et al. 2002) and innovation in core regions frequently takes place at the expense of remote areas (Phelps et al. 2018). As this dissertation has shown, the prevalence of innovative firms alone is not sufficient to change the trajectory of a region, especially if upscaling and marketing is realized in cities (Shearmur 2017). Hence, if the research on innovation in the periphery aims to provide guidance on how the gap to agglomerations can be narrowed, more work in a different direction is necessary. Rather than analysing the preconditions for innovation in the periphery, emphasis should be put on the question of the ways in which peripheral innovators can be supported in harvesting the benefits of their innovations locally.

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Paper I

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Review

Innovation in the Periphery: A Critical Survey and Research Agenda

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Abstract

Scholars of the geography of innovation have produced an impressive body of literature over the last decades. However, until recently this research focused on successful core regions, implicitly assuming that there is no innovation in peripheral areas. This view is being increasingly questioned, which is reflected by a rising number of papers, special issues, and edited volumes on innovation outside of agglomerations. Hence, this rapidly emerging field calls for a critical survey. In order to identify a future research agenda, this article conducts a systematic literature review of the work on innovation in the periphery (1960–2016). As such, it explores the recurring themes and key issues of the field and discusses the various periphery concepts applied, ranging from a geographic to a functional perspective on various scales. In doing so, it outlines options for policy makers and suggests avenues for future research: first, the periphery concept needs more refinement. Second, future studies should include systematic comparisons of regions. Third, an evolutionary perspective might provide new insights. Fourth, future work could explore the benefits peripheries offer for certain kinds of innovation. Fifth, urban–rural linkages might be of higher relevance than assumed. Sixth, research should go beyond the well-known examples. Finally, the analysis could be extended by applying a broader understanding of innovation.

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innovation, innovation policy, periphery, proximity, regional development

Introduction

The relation between geographical proximity and economic development is a key aspect in economic geography (Simmie 2005; Howells and Bessant 2012). Numerous scholars are citing the seminal work of Marshall (1919, 284) and his notion of the *industrial atmosphere* in Sheffield and Solingen, implying that there are benefits stemming from localization economies. However, since Jacobs (1969), there is also little doubt that urbanization economies are beneficial and that they might be even more important. This is underlined by the recent debate on the related variety (Frenken, Van Oort, and Verburg 2007), which argues that Jacobs' externalities (i.e., related variety within sectors) are crucial for economic development and innovation.

Following the ideas of Marshall (1919) and Jacobs (1969), territorial innovation models (TIMs; Moulaert and Sekia 2003, 291) have become influential within economic geography and consequently in policy-making but have hardly ever yielded the expected results (Martin and Sunley 2003). Hence, a critique of these models is now well-documented and accepted within the discipline (Moulaert and Sekia 2003; Crevoisier 2014). Some of the issues raised are the lack of conceptual clarity and the limited explanatory value for noncore regions. As TIMs assume that spatial proximity and urbanization economies are beneficial or even mandatory for innovation, this would mean that firms in peripheral settings could not innovate. The dominance of TIMs might also have been a reason why there has not been much interest in innovation processes and potentials of peripheral regions.

Recently more and more scholars are expressing their discontent with this bias toward agglomerations and the theoretical framework based on concentration (Petrov 2011; Shearmur 2011; Davies, Michie, and Vironen 2012; Shearmur 2015; Isaksen and Karlsen 2016). This bias might also be rooted in the focus on radical, patented innovations, which occur less frequently outside of cities (Davies, Michie, and Vironen 2012; Shearmur 2012). Another reason could lie in the fact that the marketing of an innovation requires services and financing available only in agglomerations, meaning that peripheral origins of an innovation could be overlooked (Shearmur 2015).

These theoretical considerations are underpinned by increasing empirical evidence showing that innovation can be found in remote areas as well. For instance, Virkkala (2007) studies innovation networks in remote Finnish manufacturing, Fitjar and Rodríguez-Pose (2011a) explain innovation processes in peripheral Norway, and Petrov (2011) observes an innovative Northern Canadian periphery. The growing interest in less favored regions is also reflected by special issues of journals (Lagendijk and Lorentzen 2007; Mayer and Baumgartner 2014) and edited volumes

by Bathelt, Feldman, and Kogler (2011), Cooke and Piccaluga (2012), Danson and de Souza (2012), and Shearmur, Carrincazeaux, and Doloreux (2016). Addressing this rapidly emerging subdiscipline of economic geography, this article applies an in-depth literature review in order to identify avenues for future research.

The structure of the article is as follows: the second section briefly outlines recent theoretical advances explaining innovation in the periphery, while the third section introduces the overall approach and the methodology of the literature review. Then, the fourth section introduces the findings of the first part of the review, which comprises the preconditions for innovation in the periphery, the innovation processes, and their outcomes. Thereafter, the fifth section turns to the second part and sheds light on the different peripheries investigated. Finally, following a discussion in the sixth section, directions for further research are outlined in the seventh section.

The Theoretical Context beyond TIMs

Before reviewing the literature, it seems necessary to embed the discussion in the wider theoretical debate on the role of space in terms of the geography of innovation. While the TIM literature has assumed that geographical proximity is beneficial and in fact necessary for innovative activity (Moulaert and Sekia 2003), current theoretical developments challenge this view and provide insights into how and when innovation can also be possible in peripheral regions. There might be cases where temporary spatial proximity is sufficient or where too much proximity is indeed disadvantageous. Furthermore, different types of innovation or business strategies might rely on different regional endowments. Consequently, scholars have come up with theoretical frameworks to explain how peripheral regions can be innovative despite low accessibility and the lack of a critical mass of actors.

In this regard, the proximity approach (Rallet and Torre 1999; Torre and Rallet 2005; Knoben and Oerlemans 2006) has been quite influential. It highlights that distance should not only be understood purely in a geographical sense and that too much proximity can lead to negative lock-in effects (Boschma 2005). For example, peripheral areas can be linked via organizational, cognitive, and technological proximity to other (core) areas and use these forms of proximity in their innovation process. Therefore, geographical distance is no longer the whole story. It can facilitate spontaneous exchange and cooperation but temporary spatial proximity (e.g., at conferences or trade fairs) can be sufficient (Torre and Rallet 2005; Rychen and Zimmermann 2008). The presence at such events can therefore help to overcome the disadvantages resulting from a peripheral location.

Related to this approach is the idea of global pipelines complementing—or under certain circumstances even replacing—a local buzz (Bathelt, Malmberg, and Maskell 2004). The basic assumption is that knowledge sourcing increasingly occurs on a global scale. This is necessary due to the high specialization in niches often required for innovation processes. Hence, firms might have to look beyond cities or regions for suitable partners and expert knowledge. There is evidence that such

global pipelines have already become more important than the regional environment (Fitjar and Rodríguez-Pose 2011b). Accordingly, this has profound implications for peripheral regions: if the local endowments become less important, then individual firms in a peripheral region lacking the option of local buzz can be innovative if they are well integrated in global pipelines.

Another important strand argues for a more diverse understanding of the pre-conditions for different types of innovations. In this regard, Jensen et al. (2007) introduced the concept of innovation modes. While the science, technology, and innovation mode highlights the importance of codified scientific and technological knowledge usually brought forward in cities, the doing, using, and interacting mode focuses on informal processes of learning and experience-based expertise. As such, the latter mode can be found not only in firms located in core but also in peripheral areas. In other words, not only high-tech industries usually located in cities can be innovative but many industries possess potential for innovation. In addition, a synthesis of these modes—the so-called combined and complex innovation mode—is also not exclusive to urban areas (Isaksen and Karlsen 2012).

Similarly, the knowledge base approach (Asheim, Boschma, and Cooke 2011) distinguishes between an analytical (science-based), synthetic (engineering-based), and a symbolic (arts-based) knowledge base. While the synthetic base also has potential to be available in more remote areas focusing on the combination of already existing knowledge and problem-solving, the other two are more likely to be found in larger cities with universities and their numerous amenities. Finally, Shearmur (2015) argues that such a vibrant environment might be suitable for innovations relying on the latest knowledge and on frequent interaction (fast innovators). However, firms might prefer a more isolated location with little interaction, building their innovation process more on in-house development and secrecy (slow innovators).

Recently, such ideas have also been incorporated into the debate on regional innovation systems (RISs). Although they initially belonged to the TIM family (Moulaert and Sekia 2003), a distinctive feature of RISs has always been that from early on, scholars provided typologies of different shapes of RISs (see, e.g., Cooke 1998, 2004; Asheim and Gertler 2005; Asheim and Coenen 2006). Hence, the concept has been refined over the years, and efforts have been undertaken to describe institutionally and/or organizationally thin RISs (Trippl, Asheim, and Miörner 2016). As such, RISs are also the theoretical framework for many studies investigating innovative activity in peripheral regions.

Furthermore, numerous studies refer to the relational turn (Bathelt and Glückler 2003) in this debate, as a large body of the work is emphasizing the importance of personal innovation networks and not focusing a priori on a spatial dimension. To conclude, there is now a broad theoretical foundation for conducting research on innovation in remote settings. Hence, the following section explores how these ideas have been tested empirically.

Research Approach, Method, and Sample Structure

The overarching goal of this article is to establish a knowledge base of the literature on innovation in the periphery. As such, the review follows a systematic approach outlined by Wee and Banister (2016). In doing so, the journal articles for this review were retrieved from two scientific databases: Google Scholar and Elsevier's Scopus. The search included two search strings targeting a publications title, abstract or its key words, namely (1) "Innovation AND Periphery OR Peripherality OR Peripheral" and (2) "Innovation AND Lagging OR Less-Favo(u)red OR Remote OR Rural." This was done to include not only articles using the term periphery explicitly but similar notions that are often used synonymously. In addition, (3) forward snowballing ensured that frequently cited journal articles and especially book sections not fulfilling these criteria or not included in these databases are considered in the review.

It is important to note that innovation is understood here as firm-level economic innovation, predominantly observed in the manufacturing sector. This was done in order to limit the scope of the review and to arrive at valid results for this kind of innovation. This seems legitimate as economic geography clearly has focused on this type so far (Shearmur 2012), and including other forms of innovation (i.e., social innovation, policy innovation, or public innovation) would lead too far.

The search was further restricted to original scientific publications in English, to the period January 1960 (i.e., the beginning of the period covered by Scopus) to December 2016, and to the fields of economic geography and regional science (the distinction is based on the background and affiliations of the authors as well as the methods of the papers), resulting in 124 publications. The search was not limited to specific journals or books but included all publications fulfilling the aforementioned criteria. However, nineteen publications were excluded from the analysis because they were lacking a clear geographical perspective or provided no specific results for peripheral areas. Additionally, in order to limit the scope of the review, studies on entrepreneurship (four) and path creation (three) in peripheral areas were excluded as well, as these important issues would justify their own respective reviews. Consequently, ninety-eight publications were found eligible for this review.

The vast majority (eighty) of publications follow a case study design, describing one or more particular cases. Only eighteen publications can be classified as spatial analyses (Shearmur 2011), meaning that an issue is explored for a larger study area and afterward conclusions for peripheral and central regions are drawn. Furthermore, forty publications are of a qualitative and forty-four are of a quantitative nature. The remaining fourteen combine both qualitative and quantitative methods. Finally, most studies (seventy-nine) explicitly mention peripheral regions, while the remainder is concerned with noncore areas in a more subtle way without labeling them as peripheral. An overview of the database for the literature review is provided in Table 1.

Table 1. Structure of the Database for the Literature Review.

Research Design/Methods	Publication Type		Discipline		Mentions of Periphery		
	Journal Articles	Book Sections	Economic Geography	Regional Science	Explicit	Implicit	Total
Case study	70	10	44	36	72	8	80
Spatial analysis	18	0	5	13	7	11	18
Qualitative	31	9	29	11	37	3	40
Quantitative	44	0	11	33	28	16	44
Both	13	1	9	5	14	0	14
Total	88	10	49	49	79	19	98

The coding of the ninety-eight publications regarding the main topics and the theories applied was rather exploratory and is in fact based on the reviewed literature itself. Hence, the following three recurring themes were identified: (1) preconditions for innovation, (2) innovation processes, and (3) innovation outcomes. Reflecting the brief overview on recent theoretical developments, the publications were also classified according to their theoretical framework: (1) proximity approach, (2) local buzz/global pipelines, (3) innovation modes, (4) knowledge bases, (5) RISs, and (6) innovation networks. Additionally, category (7) TIMs summarize publications referring to TIMs and the more traditional understanding of space of the 1980s and 1990s. Not classifiable publications according to this scheme were grouped into a separate class (8).

The study of innovation in peripheral areas has received increasing attention within the field of economic geography especially over the last decade, when the number of publications has risen significantly (see Figure 1). However, the origins date back to the work by Stöhr (1986) on innovation complexes in the periphery but remain scattered until the 2000s publications. From 2006 onward—with the exception of a few single years—the amount of literature has been growing, and recently publications per year have remained at a high level.

In terms of geographical coverage, it becomes clear that empirical work is predominantly of European origin. However, many countries appear only in multinational comparative analyses; in-depth case studies are generally available for countries with at least five publications. With a few exceptions coming from the developing countries, there is undoubtedly a spatial focus on the Northern and Southern peripheries of Europe, while the former has received more attention recently. The exception is Canada where the province of Quebec is the subject of various studies. Nevertheless, with twenty-two empirical studies, it is

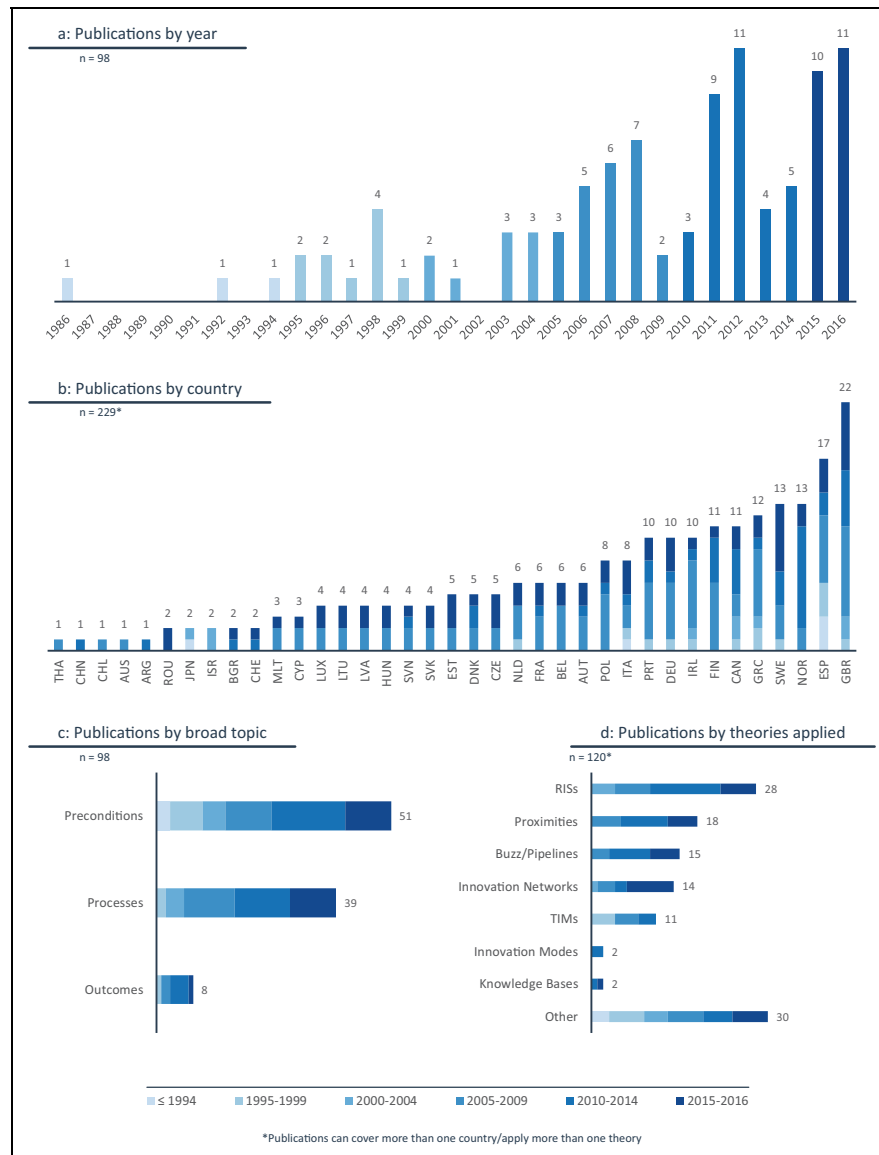


Figure I. Publications by year, country, broad topic, and theories applied.

Great Britain—mainly the Northern parts of the country—that is leading this list. Findings from all these countries are contributing to the literature on innovation in the periphery (for an overview of the sample, see Figure 1).

Consequently, the next section reviews the recurring themes and key issues found in the literature.

Characterizing an Innovative Periphery: Preconditions, Processes, and Outcomes

As mentioned above, three recurring themes could be identified in the publications targeting innovation in peripheral areas. First, the majority of the papers (fifty-one) deal with the preconditions for innovations and describe regional or company-related factors essential to triggering or maintaining innovative activities. Second, thirty-nine publications analyze the innovation processes in remote areas. Third, another and just recently emerging strand (eight) investigates the different types of innovation outputs and strategies in peripheral regions. In the following, each of these issues is discussed in detail.

Preconditions: When Is the Periphery Innovative?

Numerous studies focus on the preconditions that allow innovative activities also in peripheral settings, despite the lower accessibility, the lack of research and development (R&D), or a critical mass of actors. Work discussing the regional factors in particular is predominantly quantitative—though not always conclusive. For instance, Crescenzi (2005) argues that innovation efforts might have different outcomes in different regions. Consequently, if factors such as R&D expenditure or education are targeted, this might only yield a limited success. However, there is evidence that specialization externalities are more important for low-density regions, while diversity matters more for denser urban areas (Caragliu, de Dominicis, and de Groot 2016). Some authors argue that peripheral regions might be able to provide an innovative environment for small- and medium-sized enterprises (SMEs), while large enterprises rely on the richer environment usually found in core regions (Karlsson and Olsson 1998).

However, this is disputable and recent research challenges this view by arguing that especially in peripheral regions, company-related factors are crucial if a firm aims to be innovative. Some of these factors are absorptive capacity, company growth, firm size, and strategical planning (e.g., North and Smallbone 2000; McAdam, McConvery, and Armstrong 2004; Copus, Skuras, and Tsegenidi 2008; Varis and Littunen 2012; McAdam, Reid, and Shevlin 2014). Consequently, it seems that there is little doubt nowadays that regional factors influencing innovation in peripheral regions are diverse and that they might actually be of limited importance. Innovative firms are compensating for their location disadvantages through a more efficient internal organization (McAdam, McConvery, and Armstrong 2004; Glückler 2014).

Hence, considering these recent findings, it might be more accurate to speak of innovative firms located in the periphery rather than of innovative peripheral

regions. In other words, a relational perspective seems more suitable than a mere territorial perspective in describing peripheral innovative activity. With the absence of a vibrant environment and fewer possibilities to discover new ideas, scientific research, and possibilities for cooperation by chance, firms rely more on their own initiatives. Accordingly, it is unlikely that a peripheral region could provide all inputs necessary for a firm's innovation process.

Nevertheless, the importance of public subsidies, support institutions, and innovation policies should not be underestimated. Various papers focus on innovation policy targeting the periphery on different spatial scales: on the supranational (Kyr-giafini and Sefertzi 2003; Liagouras 2010), the national (Collins and Pontikakis 2006), but predominantly on a regional level (e.g., Frenkel 2000; North and Smallbone 2006; Soursa 2007; Karlsen, Isaksen, and Spilling 2011; Melançon and Dolor-eux 2013; Carlsson et al. 2014). This indicates that policy makers indeed see the regional level as most appropriate for innovation policy today, as was already suggested by Cooke (1998).

Most scholars acknowledge that a well-targeted innovation policy is crucial to triggering innovation in peripheral regions if it is based on a thorough analysis. The bad reputation of inefficient innovation policy stems from the fact that too often one-size-fits-all solutions have been implemented, neglecting the specific regional settings (Tödtling and Trippel 2005). For example, conflicting policies have been observed in Northern Finland where a mismatch between competitiveness policies supporting high-technology development and local policies promoting employment is evident (Jauhiainen and Moilanen 2012). However, even if efforts build upon regional expertise and include local universities and R&D, locations might possess limitations that can hardly be overcome with innovation policy, as the case of the marine biotechnology cluster in Tromsø shows (Karlsen, Isaksen, and Spilling 2011). Hence, regions with an innovation policy in place seem to be better off in the long run (Carlsson et al. 2014), but there is no guarantee that it will succeed.

A crucial factor for such a success might be the existence of a university or at least university branches. Peripheral regions that host a university clearly have an advantage over regions lacking higher education institutions. Nevertheless, the successful integration of a university in a peripheral RIS is ensured only if the resources provided by the university are the ones demanded by firms in the region.

This mismatch is often neglected and the reason why universities do not yield the expected returns (Charles 2016). However, if the relationship between region and university is developed along the strengths of the university and the needs of the region, there can be positive outcomes (e.g., Benneworth and Charles 2005; Schiller 2006; Kosonen 2012; Kempton 2015; Pinto, Fernandez-Esquinas, and Uyarra 2015). Such examples underline the importance of higher education infrastructure for peripheral regions, especially in terms of endogenous development.

In sum, regional endowments might influence the innovation potential of remote areas, but it is unclear to what extent. A more crucial precondition is the prevalence of firms focusing on innovation and actively overcoming the limitations of their

location. Such firms are ideally supported by a tailor-made innovation policy, including important regional actors like a university (if available). In this case, innovators possess the preconditions necessary to organize their innovation process in an efficient way. Consequently, if there is a critical mass of actors and a certain organizational and/or institutional thickness (Zukauskaitė, Trippel, and Plechero 2017), peripheral RISs can develop, as described in the next section.

Processes: How Can the Periphery Be Innovative?

The open innovation paradigm (Chesbrough 2003) has been very influential within the discipline and has replaced both the linear and the interactive innovation models. This thinking emphasizes the importance of interaction, spillovers, absorptive capacity, and external knowledge. Although these are equally important for firms in central and remote locations, there are different challenges to establish and maintain the innovation process. And by definition, this is harder to achieve in peripheral regions.

However, similar to central regions and inspired by the relational turn in economic geography (Bathelt and Glückler 2003), a number of studies investigate innovation networks in the periphery. They focus on teleworkers located in remote locations (Bergum 2012), core-periphery patterns in aspatial networks (Kudic, Ehrenfeld, and Pusch 2015), or innovation networks in general (e.g., Copus and Skuras 2006; Huggins and Johnston 2009; Li, Li, and Liu 2011; Esparcia 2014; McKitterick et al. 2016; Merli 2016). Most scholars conclude that innovation networks are crucial for innovative SMEs in the periphery, especially connections to extraregional actors. In such networks, public institutions are often essential to set the foundations and to trigger exchange. However, the development of extraregional networks might also depend on the accessibility of the region and therefore at least to some extent on geographical proximity (Copus and Skuras 2006).

Nevertheless, faced with the absence of universities, an underdeveloped support infrastructure and the lack of a critical mass (and therefore local buzz) firms might have no choice but to rely on such external linkages. Hence, another key issue in the empirical work is how firms in a peripheral location actually access the external knowledge necessary for their innovation activities. Although there might be potential for regional cooperation and knowledge transfer, there is a tendency in the literature to assume that external information is more crucial for peripheral than for core areas.

For example, external linkages are seen as essential in order to get access to the latest research or to specialized service providers and to gain knowledge about markets (e.g., Lorentzen 2007; Onsager et al. 2007; Fitjar and Rodríguez-Pose 2011a, 2011b; Fontes 2012; Rodríguez-Pose and Fitjar 2013; Dubois 2015, 2016). Hence, scholars argue that policy makers should emphasize securing the access to such external knowledge instead of trying to upgrade the local knowledge base.

However, the empirical evidence is not as clear-cut as this might suggest. In a study on Norway, Rodríguez-Pose and Fitjar (2013) highlight that firms are actually more likely to have international partners in the capital region of Oslo compared to

firms located in more remote and smaller towns of the country. This indicates that it might be a very individual decision of a firm how external knowledge is accessed and absorbed.

Besides the need for external and often international networks, formalized cooperation is also seen to have potential to replace the local buzz usually found in more vibrant environments. The basic idea is that without possibilities for spontaneous exchange and local cooperation, firms might aim to formalize their contacts to be able to maintain innovation networks over a larger distance. Empirical work tends to confirm this relation, and firms located in peripheral regions seem indeed to focus more on formal cooperation than firms in central locations (Grillitsch and Nilsson 2015; Jakobsen and Lorentzen 2015). To establish such international ties, foreign workers can be crucial also in peripheral regions (Solheim 2016).

Besides this emphasis on extraregional networks and formal cooperation, a large body of work actually investigates the emergence and internal processes of peripheral RISs. While scholars agree that thin regions have various disadvantages in creating an RIS, there is evidence that they can be found in such regions as well. However, they might not always be based on high technology, and again, contacts to extraregional actors are highly relevant. As in core regions, RISs in more remote areas can evolve more or less accidentally (bottom-up; Doloreux and Dionne 2008) or can be strategically planned (top-down; Coenen and Asheim 2012).

Peripheral RISs are analyzed in a rather descriptive way in Canada (Doloreux 2003, 2004; Doloreux, Dionne, and Jean 2007; Doloreux and Dionne 2008), the Czech Republic (Zitek and Klimova 2016), Greece (Kominaki 2015), Japan (Abe 2004), and Spain (Todt et al. 2007). Following a framework outlined in Trippel, Asheim, and Miörner (2016, 27), the examples of Baucé (Doloreux 2003, 2004), La Pocatière (Doloreux, Dionne, and Jean 2007; Doloreux and Dionne 2008), and Western Greece (Kominaki 2015) seem to fulfil the criteria of institutionally thick *but* organizationally thin RISs. On the other hand, Tohoku (Abe 2004) and Valencia (Todt et al. 2007) exhibit signs of an organizationally thick *but* institutionally thin RIS. None of the regions under investigation can be described as institutionally *and* organizationally thin RISs, indicating that such regions do not possess many characteristics that could actually be researched.

In conclusion, the empirical work highlights that firms in peripheral areas have options to participate in global knowledge networks and extraregional innovation activities. This relates to the previous section, indicating that the strategies of individual firms actively maintaining such linkages are most important. However, with a certain degree of concentration, successful thin RISs in which the local and regional scale play a more important role can be identified as well.

Outcomes: Which Innovations Can Be Observed in the Periphery?

Scholars have increasingly been pointing out that peripheral regions might have been overlooked in innovation studies due to a focus on high-tech innovations and

indicators such as patents (Petrov 2011; Davies, Michie, and Vironen 2012; Shearmur 2015; Isaksen and Karlsen 2016). However, as the knowledge base approach indicates, other industries can also be innovative, and peripheral regions where the economy might still rely more on manufacturing than on the service or scientific sector could actually have advantages concerning the synthetic knowledge base. Hence, it appears to be necessary to distinguish between different forms of innovations—with some more likely in certain regions than others.

So far, however, only few studies have pursued this direction. For instance, there is evidence that core regions are more innovative when process innovation is considered, but original innovations, on the other hand, can be found to a same degree in more remote locations (Lee and Rodríguez-Pose 2013). Still, innovations might occur in more traditional sectors that are less frequently studied (Alderman 1998) or might be of a more incremental nature. Peripheral firms are therefore predominantly innovation followers and not leaders (Shearmur 2011; Davies, Michie, and Vironen 2012). Furthermore, as Davies, Michie, and Vironen (2012) point out there might be hidden innovations not considered in traditional innovation surveys based mainly on R & D activities. The implicit assumption often found in the literature that innovation can only be found in central areas and that peripheral areas exhibit no innovative activity at all is therefore not confirmed empirically.

This has led to the concept of *slow* and *fast innovators* (Shearmur 2015). Accordingly, the former interact with less frequency, do not depend on the latest information, and can therefore be found in the periphery as well. On the other hand, the latter depend on frequent interaction, R&D, and access to various knowledge sources. Hence, in contrast to *slow innovators*, *fast innovators* are more likely to be located in diverse and dense areas. A first empirical analysis on the province of Quebec (Shearmur and Doloreux 2016) seems to confirm these theoretical assumptions. However, it is unclear whether this is true also for peripheries in smaller countries with comparatively overall high accessibility. As Tödtling, Lehner, and Kaufmann (2009) demonstrate, advanced innovations indeed rely on knowledge exchange with universities and business organizations, patents, and R & D. However, for the case of Austria, there is no difference between central and remote firms concerning these factors.

As this section indicates, considering incremental innovations, experimental development, and traditional industries in addition to science-based, high-tech innovation and patents might draw a more realistic picture of the innovation landscape. However, the empirical literature also shows that the notion of periphery is applied to a motley mix of regions. This raises the question of what actually qualifies as a peripheral region? This issue is explored in detail in the following sections.

The Multifaceted Understandings of the Periphery

Evidence on the recurring themes identified above stems from various peripheries. As Shearmur (2012, 11) points out, there are different types of innovations, which means that the term is not always understood in the same sense.

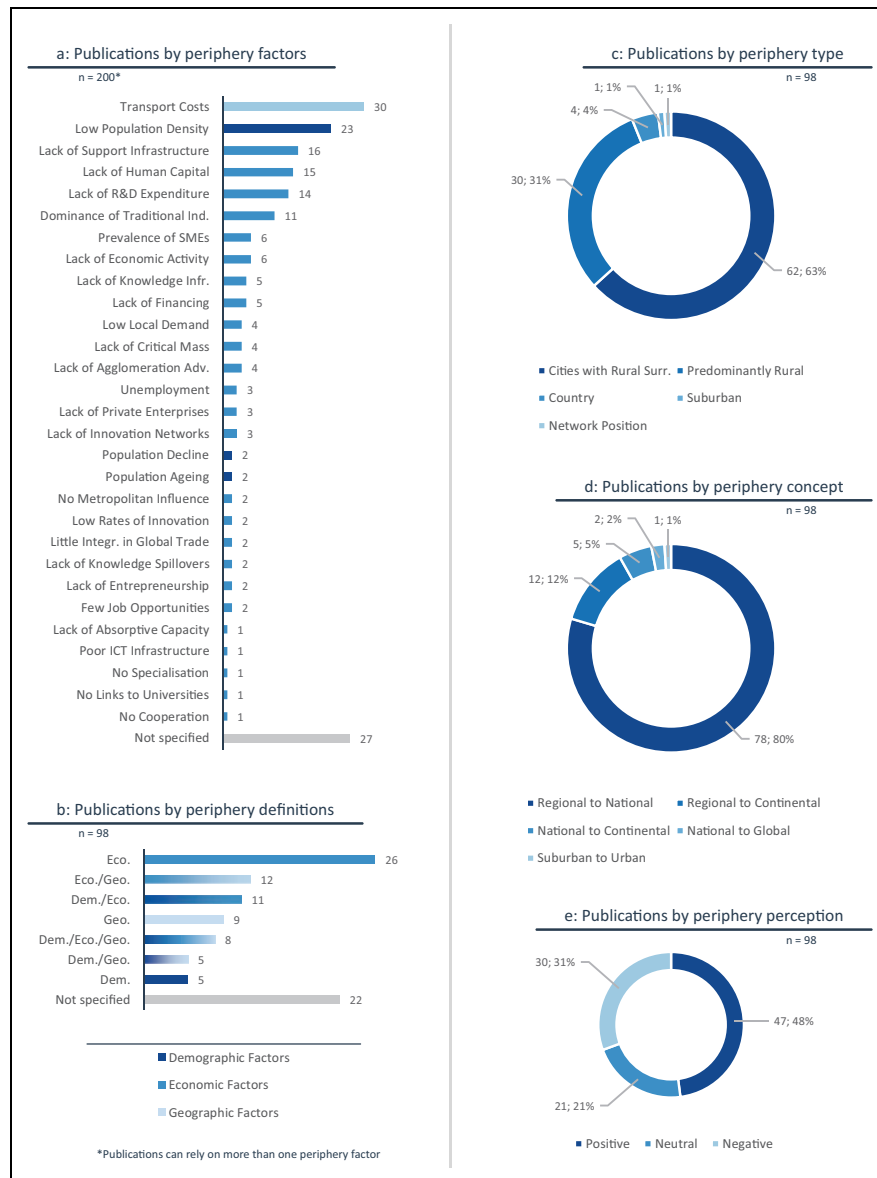


Figure 2. Publications by periphery factors, definitions, type, concept, and perception.

This is not any less true for the notion of periphery itself (see Figure 2). Hence, the comparison of results is often complicated by the different spatial contexts they stem from.

This becomes evident when analyzing the factors used to define the peripheral study regions. About thirty studies mention geographical factors—usually transport costs due to lower accessibility—in describing peripheral regions. Low population density as well as population aging and decline (i.e., demographic factors) are considered as well, although less frequently. The third and most diverse group is comprised by economic factors. Many authors see a lack of support infrastructure, human capital, R&D expenditure, and the dominance of traditional industries as decisive factors. On the other hand, twenty-seven publications are not specifying at all what challenges the region under investigation faces (e.g., Alderman 1998; Lorentzen 2007; Coenen and Asheim 2012; Brown 2016).

However, only few publications consider periphery in a purely geographical sense. These are mainly quantitative analyses for a large number of regions (e.g., North and Smallbone 2000; Rodríguez-Pose and Crescenzi 2008; Shearmur 2011). More often, only economic factors are used to define peripheral regions (e.g., Crescenzi 2005; Pinto, Fernandez-Esquinas, and Uyarra 2015; Trippl, Asheim, and Miörner 2016). Yet most studies actually apply a combination of economic, geographic, and more rarely demographic factors (e.g., Soursa 2007; Melançon and Doloreux 2013; Dubois 2015; Mayer, Habersetzer, and Meili 2016). Still twenty-two publications provide no information on why the research area is considered peripheral (e.g., Stöhr 1986; Doloreux, Dionne, and Jean 2007; Cooke 2011).

Another important distinction addresses regional infrastructure and the preconditions for innovation. About 60 percent of the studies focus on regions that host one or more large cities and therefore often include a university and a certain support infrastructure. Such regions are usually surrounded by a predominantly rural hinterland (e.g., Abe 2004; Glückler 2014; Kempton 2015; Shearmur and Doloreux 2015). In contrast, another third deals with rural peripheral areas which are—despite the lack of a critical mass—innovative at least to a certain degree (Dinis 2006; Copus, Skuras, and Tsegenidi 2008; Fløysand and Jakobsen 2011; Lee and Rodríguez-Pose 2013; Solheim 2016), although the innovation barriers are even more pronounced in such environments.

This leads to the question on which scale a region is defined as peripheral? In the vast majority of studies, a region is seen as peripheral compared to other regions of the nation it is located in. In fewer cases, it is the region (e.g., North and Smallbone 2006; Rodríguez-Pose and Crescenzi 2008; Arias-Aranda and Romerosa-Martínez 2010; Caragliu, de Dominicis, and de Groot 2016) or the country (e.g., Collins and Pontikakis 2006; Liagouras 2010; Fontes 2012; Merli 2016) that is seen as peripheral in relation to the whole continent. In addition, sometimes combinations of these concepts are applied.

Not surprisingly, about half of the studies have a positive attitude toward the periphery, concluding in most cases that innovation is possible in spite of the limitations posed by the remote location. This indicates that many studies are (purposely) selecting successful peripheral regions. Another group has a neutral attitude toward peripheral regions, mainly highlighting the challenges such regions face. However,

there is also empirical work drawing a rather sceptical picture of the issue of innovation in the periphery, concerned predominantly with ill-suited innovation policy. They question whether peripheries can actually overcome their challenges in the long run, arguing that disparities might become more pronounced (e.g., Liagouras 2010; Fitjar and Rodríguez-Pose 2011b; Karlsen, Isaksen, and Spilling 2011; Brown 2016).

As the analysis in this section has shown, rather than analyzing innovation in similar peripheral regions, the field is characterized by the study of innovation in various quite different peripheries. As the next section will point out, besides the varying application of the notion of periphery, another important question is largely absent in this debate.

Discussion: Innovation Imperative and Periphery Concepts—Peripheral Topics in Innovation Studies?

The literature review provided a detailed picture of the status quo of the research on innovation in peripheral regions. Although the selection process was designed to lead to a comprehensive database, it cannot be ruled out that single publications might have been overlooked. This should be taken into account in the following interpretation and discussion of the results.

Why Should the Periphery Be Innovative?

The most fundamental question also seems to be a trivial one: why should peripheral regions actually be innovative? Of the surveyed literature, only twenty-one publications briefly address this issue, claiming that innovation is crucial for economic growth and fostering territorial cohesion, especially for peripheral regions. The vast majority of the literature adopts uncritically the prevalent narrative of innovation studies, namely, that the changing economic landscape requires firms to be innovative, and being innovative is essential for being competitive and successful in the global economy (Shearmur 2012; Crevoisier 2014), highlighting that this might be true even more for peripheral regions with a lack of local demand (McAdam, McConvery, and Armstrong 2004).

While this at first appears compelling, at second sight, it becomes clear that applying a too positive attitude toward innovation to the periphery is challenging for such regions. As Oughton, Landabaso, and Morgan (2002, 98) put it:

The regional innovation paradox refers to the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions.

This paradox underlines that fostering an innovative culture might not be an available option for all peripheral regions, as they often lack the fundamental factors for

innovation (Tödtling and Trippel 2005; Mayer and Baumgartner 2014). It is beyond doubt that there are successful innovative peripheries and there is evidence that at least for some remote regions implementing innovation strategies might be a promising strategy to tackle depopulation (Isaksen and Trippel 2016), to diversify the economy (Doloreux and Dionne 2008; Carlsson et al. 2014), or to increase employment (North and Smallbone 2000; Virkkala 2007; Carlsson et al. 2014).

However, although these insights have provided a more comprehensive understanding of the geography of innovation, they also indicate that case studies of successful agglomerations have been accompanied by successful peripheries. In other words, while previous research was picking winners like cities or clusters, the study of innovation in peripheral areas is also looking mainly at the most notable examples. And some of these might not be that peripheral after all, like the suburbs of the Quebec agglomeration (Doloreux 2003, 2004) or university towns in Norway (Rodríguez-Pose and Fitjar 2013) or the United Kingdom and the Netherlands (Benneworth and Charles 2005).

Hence, there is also a tendency for neoregionalism in the study of innovation in the periphery. Spatial analysis—as outlined by Shearmur (2011)—remains the exception. The argument here is not that innovation cannot occur in peripheral regions or that case studies cannot provide useful insights. Rather it is important to highlight that innovation also in remote areas is often based on at least a certain degree of concentration, path dependency, external inputs, and/or accessibility. Most authors acknowledge this and point out that findings from case studies should not be transferred uncritically to other regions. However, it is important to underline this in order to avoid false hopes of policy makers from previously uncompetitive and non-innovative peripheral regions. As the research has also shown, the crucial factor is not the region itself or its innovation strategy but a firm's competences, absorptive capacity, and willingness to be innovative.

In sum, while there are critical voices directed at the pro-innovation bias (Godin and Vinck 2017) and innovation policy in peripheral areas needs to be especially careful, innovation practices certainly have the potential of overcoming the downsides of a peripheral location. Especially, if the preconditions for maintaining global pipelines or a synthetic knowledge base are available. However, the possible positive outcomes should not be overestimated. The success of some regions might rely on specific factors or on a path that is not transferable to other regions. Hence, a focus on innovation can be rewarded, but some regions clearly should not try to seek their fortune in technological, firm-based innovation but rather take another path.

What Actually Is an Innovative Periphery?

Related to this argument is the crucial question of which regions or countries should be seen as peripheral? As Jauhiainen and Moilanen (2012) point out, there is a geographical (remoteness, which leads to few relevant development actors and low innovation capabilities as well as entrepreneurship) and functional (weak human

capital, thin institutional structures, poor quality of information and communication technology infrastructure, and scarce links to markets) perspective.

As the theoretical debate outlined above has shown, a definition based only on a geographical perspective is insufficient to delimit an innovative periphery. Consequently, most scholars are acknowledging this by applying definitions that also include a functional perspective, that is, economic factors. However, the analysis revealed that a fifth applied no definition of the periphery at all. Another example highlights different perceptions of the periphery: while Stöhr (1986) describes the Third Italy as an innovative periphery, many scholars mention it alongside Silicon Valley and Baden-Württemberg as one of the most successful clusters or RISs worldwide (Doloreux and Parto 2005; Uyarra 2010). As such, it can hardly be described as peripheral.

Indeed, the scope of innovative peripheries found in the literature is broad. It ranges from fishing villages in Northern Norway (Fløysand and Jakobsen 2011) and regions with bigger cities at the edges of the European Union (e.g., Arias-Aranda and Romerosa-Martínez 2010; Fontes 2012; Harris, McAdam, and Reid 2016; Merli 2016) to countries in the Global South (Schiller 2006; Glückler 2014). This illustrates that the research on innovation in the periphery is more diverse than one might assume, which is also the result of an arbitrary application of the term periphery itself.

Despite this, a theorization of the notions of central and peripheral regions is largely absent within the geography of innovation. As pointed out above, most studies do not go beyond acknowledging that not only geographical but also functional factors are important in delimiting peripheral regions. However, this does not represent a sound theoretical framework that would allow for a profound cross-regional or cross-country analysis. Hence, from the perspective of an individual reader not familiar with the peculiarities of a country or a region, a case study might not seem to fulfil the criteria of being peripheral.

It is not the aim of this article to argue that some regions or countries are not peripheral enough and should be neglected in further analyses. However, the scope should also not become too arbitrary—an issue for which the research conducted under the umbrella of the TIM family has been widely criticized (Moulaert and Sekia 2003). As a comprehensive framework is currently not available, this complicates the scientific debate and the comparison of case study results across regions. Therefore, future work would benefit from a more careful, theory-led application of the concept of periphery.

Questions toward a Research Agenda

The amount of work on innovation in the periphery is still low in comparison to what has been written on cities and clusters (Shearmur 2012). Nevertheless, recent theoretical developments and empirical work have started to open the black box of innovative activities in peripheral areas. While some topics have received quite an

amount of attention, more efforts are needed to understand less frequently explored issues.

Some scholars have already shown interest in such more marginalized topics. Among these topics are lack of financing (Lee and Brown 2017) and poor governance (Rodríguez-Pose and Di Cataldo 2015), which can hamper innovative activities in peripheral regions. Furthermore, Birch and Cumbers (2010) highlight the challenges of such regions in becoming integrated in knowledge-based commodity chains. Another body of work indicates that in some regard, peripheral regions might be quite similar to central ones. There is evidence for a positive impact of immigration (Kalantaridis and Bika 2011) or niche marketing strategies (Dinis 2006), and there is no difference in the uptake of knowledge intensive business services based on a firm's location (Shearmur and Doloreux 2015).

Additionally, future research could develop along the following issues: first, there is a need to be more explicit about the type of periphery under investigation. Future studies should put more emphasis on outlining the peripheral setting (both from a geographical and functional perspective) of the study area in order to make research results comparable across regions and countries. Another step would be to try and arrive at a more theory-driven definition of innovative regions, both peripheral and central. Such a framework could include new theoretical developments such as the innovation modes or the knowledge base concepts, highlighting the different strengths and weaknesses of regions concerning different types of innovations.

Second, as the literature is seemingly dominated by case studies of successful regions, the identification of crucial factors for innovation might be biased. Hence, a systematic comparison between peripheral regions with and without innovative firms might provide important insights. This would go beyond the focus on best practice examples but would also include unsuccessful strategies and failed firms. Such analyses might help to answer questions such as why different regions produce different innovations? Why similar points of departure lead to different outcomes? and why some regions fail to be innovative at all?

Third, related to the above is the need for a dynamic perspective. Only few studies (Doloreux, Dionne, and Jean 2007) employ an evolutionary perspective, although this is crucial to understanding whether and how regions or firms located in the periphery can become innovative over time. Hence, future studies should go beyond describing the status quo. This is also important as a region might become central or peripheral over time, and periphery should be seen as a dynamic concept.

Fourth, the current work is overwhelmingly trying to explain how firms located in peripheral locations can be innovative despite the challenges imposed on them by their environment. However, there are indications that (relative) isolation might in fact be a business strategy (Shearmur 2015) and that SMEs might rely on secrecy (Shearmur 2012). Furthermore, a peripheral location can serve as a testing ground (Glückler 2014). This strand is in opposition to the view that concentration is always beneficial and provides plausible arguments. It also argues for more analysis on the individual firm level instead of the regional level. However, evidence of firms

deciding deliberately to locate to remote locations in order to harvest this potential has so far been limited (Mayer and Baumgartner 2014).

Fifth, and directly linked to the above, is the importance of urban–rural linkages. Although this is indirectly addressed in studies focusing on knowledge sourcing and innovation networks, there is only little work acknowledging that ties to urban cores can be a crucial factor for peripheral innovation (Mayer, Habersetzer, and Meili 2016). Future research could therefore overcome the dichotomy of studying urban or peripheral areas, focusing on the one hand on mutual interaction and on the ways they can benefit from each other. On the other hand, studies could explore how such ties can actually suppress the innovation base in peripheral regions, for example, by the recoupling of a global production network (MacKinnon 2012).

Sixth, scholars of the geography of innovation have expressed a discontent with the bias toward successful core regions (Petrov 2011; Shearmur 2011, 2015; Isaksen and Karlsen 2016). However, the literature on innovation in the periphery also seems to focus on the most successful examples in some of the most well-developed economies worldwide. It might make sense to look at peripheral regions with no innovative activity for comparative reasons. Furthermore, the field could benefit from more research applying a spatial analysis approach (Shearmur 2011) and by looking at thus far understudied regions and countries rather than analyzing well-known examples anew.

Finally, the pro-innovation bias has led to the assumption that all peripheral regions should be innovative and that fostering innovation activities is a crucial task for policy makers. However, as the innovation paradox (Oughton, Landabaso, and Morgan 2002) and critical voices (Godin and Vinck 2017) show, this might not be an option for all regions, especially not for peripheral ones. Research on the economic well-being of remote regions could therefore look at successful firms, despite being seemingly not innovative. At least in terms of classical indicators such as R&D spending or patents. A broader understanding of innovation (e.g., ecological, frugal, and disruptive innovation) might provide insights into regions where firm-level technological innovation is not an option.

There is still little doubt that cities play an important role in global innovation processes (Shearmur 2012). However, as this review has shown, the actual situation is not as binary (innovative core vs. non-innovative peripheral areas) as it was often understood. Recent research has shed light on various issues and peculiarities of remote areas. Alongside theoretical advancements, there is now a sound basis for analyzing such issues. However, there are still paths less traveled and enough directions available along which future work could develop with the aim of providing a more comprehensive and comparable picture of innovation in the periphery.

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Peripheralization and knowledge bases in Austria: towards a new regional typology

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ABSTRACT

Scholars are increasingly interested in innovation in peripheral areas. However, research and policy documents are still often based on a traditional understanding of the core–periphery dichotomy. Here, the peripheralization discourse argues for a broader understanding and highlights the importance of economic, demographic, and political factors as well as knowledge intensity for defining core and peripheral areas. Concerning the latter, the differentiated knowledge base approach provides new insights, as it emphasizes the varying foundations for different kinds of innovations. By combining these hitherto unconnected strands of literature, this paper first develops a conceptual framework for a new regional typology, which considers both the degree of centralization/peripheralization and the prevailing knowledge base. Second, an exploratory analysis applies this framework to the 95 districts of Austria and provides first insights into peripheralization and issues of regional prosperity. The results show that there are indeed many nuances and that regions that are clearly either central or peripheral are the exception. Furthermore, peripheries come in many shades and are not uniform, as often assumed implicitly. Consequently, this paper argues that a tailor-made innovation policy for lagging regions would benefit from the incorporation of the peripheralization discourse. To conclude, it outlines directions for future research.

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Introduction

Over the past few years, there has been an increasing interest in innovative peripheries within economic geography (Eder, 2018). The basic question is how firms in remote locations are able to overcome barriers to innovation in so-called thin innovation systems (Doloreux, 2003; Isaksen & Trippl, 2017b; Trippl, Asheim, & Miörner, 2016). For instance, Grillitsch and Nilsson (2015) have shown that firms in peripheral areas are compensating for local knowledge spillovers by relying more on formal collaborations, while Grillitsch, Martin, and Srholec (2017) demonstrate that peripheries can also possess

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a high diversity. Others argue that innovation processes in remote regions might differ from the now widespread paradigm of open innovation (Shearmur, 2015; Shearmur & Doloreux, 2016).

However, one shortcoming in most of the existing literature is the limited understanding of the core–periphery dichotomy. Often it remains unclear, why a region is seen as peripheral, on what scale, and in relation to which core. This has led to the implicit assumption that peripheries are seemingly uniform, characterized by low accessibility and low population density, which limits the comparability of the many case studies regarding innovation in the periphery (Eder, 2018). As a consequence, the predominant view still is that remote regions have little to offer for innovative activities and that cities are the main drivers for economic prosperity, especially amongst policy makers and in the public debate (Shearmur, 2012). In this regard, the peripheralization discourse argues for a more nuanced understanding of the core–periphery dichotomy (Kühn, 2015; Kühn & Weck, 2012). In addition to accessibility and population density – still widely used in policy making but also in research (Crone, 2012) – it advocates the inclusion of economic, social, and political factors for the analysis of regions and suggests a dynamic and multiscalar perspective. These advancements are an important contribution to the discussion of periphery concepts within economic geography.

Furthermore, knowledge intensity is also one dimension within the concept of peripheralization, but it is thus far often understood in a binary way, in which the existence or absence of knowledge-intensive branches are analyzed (Kühn & Weck, 2012). Here, approaches like innovation modes (Jensen, Johnson, Lorenz, & Lundvall, 2007) and knowledge bases (Asheim, 2007; Asheim & Coenen, 2005) have shown that the preconditions for innovation can rely on different foundations and practices and that the combination of innovation modes (Isaksen & Karlsen, 2012) and especially knowledge bases (Asheim, Grillitsch, & Trippel, 2017; Strambach & Klement, 2012) results in the most innovative output. Consequently, the concept of peripheralization might benefit from the incorporation of these approaches for a better integration of knowledge dynamics and innovation activities.

Hence, based on the peripheralization discourse and differentiated knowledge bases, the main aim of this paper is to analyse the degree of peripheralization on various dimensions in order to highlight the multifaceted characteristics of peripheral regions. They might suffer from various shortcomings, but might still be able to provide basic preconditions for innovations. Knowing about regional specificities can be seen as crucial for policy makers, as common categories like ‘old industrial regions’ or ‘remote agricultural regions’ might be too broad. Consequently, the focus here lies not on the innovation process or the behaviour of peripheral firms, but rather on the regional preconditions for innovation and the challenges local firms face. The paper first develops a framework that connects the hitherto unconnected strands of literature of peripheralization and knowledge bases, which allows for a new typology and accordingly for a differentiated view on peripheral regions. Second, a peripheralization index (PI) is constructed in order to analyse the empirical example of Austria. Accordingly, the following research questions are the basis for this paper: How do various dimensions of peripheralization vary across regions? What role does accessibility play in this regard? In addition, how does accessibility relate to differentiated regional knowledge bases?

The results show that neither central nor peripheral regions are uniform when different factors of peripheralization are considered. Furthermore, the frequent assumption that

central regions combine various knowledge bases while they are largely absent in peripheral areas can only be partly confirmed. Hence, accessibility alone is not sufficient to characterize the degree of a region's peripheralization. These findings strengthen the argument that regional innovation policies need to be based on a systematic analysis of the characteristics of a region (Tödtling & Trippel, 2005) and that the analysis of peripheral regions has to go beyond accessibility and agglomeration advantages (Crone, 2012). Section 2 of this paper reviews the literature on peripheralization and knowledge bases and develops a conceptual framework. Section 3 introduces the data and methods used, while section 4 presents and discusses the results. Finally, section 5 concludes this paper and identifies paths for further research.

Theoretical framework: peripheralization and differentiated knowledge bases

Recently, a periphery discourse has been developing within economic geography, but has thus far not been very influential in the research on the geography of innovation. It builds upon classical concepts like land economy, regional science (Copus, 2001) and polarization theories (Copus, 2001; Kühn, 2015) and incorporates insights from other disciplines such as sociology and political science (Kühn, 2015). In contrast, the differentiated knowledge base approach (Asheim, 2007; Asheim & Coenen, 2005) is well established within the discipline and serves as the theoretical underpinning of a large body of empirical work. This section briefly reviews both bodies of work and develops a conceptual framework that combines these hitherto unconnected strands of literature.

The periphery discourse in economic geography

Historically, distance plays the decisive role in defining the periphery in economic geography. Early theories dating back to the eighteenth century assume that distance from agglomerations can at least partially explain weak economic activity, as penalties arise from increasing transport costs (Copus, 2001). Similar premises hold true in polarization theories developed in the 1950s (Hirschman, 1958; Myrdal, 1957), when the focus shifted towards regional divergence. In addition, more recent advancements in economic modelling within the discipline – like the new economic geography (Krugman, 1991) – also focus on distance cost and the lack of agglomerative economies (Copus, 2001). This emphasis on accessibility points to a certain intellectual lock-in of these quantitative approaches. Moreover, empirical research and policy concepts targeting the periphery are still often based on simplistic indicators like location and population density (Crone, 2012; Kühn & Weck, 2012). This can also be observed in Austria, as the example of the current national spatial development strategy shows (Humer, 2018, p. 646).

Already in the 1980s, Stöhr (1982) argued that regional science has focused too long on quantitative indicators and neoclassical theories only and suggests taking socio-cultural and political variables into consideration. However, although he sees potential in opening up the discipline, he still defines peripheral regions

as areas of low accessibility to large-scale (national, continental, world-wide) interaction centres regarding access to markets, to production factors (including technological

innovation), to private and public services, cultural facilities, to sources of social innovation and of economic and political power. (Stöhr, 1982, p. 73)

Only recently and in the light of improvements in transport and information and communication technology (ICT) infrastructure scholars have argued for definitions going beyond accessibility and agglomeration (Copus, 2001; Danson & de Souza, 2012; Kühn, 2015; Lorentzen, 2012).

Copus (2001, p. 544) introduced the notion of an *aspatial* periphery, suggesting that the availability of high quality ICT infrastructure, human capital, and networks is the crucial factor for definitions of periphery in the knowledge economy. Similarly, Kühn (2015, p. 374) – based on Crone (2012, pp. 50–52) – emphasizes that five aspects should receive due attention in discussions about and definitions of periphery. First, periphery is a relational concept and a region can only be seen as peripheral in relation to a core. Second, it is a process-centred concept. Analyses should therefore focus on dynamics. Third, periphery is a multidimensional phenomenon that includes economic, demographic, and political dimensions in addition to geographical dimensions. Fourth, peripheries can be found on all scales due to the multiscale nature of space. Fifth, periphery is a dynamic and not a static concept that allows regions to change their position over time.

Following these considerations, scholars are increasingly questioning the term *periphery* itself, which was adopted in economic geography in the early twentieth century. The term usually refers to rural or border regions as well as suburban fringes (Kühn, 2015). As such, the understanding of periphery is rather static, as accessibility and population density only change over longer periods of time, if at all. This assumption neglects the notion that also larger cities can be peripheral or that *re-centralization* is possible. The approach of *peripheralization* acknowledges these dimensions and appears to be better suited to capturing recent economic developments and processes (Kühn, 2015; Kühn & Weck, 2012). The awareness that peripheralization is a process with a temporal dimension is the foundation for any policy intervention to achieve *de-peripheralization* or *re-centralization*. In a static understanding of periphery, regional policy would be irrelevant, as no improvement could be achieved (Lorentzen, 2012). This is an important premise, as Rodríguez-Pose and Di Cataldo (2015) have shown that poor government quality and therefore political marginalization are indeed a hindering factor concerning innovation activities.

Although scholars admit this complexity bears the danger that peripheralization becomes a fuzzy concept (Crone, 2012; Kühn, 2015), conclusions can be drawn from this discourse for the study of innovation potentials based on regional characteristics. First, it is insufficient to define a core–periphery pattern based solely on geographical factors (e.g. accessibility); functional indicators should be included as well. Second, in line with a process perspective, at least some indicators should incorporate a temporal dimension. Third, the characteristics of a region should be related to a broader context (e.g. national or international) in order to specify the relational and scalar dimension of the concept for the specific case or study area. These findings underline the relevance of the peripheralization discourse for questions of regional innovation potentials and prosperity. Hence, they will serve as a key pillar for the analysis of the core–periphery pattern below.

Differentiated knowledge bases

Knowledge bases are sometimes seen as the third knowledge taxonomy within economic geography, next to the classic distinction between *codified* and *tacit* knowledge and the concept of *know-what*, *know-why*, *know-how*, and *know-who* (Martin & Moodysson, 2013, p. 172). The approach was introduced by Asheim and Gertler (2005) – referring to Laestadius (1998) – and has been frequently refined in the subsequent years. In relation to the other taxonomies, knowledge bases are seen as superior, as they explicitly consider the content of interactions that occur in innovation networks. However, they are not clear-cut categories, as overlaps do occur (Martin & Moodysson, 2013). They also offer an epistemological dimension and are defined ‘*by the approaches to how, and principles of reasoning through which, knowledge is developed*’ (Manniche, 2012, p. 1824). This means that regions can be characterized through the prevailing knowledge base, incorporating firms from different industries, which makes analyses more independent from at times rather arbitrary industrial classifications (Martin & Moodysson, 2013).

Originally, only two knowledge bases were discussed: the analytical and the synthetic knowledge base (Asheim & Coenen, 2006; Asheim & Gertler, 2005). The symbolic knowledge base was introduced later to capture the increasing importance of creative industries (Asheim, 2007; Asheim, Coenen, & Vang, 2007). The analytical knowledge base is found, for instance, in biotechnology or ICT industries where scientific knowledge is highly important and where knowledge creation is formalized. Firms usually have their own research and development (R&D) departments and collaborate with universities and other institutions for higher education. Hence, basic research plays an important role, although applied research and systematic product development may also be observed. Whilst tacit knowledge is not irrelevant, knowledge creation is predominantly based on codified knowledge contained in publications, reports, and patents. The analytical knowledge base requires abstraction, theory building, and testing. Consequently, the workforce often consists of employees with university degrees and research experience. The reliance on research often leads to radical innovations, the establishment of new firms, and spin-offs (Asheim, 2007; Asheim & Coenen, 2006; Asheim, Coenen, & Vang, 2007; Asheim & Gertler, 2005).

In contrast, the synthetic knowledge base relies on the application or the novel combination of existing knowledge. Therefore, it is more relevant in industrial production, where innovation occurs through problem solving and interacting with customers and suppliers (experimental development). R&D and university links can be observed but are less frequent and are targeted more towards applied research and experimental development. Knowledge is created inductively through testing or practical work. Hence, tacit knowledge plays a more important role, although knowledge is also partially codified. Consequently, on-the-job training and experience are extremely important, which is why the workforce often consists of employees who have completed professional schools (apprenticeships). However, this also means that incremental innovation is more frequent and spin-offs are scarce (Asheim, 2007; Asheim & Coenen, 2006; Asheim, Coenen, & Vang, 2007; Asheim & Gertler, 2005).

Finally, the symbolic knowledge base targets creative and cultural industries (e.g. filmmaking, publishing, music) and milieus. Here, innovation is based on new ideas but requires a deep understanding of norms and habits, which is why tacit knowledge plays

a crucial role. *Creative* innovation, i.e. the combination of existing knowledge in new ways, is not tied to specific academic degrees, but rather to experience, skills, and personal networks. Exchange of symbolic knowledge often occurs in temporary networks (Asheim, Coenen, Moodysson, & Vang, 2007; Asheim, Coenen, & Vang, 2007). Scholars acknowledge that these are ideal types and that there tend to be overlaps. In fact, even phases of innovation processes frequently rely on different knowledge bases (Asheim et al., 2017; Manniche, Moodysson, & Testa, 2017; Strambach & Klement, 2012) and firms that are able to combine various knowledge bases are the most innovative (Grillitsch et al., 2017; Tödtling & Grillitsch, 2015). Therefore, the differentiated knowledge base approach has shown that firms can take different paths towards innovation but there is also scope for regional specialization in knowledge bases.

However, the relationship between knowledge bases and issues of centralization and peripheralization has only been rarely discussed. Usually, the assumption is that due to their dependence on scientific research (analytical knowledge base) and cultural milieu (symbolic knowledge base) these two bases are often, though not exclusively, attributed to agglomerations. In contrast, the synthetic knowledge base has a broader scope related to its focus on industrial production and can extend to intermediate regions, which are production centres, as shown by Martin (2012) for Sweden. In addition, all three knowledge bases are seen as important drivers for regional innovativeness and therefore prosperity, although the significance of the analytical knowledge base is often emphasized (Grillitsch et al., 2017). Accordingly, above-average regional knowledge bases in peripheral regions seem unlikely to exist, although it is sometimes acknowledged that there are exceptions to this classical understanding (Martin, 2012). Additionally, there also might be isolated individuals or firms with a strong knowledge base performance in these unfavourable environments. However, so far this relationship has not been tested systematically. Hence, the following section develops a framework for this purpose.

Towards a conceptual framework of peripheralization and knowledge bases

Knowledge bases have been frequently combined with other approaches in order to arrive at a more nuanced understanding of innovation practices of different industries and regions. For example, Mattes (2012) relates them to Boschma's (2005) proximity dimensions, while Martin and Trippel (2014) build a connection to regional innovation systems (RISs) (Cooke, Heidenreich, & Braczyk, 2004). The periphery discourse has also been related to key variables of the knowledge economy, such as knowledge-intensive business services (KIBS) (Crone, 2012). However, the relationship between peripheralization on the one hand and knowledge bases on the other hand has not yet been conceptualized.

Unpacking this relationship is promising for two reasons. First, the prevalence of knowledge-intensive branches is seen as an important dimension of the peripheralization discourse (Kühn, 2015). As such, the knowledge base approach cannot only hint at the existence or absence of these businesses, but also provide further insights into their characteristics and nature. Second, the existence of knowledge bases is usually seen as a main driver for economic prosperity, but their regional occurrence and their relations to geographic, demographic, and economic dimensions (going beyond mere innovation indicators) remain largely unclear.

To ensure clarity and due to the limited possibilities for measuring the symbolic knowledge base quantitatively in the Austrian context (see section 3), the focus of this framework lies on the analytical and on the synthetic knowledge base. These knowledge bases are combined with the peripheralization discourse, which leads to the framework presented in Figure 1. First, it assumes that peripheralization is a continuum and that not all regions are clearly peripheral or central when various indicators are considered. In the classical understanding, peripheral regions exhibit low accessibility, population decline, job loss, predominantly small and medium-sized enterprises (SMEs), low knowledge intensity, and little political influence. In contrast, central regions are characterized by high accessibility due to a well-developed transport infrastructure, a growing workforce, the prevalence of major enterprises, an increase in jobs, and they are centres of political decision making. However, in between these extremes intermediate regions can be found that share characteristics of both peripheral and central regions and the underlying assumption is that this is the case for most areas. Hence, this intermediate category serves as a container for all regions in between the two poles.

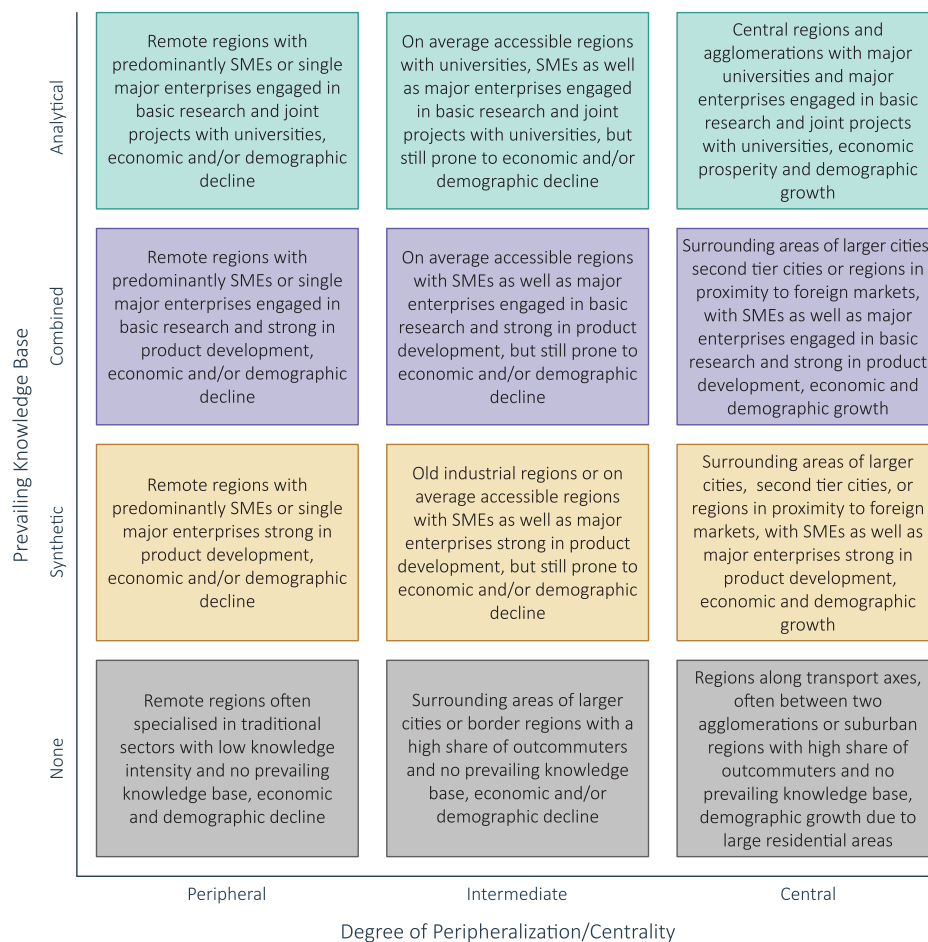


Figure 1. Conceptual framework for the analysis of regions according to peripheralization/centrality and knowledge bases.

Second, the framework distinguishes between four different types of prevailing regional knowledge bases: analytical, synthetic, a combination of both, and neither. Hence, the basic idea is that there are various combinations and degrees of peripheralization and knowledge bases, resulting in a large variety of both central and peripheral regions. Under certain circumstances, there might also be peripheral regions with a predominantly analytical knowledge base. This could be the case, if local SMEs or single and independent major enterprises are engaged in basic research and maintain links to universities or if a peripheral university exists. Similarly, a focus on the synthetic knowledge base is expected in various types of regions, as central regions might possess an underdeveloped analytical knowledge base due to the lack of adequate higher education institutions.

As the combination of knowledge bases is considered to result in the highest innovative output (Grillitsch et al., 2017), the framework also accounts for regions along the peripheralization continuum that are strong in research-intensive but also in industrial innovation. A last set of areas concerns those with low knowledge intensity and therefore without a pronounced knowledge base. These can be peripheral regions specialized in traditional sectors or central residential areas with a high share of outbound commuters and accordingly low economic activity. As such, this type acknowledges that centrality does not necessarily result in above average innovation activity. In total, the framework proposes twelve types of regions that differ in their degree of peripheralization but also in their prevailing knowledge bases (and therefore knowledge intensity).

Data and methods

The following analysis applies the framework developed above to the 95 districts of Austria. These regions are classified according to seven peripheralization indicators and eleven knowledge base indicators, which allows for conclusions about both the degree of peripheralization of a region and the prevailing knowledge base. First, data on peripheralization are obtained from the Austrian Conference on Spatial Planning (ÖROK, 2007) and Statistics Austria,¹ while the indicators are based on Kühn (2015, p. 375). Accessibility targets the geographic dimension of the periphery discourse and measures the average travel time to trans-regional centres. The calculations consider trans-regional centres abroad (e.g. Passau/Germany), acknowledging the integrated position of Austria within the European single market as well as trans-border relations (ÖROK, 2007). The demographic and economic dimensions of peripheralization are captured with indicators on population and economic development, some explicitly with a temporal dimension to adapt the process perspective of the concept. No data were available on the political dimension (marginalization) of the peripheralization process on a regional scale, which is why the analysis excludes this dimension. However, as the capitals of the federal states (*Bundesländer*) of Austria are seats of regional governments, some qualitative conclusions can be drawn from the interpretation of the results.

Second, data on knowledge bases also refer to the regional scale due to the lack of data on the firm level in Austria. Because of data protection regulations, the results of the EU-wide Community Innovation Survey (CIS) are published only at the national scale. Similarly, figures from the national R&D survey are usually limited to the national or the federate state level (*Bundesländer*). Furthermore, data on occupations that could help measure regional knowledge bases, as sometimes suggested (Asheim & Hansen, 2009;

Blažek & Kadlec, 2018; Martin, 2012) are also not available regionally (i.e. below NUTS-2 regions). Consequently, this paper proposes a different approach and analyses indicators derived from a definition by Asheim (2007, p. 225). Data on these indicators were provided by Statistics Austria and the Austrian Patent Office and are a tailor-made extract from the national R&D survey 2015 for the purpose of this study. Hence, rather than on occupations, this analysis builds on R&D related indicators for the private sector and thus excludes universities and other public research organizations, as the emphasis of this paper lies on firm-level innovation.

Although it is acknowledged that prevailing knowledge bases vary greatly between branches, firms, and even phases in the innovation process (Manniche et al., 2017; Strambach & Klement, 2012) and can only be captured approximately with a quantitative approach, an analysis on the regional scale can provide an interesting first overview of the knowledge specialization of a region (Martin, 2012). As such, an assessment of the prevailing regional knowledge base can serve as a basis for further in-depth qualitative research and as a foundation for policy makers.

Both data on peripheralization and knowledge bases refer to the district level, as it is the intention of this paper to analyse peripheralization on a small scale of urban and rural areas separately. Hence, districts are chosen over other regional classifications such as the NUTS-2 or NUTS-3 level, as these classifications often conflate urban and rural areas. In the next step, these data are used to construct a weighted, additive peripheralization index (PI), which consists of five sub-indices on geographic, demographic, and economic factors as well as on the analytical and synthetic knowledge base. As such, it deepens the peripheralization discourse by taking the nature of knowledge-intensive branches into account. For this exercise, this index is chosen over other frequent quantitative approaches like cluster analysis (Hedlund, 2016; Kronthaler, 2005), as a cluster solution always conflates dimensions. A cluster of regions might exhibit a clear analytical knowledge base but the dimensions of peripheralization might actually be diverse. Furthermore, location quotients (LQs) (Asheim & Hansen, 2009; Blažek & Kadlec, 2018; Martin, 2012) seem equally unsuitable for this small-scale analysis, as they do not consider size effects. A region might reveal above average expenditures for basic research but in absolute numbers, the amount might be insignificant.

The construction of the index follows an approach suggested by Heintel, Springer, Schnelzer, and Bauer (2017). First, as the indicators are measured on various scales, z-values (ZI) of the indicators (I) are calculated for every region (i) and indicators (j) for all dimensions (r) in order to make them comparable:

$$ZI_{j,r}^i = \frac{I_{j,r}^i - \bar{I}_{j,r}}{s_{j,r}}$$

Second, the indicators are weighted so that all five dimensions influence the total index (PI) to the same degree, although the dimensions have a different number of indicators. This ensures that certain dimensions are not overemphasized. Additionally, modest weights (W) are introduced within the dimensions in order to accentuate particularly important indicators identified in the literature. In terms of peripheralization, the net migration rate and the development of employees are weighted disproportionately high, as they are a crucial dimensions in this regard (Kühn, 2015). In terms of knowledge

bases, education is seen as central (Martin, 2012). Additionally, total expenditures by type of R&D are highlighted in order to capture size effects accurately. To estimate the influence of the weights, some robustness checks are conducted. Third, the direction (V) of the indicators has to be determined. In general, a higher score on an indicator means higher centrality. However, in the present case, lower z-values mean less travel time to trans-regional centres and a younger labour force. Consequently, these two indicators are multiplied by -1 to ensure that the indicator influences the index as desired. All other indicators do not require this multiplication, as their direction is already correct. In the following formula, a dimension (D) is built by summing up the weighted and multiplied (if necessary) z-scores, using all indicators per dimension:

$$D_r^i = \sum_{j=1}^k ZI_{j,r}^i * W_{j,r} * V_{j,r}$$

An overview of the indicators, their directions, and weights applied can be found in Table 1.

In order to analyse whether a district is peripheral along the three dimensions of peripheralization or which knowledge base is prevailing five sub-indices are calculated. In terms of accessibility, districts with an average travel time to a trans-regional centre of less than 45 min are classified as central, while the remaining districts are geographically peripheral (ÖROK, 2007). All other dimensions are based on the distribution of their respective sub-index: Districts with an above average score on the demographic and economic dimension are considered demographically or economically central, respectively. Those ranking below average are classified as peripheral on the respective dimension. For each knowledge base, there are three corresponding groups: (1) a strong analytical or synthetic knowledge base, (2) a weak analytical or synthetic knowledge base, and (3) an underdeveloped analytical or synthetic knowledge base. Due to the absence of natural breaks and the continuous distribution of the data (see Figure A1), quartiles were chosen in order to classify the knowledge base data.

The sub-indices allow for a separate analysis of the performance of every district along one dimension. However, they can also be combined to construct the total PI, indicating the overall performance and knowledge intensity of a district. Hence, in a final step, all dimensions for each district are summed up and divided by the number of dimensions (n):

$$PI_i = \frac{\sum_{r=1}^n D_r^i}{n}$$

Consequently, districts with an overall value of above zero are performing better than average in comparison to Austria. In contrast, districts with negative values are considered peripheral in relation to the national average.

Results: peripheral diversity

Core-periphery: accessibility and beyond

Figure 2 shows the distribution of dimensions for all 95 districts of Austria in 2015, where a few interesting examples are highlighted. This distribution and the overall results seem not to be greatly influenced by the introduction of the weights used in building the dimensions. For example, comparing the presented solution to an index where no weights are

Table 1. Peripheralization and regional knowledge base indicators.

Dimension of peripheralization	Direction	Weight		Indicator
		Dimension	Indicator	
Geographic	-1	1.00	1.00	1. Average accessibility of trans-regional centres by motorised private transport [2005]
Demographic	1	1.00	0.25	2. Development of the population aged 15–64 [2011–2015]
	1		0.50	3. Net migration rate of the population aged 15–64 [2011–2015]
	-1		0.25	4. Share of the population aged 45–64 out of the population aged 15–64 [2015]
Economic	1	1.00	0.50	5. Development of persons employed [2011–2015]
	1		0.25	6. Net commuter rate [2015]
	1		0.25	7. Share of persons employed by firms with 250+ employees [2015]
Analytical knowledge base	1	1.00	0.09	8. Granted patents per 1000 persons aged 15–64 [2011–2015 – mean]
	1		0.29	9. Employees [FTEs] of private firms in R&D with a bachelor's degree or higher per 1000 persons aged 15–64 [2015]
	1		0.09	10. Share of employees of private firms in R&D with a bachelor's degree or higher out of the total R&D employees [2015]
	1		0.29	11. Expenditures by private firms in 1000 € for basic research per 1000 persons aged 15–64 [2015]
	1		0.09	12. Share of expenditures by private firms for basic research out of the total R&D expenditures [2015]
	1		0.09	13. Expenditures by private firms for external R&D at universities in 1000€ per 1000 persons aged 15–64 [2015]
	1		0.09	14. Share of expenditures by private firms for external R&D at universities out of the total R&D expenditures [2015]
	1		0.09	15. Employees [FTEs] of private firms in R&D with less than a bachelor's degree per 1000 persons aged 15–64 [2015]
Synthetic knowledge base	1	1.00	0.33	16. Share of employees of private firms in R&D with less than a bachelor's degree out of the total R&D employees [2015]
	1		0.33	17. Expenditures by private firms in 1000€ for experimental development per 1000 persons aged 15–64 [2015]
	1		0.17	18. Share of expenditures by private firms for experimental development out of the total R&D expenditures [2015]

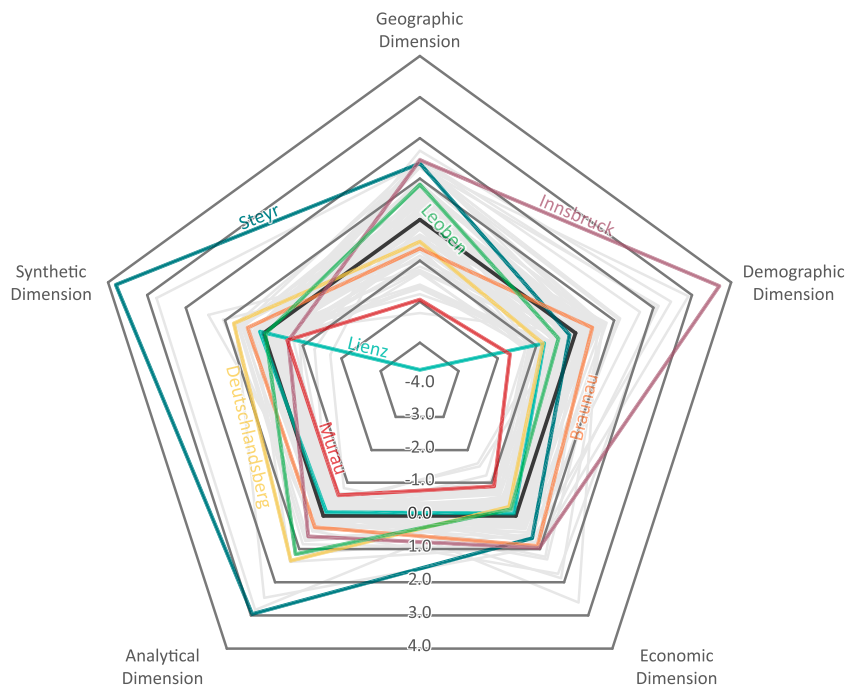


Figure 2. Scores of the index dimensions for all 95 districts.

applied, only eleven out of 95 districts move upward or downward by more than five ranks in the total PI. Furthermore, the patterns of the overall distribution (presented in Figures 2 and 3) remain stable and concerning the total PI (presented in Figure 4) 84% of all districts stay in the same class. This indicates a high robustness of the results, which are not disturbed by these modest weights based on recommendations in the literature (for a detailed overview on ranks and z-scores by district and dimension see Table A1).

As such, it becomes clear that the core periphery continuum is diverse rather than clear-cut. Accordingly, the various dimensions of peripheralization are highly fragmented. Central regions in all of the dimensions are predominantly the agglomerations of the larger cities in Austria, usually the capitals of the nine federal states (*Bundesländer*). They are accessible, experience population and economic growth, and are the seat of regional governments. These cities like Innsbruck, for example, rank especially high on the demographic dimension, as they usually have highly positive net migration rates (see Figure 2). In general, they have also above average performance on the analytical and synthetic knowledge base dimensions. And since Austria is a federal state, they possess political influence, too. Predominantly peripheral regions are located at the northern and southern borders as well as in the alpine regions in the centre of the country, like Lienz (Tyrol) or Murau (Styria). Often, these districts are also underperforming on the knowledge base dimensions (see Figure 2). This corresponds with the absence of governmental institutions and, to a certain degree, with political marginalization, though the latter is limited due to the representative democracy in Austria.

Nevertheless, there are exceptions to this traditional dichotomy. Geographically central but demographically and economically peripheral regions can be found in the south of

Austria, for example in the surrounding areas of Klagenfurt and Villach (both Carinthia). These areas have a high-ranking transport infrastructure, and the two cities serve as trans-regional centres with a dynamic labour market, Villach performing especially high on the knowledge base dimensions, as it hosts research-intensive major enterprises like Infineon, a semiconductor manufacturer. Still, the positive effects of these agglomerations are seemingly not large enough to stabilize their surrounding districts in terms of demographic and economic development. In addition, some border regions also experience high accessibility but rank low in the other dimensions.

In contrast, the district of Braunau (Upper Austria) is comparably far away from trans-regional centres but exhibits demographic and economic growth as well as a strong combination of both knowledge bases (see [Figure 2](#)). This district is home to the headquarters of major enterprises, like KTM (motorcycle and sports car manufacturer) and B&R Industrial Automation (manufacturer of automation technology). This confirms findings from other studies that show that firms of a considerable size are able to compensate for a geographically disadvantageous location, which has a significant positive effect on the regional economy and demographic profile (Isaksen & Trippel, 2017a).

The districts of Reutte (Tyrol), Sankt Johann (Salzburg), and Scheibbs (Lower Austria) are geographically and demographically peripheral but economically central. In these cases, the regional economic performance is above average and there are major enterprises, leading to high performances on both knowledge bases (Reutte) or on the synthetic knowledge base (Sankt Johann, Scheibbs). However, these benefits do not seem sufficient for demographic stabilization. No regions were found to rank low on the geographic and economic but high on the demographic dimension. The tourism-intensive districts of Kitzbühel (Tyrol) and Zell am See (Salzburg) almost fulfil these criteria and are only slightly below average on the demographic dimension. In general, though, this confirms that regions with low accessibility to agglomerations and a weak regional economy also do not thrive demographically.

In between the two extremes – central agglomerations and remote peripheral regions – there are many nuances and combinations of dimensions of peripheralization. This indicates that the periphery is diverse and that a robust regional economy does not necessarily depend on accessibility and/or demographic growth. On the other hand, above average economic performance does not always lead to demographic growth. One example is the city of Steyr, ranking highest on the knowledge base dimensions, with a robust economic performance and high accessibility. Still, in demographic terms, it ranks below average (see [Figure 2](#)). This illustrates that accessibility or population density alone are not sufficient for capturing economic prosperity and demographic developments. Regional classifications benefit largely from the incorporation of indicators suggested by the peripheralization discourse. Hence, after focusing on the geographic, demographic, and economic dimensions, the following section turns to the question of knowledge intensity and analyses the prevalence and nature of regional knowledge bases.

The spatial pattern of regional knowledge bases

The consideration of the knowledge base approach enables a deeper understanding of regional innovation activities and goes beyond measuring the mere existence of knowledge-intensive activities. The assumption that an analytical knowledge base can only be

found in agglomerations and that peripheral areas usually do not possess such knowledge bases can only be partly confirmed. Private sector firms do indeed have a predominantly analytical knowledge base in the agglomerations but there are also peripheral regions that show at least weak signs of an analytical knowledge base. One example for this is Upper Styria, an old industrial region with a population decline. The area is home to the Montanuniversität in Leoben (specialized in mining, metallurgy, and materials), a branch office of the Austrian Academy of Sciences, and a university of applied sciences. Alumni from these institutions, who stay in the region after having completed their studies and work for local firms, might be the reason for a predominantly analytical knowledge base and the comparably good economic performance (see [Figure 2](#)). Other examples are the districts of Gmunden and Vöcklabruck (both in Upper Austria), which are both economically peripheral but show a strong analytical knowledge base.

Equal combinations of knowledge bases show diverse patterns. A strong combination is found in major cities like Graz, Linz, and Villach. On the other hand, more peripheral regions like Reutte (Tyrol), Braunau and Ried (both Upper Austria), and Deutschlandsberg (Styria) combine a pronounced analytical with a pronounced synthetic knowledge base (see [Figure 2](#)). A weak combination of both knowledge bases is not only limited to the surrounding areas of larger cities, although it frequently occurs in suburban areas. Apparently, firms in such regions build upon their strong industrial base and rely on high-level transport and ICT infrastructure when accessing the analytical knowledge bases in the centres.

There are peripheral regions on all dimensions that show no signs of a knowledge base in terms of analytical or synthetic innovation, but the pattern is again diverse. A strong synthetic knowledge base in combination with a weak analytical knowledge base is found in Amstetten and Scheibbs (both Lower Austria) and in the Tyrolean Unterland (Schwaz and Kufstein). Districts with a specialization only on the synthetic knowledge base are found in more remote locations (Sankt Johann – Salzburg, Schärding – Upper Austria). The last set of regions, those with low knowledge intensity and therefore no pronounced analytical or synthetic knowledge base, are evident along borders or in alpine regions. Here, disadvantages in all dimensions add up, resulting in numerous challenges for future development.

These findings show that regional knowledge bases do not necessarily follow the classical pattern of accessibility. Certainly, there are peripheral regions without many preconditions for analytical or synthetic innovation, but peripheral districts with a developed analytical knowledge base are observed as well. Some examples for the latter pattern are if a peripheral region hosts major enterprises or higher education institutions, though this is no guarantee for demographic and economic growth. This raises questions about the interplay between the individual dimensions of peripheralization and knowledge bases but also indicates that a strong knowledge base alone might not be enough for regional prosperity.

The interplay between peripheralization and knowledge bases

A classification of all 95 districts following the conceptual framework is depicted in [Figure 3](#), where the bubble size corresponds to the number of districts in the specific group. As one might expect, a greater degree of centrality on all dimensions correlates with the existence of analytical and/or synthetic innovation. Central regions can indeed

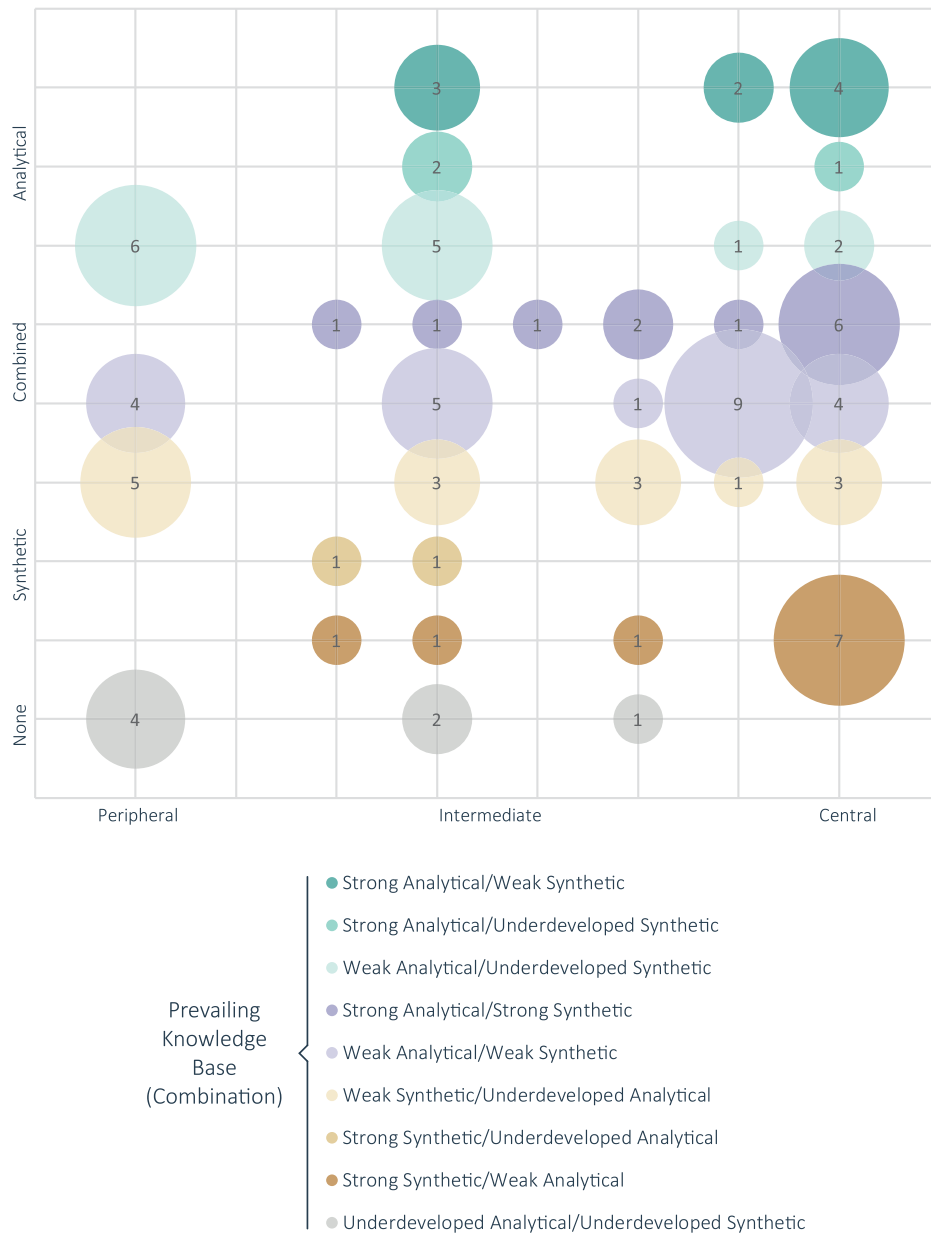


Figure 3. Districts of Austria classified according to the conceptual framework.

possess a strong analytical or synthetic knowledge base, or even a combination of both. This variant also occurs in intermediate and, to a lesser extent, peripheral regions, which confirms earlier findings by Grillitsch et al. (2017). However, as the continuum shows, the more dimensions on which a region ranks peripheral, the harder it is to maintain a pronounced knowledge base.

Nevertheless, with regard to the conceptual framework, examples can be found for almost every described region in this exploratory analysis. On the one hand, in

agglomerations like Vienna or Innsbruck, firms are predominantly engaged in the analytical knowledge base in their R&D efforts. Other cities like Graz and Linz, accessible suburbs or even peripheral districts with major enterprises are strong in combining both knowledge bases. On the other extreme, there are peripheral regions that exhibit low accessibility, depopulation, and economic decline. Examples for this are the northern region of Lower Austria and the inner alpine districts of Landeck (Tyrol), Tamsweg (Salzburg), and Murau (Styria). These three examples have neither a visible analytical nor synthetic knowledge base but 15 regions in this category exhibit weak signs of the considered knowledge bases.

However, when all peripheralization indicators are considered, very few regions are either clearly central or clearly peripheral. Hence, there are numerous examples for other nuances as suggested by the framework. This is illustrated by the 23 districts ranking low in accessibility but central in the demographic and economic dimension (see Figure 3). Here, all variations from a strong analytical to a strong synthetic knowledge base are found, which underlines the limited role of accessibility in Austria (Tödtling, Lehner, & Kaufmann, 2009). Strong knowledge bases are even found in districts that rank peripheral in two out of three dimensions of peripheralization. Hence, although the analysis confirms the classical pattern, these findings argue for a more differentiated understanding of peripheries.

Table 2 shows the regional knowledge base profile in combination with the three dimensions of peripheralization. It highlights the share of districts classified as central in each dimension for each set of regions. This allows for further insights into the relationship between the peripheralization and the knowledge base literature. A strong analytical knowledge base – also in combination with the synthetic knowledge base – is overwhelmingly found in accessible districts. This observation confirms the assumptions of the literature, as it links the analytical knowledge base to trans-regional centres, which usually host universities and other public research institutions. In addition, districts with a strong combination of knowledge bases tend to show good demographic and economic performance. This relates to the literature, which underlines the relationship between combinatorial knowledge bases and regional demographic and economic prosperity (Asheim et al., 2017). However, regions with a focus on the synthetic knowledge base in combination with a weak analytical base seem to thrive especially in economic terms – and such regions are usually not the bigger cities, which are often more orientated towards the analytical knowledge base. This indicates that the relationship between knowledge bases and economic performance might require further investigation and a more differentiated perspective. The analytical

Table 2. Share of districts classified as central by knowledge base and dimensions.

Prevailing knowledge base (Combination)	n	Peripheralization dimension		
		Geographic	Demographic	Economic
Strong analytical/Weak synthetic	9	100%	67%	44%
Strong analytical/Underdeveloped synthetic	3	100%	33%	33%
Weak analytical/Underdeveloped synthetic	14	57%	21%	14%
Strong analytical/Strong synthetic	12	83%	67%	83%
Weak analytical/Weak synthetic	23	83%	57%	22%
Weak synthetic/Underdeveloped analytical	15	67%	27%	40%
Strong synthetic/Underdeveloped analytical	2	50%	0%	50%
Strong synthetic/Weak analytical	10	90%	70%	90%
Underdeveloped analytical/Underdeveloped synthetic	7	43%	0%	14%

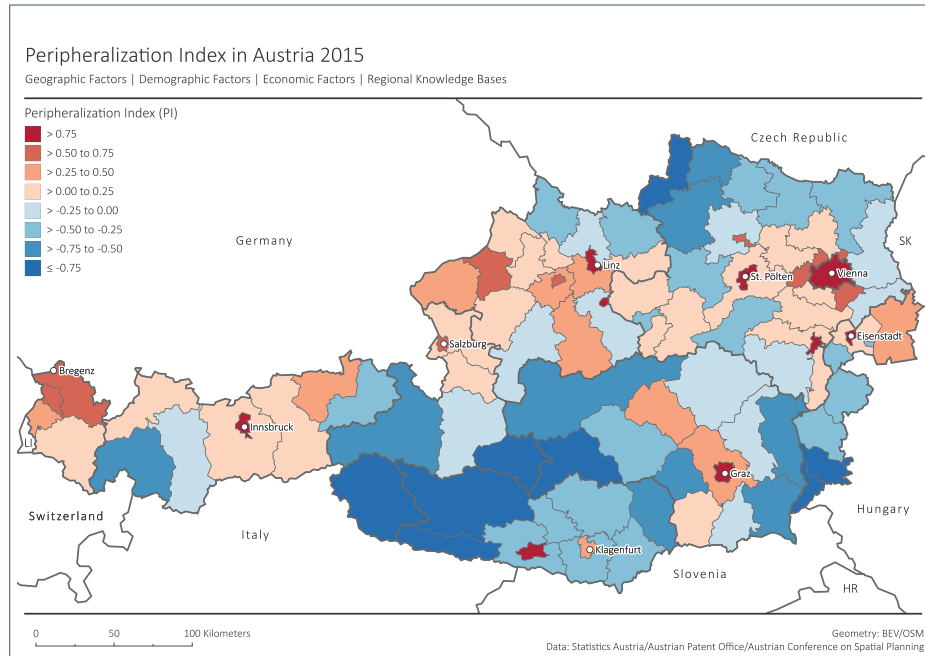


Figure 4. Peripheralization index (PI) in Austria 2015.

knowledge base might be especially important for radical innovations, but its significance for regional prosperity might be much smaller. This relates to the question of the actual individual and regional benefits of innovation activities (Zeller, 2003).

Finally, [Figure 4](#) displays the results of the total PI, which combines the geographic, demographic, economic, and knowledge base dimension. Districts with a value above zero rank above the Austrian average, those below show a disadvantaged position. On the one hand, this map is an advancement over more classical delimitations, which are based on accessibility and population density, as it provides a more detailed picture based on many indicators. On the other hand, it also conflates the various dimensions, which indicates that for an in-depth regional analysis the dimensions should also be considered separately (see [Table A1](#)).

Not surprisingly, the major cities of Austria rank high on the index but not all of them are in the top category, as the examples of Salzburg and Klagenfurt show. Less accessible districts like Braunau are even outperforming the Carinthian capital. Above average performance is also especially high in the federal state (*Bundesland*) of Vorarlberg, in the surrounding regions of Innsbruck, and between Salzburg and Vienna, along one of the most important transport axes of the country. In contrast, cities in the southern part of Austria seem more like central islands in a predominantly peripheral hinterland. This again underlines that the challenges for regional and innovation policies are diverse and that accessibility alone does not compensate for other regional deficits.

Conclusions

The analysis was carried out on the district level in order to capture regional diversity on a small scale. However, this might not be the appropriate level for policy interventions,

which need to consider trans-regional relations. It is clear that not every district can host a university and that efforts towards enhancing a district's regional economy have to be integrated into a broader scope. Nevertheless, a clear understanding of regional disparities and the rural-urban divide is a precondition for innovation and regional policies at the level of federal states (*Bundesländer*) and at the national level. The results also demonstrate the diversity of both central and peripheral regions, which certainly pose a challenge for policy makers. However, this should not imply that meaningful regional innovation policies are impossible because of this variety. It rather underlines the necessity of place-based, well-informed, and tailor-made concepts (Tödtling & Trippl, 2005) and highlight the importance of new policy approaches, like the shift from traditional cluster policies towards platform policies (Asheim, Boschma, & Cooke, 2011; Cooke, 2012). Also, policy makers need to go beyond the dichotomous categorizations of core/periphery, urban/rural, and metropolitan/non-metropolitan, acknowledging in their strategies the many regions that lie in between such poles (Leick & Lang, 2018).

The conceptual and exploratory analysis above has shown that both central and peripheral regions are diverse and that the peripheralization discourse can provide important insights into the actual strengths and deficits of a region. Hence, this paper contributes to the literature by arguing for a diversified understanding of regions (Tödtling & Trippl, 2005). In doing so, it convincingly shows that spatial analysis (Shearmur, 2011) within economic geography should go beyond accessibility and should incorporate indicators and concepts from the peripheralization literature. This is also true for policy documents which still apply simplistic periphery concepts, also in Austria (Humer, 2018). A first step would be to adapt the peripheralization discourse more profoundly in spatial development strategies on all geographic scales. Regional and innovation policies should be designed in line with such overall strategies and should address the most pressing issues at hand, whether it is limited physical accessibility, broadband connection, outmigration, or the lack of adequate higher education institutions.

The analysis of regional knowledge bases might provide first insights into the specific needs of firms in a region, but in order to ensure a match between policies and regional requirements, a close cooperation of local decision makers and firms should be reached as well. Regions with firms that build upon an analytical knowledge base might benefit from higher accessibility (including broadband availability) for cooperation and exchange with universities outside of the region, if higher suitable education institutions are not available locally. In contrast, for regions with a strong synthetic knowledge base, programmes for tackling depopulation and subsidiaries for on-the-job training programmes (apprenticeships) might be beneficial. The analysis of regional knowledge bases also allows for the identification of regions with low knowledge intensity, often specialized in agriculture or tourism, where firm-level, R&D-based innovation is scarce or even non-existent. Yet, these regions might be innovating without R&D or in other sectors and analytical and synthetic knowledge could still be helpful to diversify the economy. However, in such regions, policies need an especially careful design along the needs and possibilities of regional actors to ensure effective operation.

In this regard, the framework developed above provides a regional typology for a differentiated regional analysis and can serve as a point of departure for policy makers. The developed index allows for a first overview of the regional diversity of a country, the separate analysis of the sub-dimensions offers more details on the actual characteristics and

performance of regions. The results also provide insights into the interplay between accessibility, demographic and economic growth, and pronounced knowledge bases. While the overall pattern of urban regions with a strong analytical knowledge base and a more diverse pattern of the synthetic knowledge base is partly confirmed, the results also emphasize regional variety.

However, this exploratory study has several limitations, which could be addressed in follow-up research. First, for reasons of clarity and data availability, the framework and consequently the analysis were limited to the analytical and synthetic knowledge base. However, as creative industries are also not restricted to agglomerations (Martin, 2012; Trippl, Tödting, & Schuldner, 2013), expanding the framework and incorporating indicators targeting the symbolic knowledge base might be promising. However, in order to avoid fuzziness and cumbersome complexity, the framework might have to be adjusted to the underlying research questions, limiting the number of dimensions under consideration.

Second, the analysis indicates that not all regions with a strong knowledge base (combination) are also demographically and economically central. Hence, the relationship between knowledge bases and economic prosperity and uneven geographic development could be studied more rigorously, as regional innovative activity alone does not necessarily result in individual well-being (Martin, 2016; Zeller, 2003). Such issues might be of increasing relevance due to the ongoing digitization and automation processes.

Third, as comparable, ready-to-use international data sets are not available for Austria (e.g. regional CIS data), this analysis was limited to the national context. Nevertheless, international comparisons might provide more insights into the competitiveness and peripheralization dimension of regions on a larger scale. Research in other contexts is also necessary in order to validate and further enhance the conceptual framework.

Fourth, this paper has acknowledged the process dimension of peripheralization and included some temporal variables. However, future work should extend this dynamic perspective and analyse the impact of changing knowledge bases over time on the regional demographic and economic profile. This research could address questions like whether an upgrade in a regional knowledge base can actually stabilize a region demographically over time. Research of this kind would provide insights into the causal relationship, i.e. whether dynamic regions generate a strong knowledge base or vice versa.

Finally, the interplay between the various dimensions of peripheralization and their effects on regional knowledge bases should be studied in more detail. Such analyses on a larger scale could also include data on the political marginalization or quality of government in order to capture all dimensions of the peripheralization literature. In addition, qualitative analyses might provide important insights into these questions.

Note

1. Various calculations based on extractions from register data via Statistics Austria's STATcube: http://www.statistik.at/web_en/publications_services/statcube/index.html.

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Appendix 1

Table A1. Rank and Z-scores by district and dimension.

District	Federal state	Dimension												Total	
		Geographic		Demographic		Economic		Analytical		Synthetic					
		Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score
Eisenstadt (Stadt)	Burgenland	2	1.490	5	2.058	3	1.741	14	0.451	11	0.571	4	1.262		
Rust (Stadt)	Burgenland	20	0.853	72	-0.592	33	0.205	95	-0.852	95	-1.706	73	-0.418		
Eisenstadt (Umgebung)	Burgenland	16	0.910	37	0.104	42	-0.023	63	-0.313	52	-0.115	33	0.113		
Güssing	Burgenland	87	-1.303	90	-1.151	64	-0.288	64	-0.326	93	-0.958	91	-0.805		
Jennersdorf	Burgenland	89	-1.624	91	-1.197	87	-0.836	47	-0.191	74	-0.321	93	-0.834		
Mattersburg	Burgenland	20	0.853	58	-0.302	94	-1.506	82	-0.480	47	-0.073	65	-0.302		
Neusiedl am See	Burgenland	66	-0.515	12	0.724	2	1.875	59	-0.299	24	0.144	19	0.386		
Oberpullendorf	Burgenland	51	-0.085	71	-0.565	83	-0.741	61	-0.309	38	-0.033	69	-0.347		
Oberwart	Burgenland	67	-0.531	65	-0.458	74	-0.454	54	-0.238	71	-0.288	72	-0.394		
Klagenfurt (Stadt)	Carinthia	7	1.387	7	1.149	22	0.379	34	-0.022	80	-0.467	17	0.485		
Villach (Stadt)	Carinthia	8	1.382	15	0.641	67	-0.300	2	2.834	2	2.756	3	1.463		
Hermagor	Carinthia	85	-1.246	93	-1.286	86	-0.828	93	-0.671	46	-0.069	92	-0.820		
Klagenfurt (Land)	Carinthia	26	0.729	80	-0.835	70	-0.333	48	-0.196	94	-1.303	71	-0.388		
Sankt Veit an der Glan	Carinthia	53	-0.116	89	-1.146	84	-0.777	56	-0.274	30	0.102	76	-0.442		
Spittal an der Drau	Carinthia	76	-0.712	94	-1.287	93	-1.233	36	-0.042	84	-0.534	89	-0.762		
Villach (Land)	Carinthia	30	0.620	84	-0.857	77	-0.529	52	-0.233	81	-0.480	64	-0.296		
Völkermarkt	Carinthia	59	-0.235	76	-0.744	32	0.226	86	-0.530	43	-0.056	63	-0.268		
Wolfsberg	Carinthia	78	-0.769	87	-1.032	82	-0.674	57	-0.284	78	-0.413	83	-0.634		
Feldkirchen	Carinthia	45	0.133	81	-0.838	92	-1.052	79	-0.424	50	-0.099	77	-0.456		
Krems an der Donau (Stadt)	Lower Austria	3	1.475	32	0.285	5	1.228	44	-0.162	49	-0.090	14	0.547		
Sankt Pölten (Stadt)	Lower Austria	11	1.345	16	0.569	1	2.610	80	-0.427	63	-0.179	9	0.784		
Waidhofen an der Ybbs (Stadt)	Lower Austria	62	-0.391	68	-0.503	80	-0.645	69	-0.355	23	0.175	67	-0.344		
Wiener Neustadt (Stadt)	Lower Austria	4	1.470	6	1.659	17	0.561	6	1.166	29	0.106	8	0.992		
Amstetten	Lower Austria	50	-0.038	42	0.019	35	0.145	25	0.154	21	0.223	34	0.101		
Baden	Lower Austria	35	0.454	19	0.528	53	-0.152	70	-0.393	37	0.001	36	0.088		
Bruck an der Leitha	Lower Austria	41	0.262	21	0.483	85	-0.807	84	-0.496	67	-0.221	54	-0.156		
Gänserndorf	Lower Austria	52	-0.106	28	0.355	39	0.061	83	-0.481	61	-0.143	51	-0.063		
Gmünd	Lower Austria	92	-1.816	73	-0.634	91	-0.939	58	-0.288	54	-0.118	88	-0.759		
Hollabrunn	Lower Austria	74	-0.686	66	-0.464	49	-0.097	71	-0.393	91	-0.771	78	-0.482		
Horn	Lower Austria	70	-0.609	70	-0.529	89	-0.876	46	-0.189	35	0.034	75	-0.434		
Korneuburg	Lower Austria	32	0.552	31	0.290	57	-0.190	41	-0.128	65	-0.210	40	0.063		
Krems (Land)	Lower Austria	25	0.770	48	-0.147	72	-0.376	75	-0.416	82	-0.495	53	-0.133		



Lilienfeld	70	-0.609	69	-0.519	27	0.304	85	-0.513	33	0.080	61	-0.251
Melk	55	-0.127	51	-0.152	76	-0.485	49	-0.212	72	-0.301	62	-0.255
Mistelbach	72	-0.635	63	-0.413	44	-0.046	73	-0.404	88	-0.605	74	-0.420
Mödling	18	0.858	29	0.335	50	-0.114	33	-0.018	44	-0.061	29	0.200
Neunkirchen	36	0.418	54	-0.189	46	-0.056	68	-0.343	56	-0.124	50	-0.059
Sankt Pölten (Land)	31	0.563	36	0.159	79	-0.582	18	0.276	70	-0.279	47	0.027
Scheibbs	81	-1.008	62	-0.400	7	0.981	30	0.013	3	1.426	28	0.202
Tulln	46	0.127	20	0.516	23	0.357	38	-0.081	73	-0.320	32	0.120
Waichhofen an der Thaya	91	-1.681	85	-0.940	65	-0.297	76	-0.416	62	-0.155	86	-0.698
Wiener Neustadt (Land)	29	0.635	41	0.021	45	-0.053	40	-0.124	42	-0.050	37	0.086
Wien (Umgebung)	27	0.661	11	0.751	4	1.308	29	0.062	58	-0.134	15	0.530
Zwettl	82	-1.013	86	-0.961	60	-0.244	89	-0.557	83	-0.521	84	-0.659
Lower Austria	13	1.304	4	2.139	10	0.930	4	1.380	19	0.243	6	1.199
Upper Austria	10	1.376	50	-0.150	14	0.677	1	2.961	1	3.803	1	1.733
Steyr (Stadt)	6	1.413	13	0.699	19	0.485	27	0.096	22	0.185	12	0.576
Braunau am Inn	75	-0.702	23	0.435	11	0.903	16	0.340	15	0.418	25	0.279
Wels (Stadt)	39	0.381	45	-0.007	24	0.340	90	-0.562	32	0.081	43	0.047
Braunau am Inn	58	-0.220	61	-0.389	56	-0.187	13	0.462	92	-0.923	60	-0.251
Eferding	69	-0.593	56	-0.274	63	-0.271	23	0.214	60	-0.141	58	-0.213
Freistadt	43	0.241	35	0.204	43	-0.037	45	-0.185	28	0.115	39	0.068
Gmunden	48	-0.002	55	-0.214	28	0.267	9	0.750	8	0.654	24	0.291
Grieskirchen	24	0.796	24	0.419	37	0.102	24	0.181	27	0.123	22	0.324
Kirchdorf an der Krems	59	-0.235	39	0.085	16	0.667	60	-0.304	10	0.590	31	0.161
Linz (Land)	49	-0.007	38	0.094	6	0.994	8	0.849	7	0.679	16	0.522
Perg	73	-0.681	75	-0.706	55	-0.173	65	-0.333	39	-0.038	70	-0.386
Ried im Innkreis	Upper Austria	0.402	53	-0.186	40	-0.011	72	-0.403	12	0.560	38	0.072
Rohrbach	Upper Austria	0.397	60	-0.368	68	-0.311	78	-0.421	48	-0.076	55	-0.156
Schärding	Upper Austria	0.640	52	-0.165	71	-0.363	17	0.282	90	-0.644	49	-0.050
Steyr (Land)	Upper Austria	-0.360	30	0.324	52	-0.146	22	0.224	26	0.133	44	0.035
Urfahr (Umgebung)	Upper Austria	0.837	33	0.273	25	0.311	50	-0.218	14	0.513	21	0.343
Vöcklabruck	Upper Austria	1.382	8	1.133	12	0.795	43	-0.159	53	-0.117	11	0.607
Wels (Land)	Salzburg	0.319	17	0.564	51	-0.116	55	-0.245	66	-0.210	41	0.062
Salzburg (Stadt)	Salzburg	0.480	26	0.399	78	-0.548	28	0.073	57	-0.132	42	0.054
Hallein	Salzburg	-0.951	43	-0.002	36	0.135	74	-0.416	20	0.238	57	-0.199
Salzburg (Umgebung)	Salzburg	-1.630	83	-0.854	73	-0.389	77	-0.416	86	-0.566	90	-0.771
Sankt Johann im Pongau	Salzburg	-2.278	46	-0.012	69	-0.326	81	-0.441	45	-0.062	82	-0.624
Tamsweg	Salzburg	1.319	2	2.904	9	0.936	3	2.467	6	0.726	2	1.670
Zell am See	Styria	-0.536	82	-0.838	62	-0.269	5	1.350	5	0.771	35	0.096
Graz (Stadt)	Styria	0.537	34	0.247	29	0.247	10	0.723	9	0.637	18	0.478
Deutschlandsberg	Styria	0.008	25	0.414	61	-0.247	66	-0.337	79	-0.454	52	-0.123
Graz (Umgebung)	Styria											
Leibnitz	Styria											

(Continued)

Table A1. Continued.

District	Federal state	Dimension												Total	
		Geographic		Demographic		Economic		Analytical		Synthetic					
		Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score	Rank	Z-Score
Leoben	Styria	18	0.858	64	-0.433	58	-0.198	7	1.152	40	-0.042	26	0.268		
Liezen	Styria	88	-1.583	77	-0.773	41	-0.017	87	-0.532	41	-0.049	81	-0.591		
Murau	Styria	93	-1.951	95	-1.680	90	-0.901	92	-0.626	87	-0.601	95	-1.152		
Voitsberg	Styria	64	-0.463	74	-0.683	95	-1.583	67	-0.339	76	-0.343	85	-0.682		
Weiz	Styria	63	-0.412	49	-0.148	21	0.382	62	-0.311	17	0.353	48	-0.027		
Murtal	Styria	54	-0.119	78	-0.782	75	-0.466	35	-0.030	75	-0.336	68	-0.346		
Bruck-Mürzzuschlag	Styria	44	0.203	88	-1.098	66	-0.298	21	0.230	69	-0.259	59	-0.244		
Hartberg-Fürstenfeld	Styria	79	-0.873	67	-0.469	88	-0.862	37	-0.048	77	-0.366	79	-0.523		
Südoststeiermark	Styria	77	-0.736	92	-1.209	81	-0.668	94	-0.680	64	-0.205	87	-0.700		
Innsbruck (Stadt)	Tyrol	5	1.459	1	3.698	8	0.965	12	0.616	89	-0.624	5	1.223		
Imst	Tyrol	65	-0.469	40	0.029	31	0.229	91	-0.569	55	-0.120	56	-0.180		
Innsbruck (Land)	Tyrol	23	0.822	14	0.655	54	-0.165	51	-0.223	36	0.021	27	0.222		
Kitzbühel	Tyrol	83	-1.142	44	-0.004	59	-0.212	32	-0.015	68	-0.256	66	-0.326		
Kufstein	Tyrol	56	-0.147	10	0.802	15	0.672	42	-0.155	16	0.372	23	0.309		
Landeck	Tyrol	86	-1.267	59	-0.337	47	-0.058	88	-0.546	85	-0.559	80	-0.553		
Lienz	Tyrol	95	-3.661	79	-0.801	48	-0.077	39	-0.113	31	0.100	94	-0.910		
Reutte	Tyrol	84	-1.225	57	-0.286	30	0.242	15	0.366	4	1.046	46	0.029		
Schwarz	Tyrol	57	-0.153	22	0.447	34	0.191	26	0.124	18	0.340	30	0.190		
Bludenz	Vorarlberg	42	0.257	47	-0.070	38	0.083	53	-0.237	25	0.134	45	0.033		
Bregenz	Vorarlberg	17	0.900	27	0.370	26	0.308	11	0.654	13	0.544	13	0.555		
Dornbirn	Vorarlberg	14	1.273	9	1.100	18	0.498	20	0.236	34	0.058	10	0.633		
Feldkirch	Vorarlberg	15	1.014	18	0.536	20	0.389	31	0.000	51	-0.106	20	0.367		
Vienna	Vienna	1	1.687	3	2.456	13	0.704	19	0.253	59	-0.136	7	0.993		

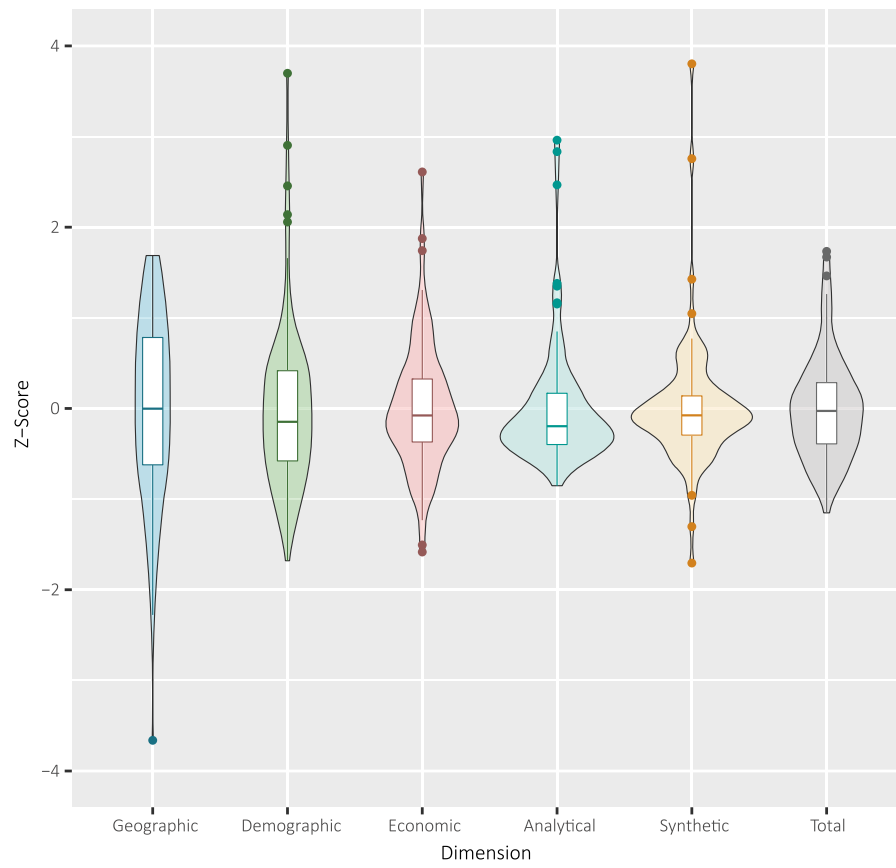


Figure A1. Distribution of peripheralization dimensions.

Paper III

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Innovation in the periphery: Compensation and exploitation strategies

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Abstract

Recent research has challenged the urban bias in economic geography and innovation studies, showing that highly innovative and competitive firms are also located in peripheral regions. So far, however, analyses has focused on how firms innovate despite their unfavourable location and little has been said about the innovation benefits of peripheral areas. Hence, this article identifies different compensation and exploitation strategies adopted by firms in order to overcome regional innovation constraints and to reap innovation benefits found in the periphery. Drawing on 20 in-depth qualitative interviews with innovative firms situated in the Austrian periphery, our analysis reveals that innovation in peripheral regions is the outcome of a combination of compensation and exploitation practices. The uptake and composition of these strategies depend on the firm and regional characteristics, with firm size being the most influential factor.

1 | INTRODUCTION

Scholarly work on the geography of innovation has tended to focus on core regions, clusters, and the virtues of agglomeration for many decades (Shearmur, 2012). Over the past few years, an emerging body of literature has begun to challenge this geographic bias by analysing innovation processes in peripheral regions on different scales (for a recent review see Eder, 2019a; Isaksen & Karlsen, 2016; Shearmur, 2017). There is a growing awareness that firms in a peripheral setting also innovate, albeit that their innovation processes are diverse and differ from those of their urban counterparts

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(Isaksen, 2015; Rodríguez-Pose & Wilkie, 2019; Shearmur, 2015). As peripheries are said to offer only a few assets that innovators can deploy, an efficient internal organisation (Grillitsch & Nilsson, 2015; Isaksen & Karlsen, 2016) and strategic efforts towards innovation by individual firms (Copus, Skuras, & Tsegenidi, 2008; McAdam, McConvery, & Armstrong, 2004; North & Smallbone, 2000) are found to be of vital importance. Furthermore, linkages to nonlocal actors (Copus & Skuras, 2006; Fitjar & Rodríguez-Pose, 2011a, 2011b; Huggins & Johnston, 2009; Rodríguez-Pose & Fitjar, 2013) and a proactive role of policy (Asheim, Isaksen, & Trippl, 2019) are considered to be crucial.

While this literature has helped to move beyond understanding innovation through the urban core lens, it also suffers from a number of shortcomings. Much attention has been devoted to explain the ways in which firms overcome innovation barriers typically found in the periphery and compensate for locational disadvantages (Dubois, 2015; Grillitsch & Nilsson, 2015; Virkkala, 2007). Nonetheless, systematic accounts of compensation strategies and their relative importance are still lacking. Furthermore, the overly dominant focus on innovation constraints and compensation strategies hides the fact that peripheral locations may also provide benefits for innovation activities (Glückler, 2014; Grabher, 2018; Mayer & Baumgartner, 2014; Shearmur, 2017). Little work has thus far been done towards unravelling the nature of these benefits and examining the supposedly wide array of firm strategies for exploiting them.

This negative view on peripheries is still dominant in innovation studies, which might reflect a lack of explicit theoretical explanations of innovation processes in peripheral regions. Indeed, with some exceptions (Shearmur, 2015; Shearmur & Doloreux, 2016), the conceptual work on innovation in the periphery is scant. Approaches like Territorial Innovation Models (TIMs) with their emphasis on the spatial concentration (Moulaert & Sekia, 2003) are still influential and widely used. Other contributions are even suggesting that innovation and entrepreneurship are concentrated in agglomerations because such activities would indeed require cities (Florida, Adler, & Mellander, 2017; Glaeser, 2011). Urban areas undoubtedly possess many preconditions for innovation but an exclusive focus on cities neglects the evidence of innovation in non-core regions (Eder, 2019a).

Hence, this paper aims at gaining a deeper theoretical and empirical understanding of innovation processes in peripheral areas by casting light on *both* compensation and exploitation strategies employed by firms to overcome innovation constraints and reap innovation benefits found in their regional environment. Drawing on 20 in-depth interviews with innovative firms from different industries located in the Austrian periphery, all of which have recently introduced products new to the firm or new to the market, the paper addresses the following research questions. First, what is the portfolio of compensation and exploitation strategies of peripheral firms? Second, what is their relative importance considering the firm size and firm type? Our results suggest that innovation in the periphery is indeed the outcome of both compensation and exploitation practices. Their frequency and combinations, however, vary, depending on specific firm and regional characteristics.

The remainder of this paper is organised as follows: Section 2 reviews the extant literature, identifies a set of compensation and exploitation strategies, and develops a framework explicating the ways in which firms in the periphery might combine both practices. This is followed by notes on the investigated regions and firms as well as on the data and methods applied in Section 3. Section 4 presents and analyses our empirical findings. Section 5 concludes and outlines directions for further research.

2 | INNOVATION IN THE PERIPHERY: COMPENSATION VERSUS EXPLOITATION?

The entry and survival of innovative firms and their performance are often seen as key components of the regional development (Fritsch & Storey, 2014; Piacentino, Espa, Filippini, & Giuliani, 2017).

As these firms provide employment for highly skilled workers, they might contribute to halting brain drain and to even attract talent from outside the region (Meili & Shearmur, 2019). Recent theoretical advances like the peripheralisation approach have also highlighted that geographical remoteness is not a sufficient factor for delimiting peripheral regions. In addition, demographic, economic, political, and discursive elements are important in this regard (Kühn, 2015). This paper adopts this functional understanding of peripheries and therefore, the discussion below investigates how firms survive in such seemingly hostile environments and which challenges as well as benefits they see for their innovation process. Furthermore, it explores the role that classical location factors might play today in both well-established firms and for recent innovators in peripheral regions.

Based on the existing literature, the following section identifies frequently mentioned shortcomings of peripheral regions that firms might see a need to compensate for. In addition, it also looks at the benefits that peripheries might provide. As such, it moves beyond the dominant-negative view of such regions. To test these assumptions and perceptions, this deductive framework serves as a basis for the empirical analysis, that is, the qualitative interviews with innovative firms located in the periphery.

2.1 | Innovation challenges in the periphery and compensation strategies

Over the past years, a vast body of literature has argued that peripheral regions offer poor conditions for innovative activities. These areas are said to suffer from the absence of clusters and externalities, weak organisational support structures, and unfavourable institutional set-ups, that is, thin regional innovation systems (Isaksen & Tripp, 2017; Tödtling & Tripp, 2005). If innovation occurs in peripheral areas, scholars often attribute this to the successful compensation of locational disadvantages by firms (Virkkala, 2007). As geographical proximity and agglomeration advantages are still considered to be crucial for innovation in most theoretical and empirical works (Shearmur, 2012), the question of the ways in which firms can be innovative despite the absence of these benefits has become the main point of interest. There seems to exist widespread consensus that firms in the periphery might have to undertake more strategic efforts to generate innovations when compared with their counterparts in urban regions. Hence, an efficient internal organisation and strong in-house knowledge creation, that is, *building up high-level internal competence*, have been identified as key strategies for developing innovations in peripheral locations (Doloreux & Shearmur, 2012; Flåten, Isaksen, & Karlsen, 2015; Grillitsch & Nilsson, 2015; Isaksen & Karlsen, 2016).

Scholarly work has also shown that building a strong internal knowledge base is often combined with an extensive integration in nonlocal networks based on purpose-built searches (Fitjar & Rodríguez-Pose, 2017). In this regard, new theoretical and conceptual perspectives have gained prominence, challenging traditional TIMs (Huber, 2012). In the past decade, work done in the context of the proximity debate has suggested that knowledge exchange and innovation benefit not only from geographical proximity but also are essentially facilitated by cognitive, organisational, social, and institutional forms of proximity (Balland, Boschma, & Frenken, 2015; Boschma, 2005; Hansen, 2015; Malmberg & Maskell, 2006; Torre, 2008), with the latter four being, in principle, also available in peripheral regions. In addition, Bathelt, Malmberg, and Maskell (2004) argue in their seminal paper that with increasing globalisation, *global pipelines* (that is, deliberately established trans-regional connections to distant sources of knowledge) that complement *local buzz* have become vitally important and are positively related to innovation (Fitjar & Huber, 2015). Accordingly, peripheral firms can compensate for spatial proximity by focusing on other proximity dimensions and the *establishment of global pipelines*, often through formal collaboration (Grillitsch & Nilsson, 2015).

Furthermore, with the widespread diffusion of modern communication technology, *participating in virtual and global buzz* is argued to be sufficient for cooperation in certain innovation projects

(Grabher & Ibert, 2014; Maskell, Bathelt, & Malmberg, 2006; Rychen & Zimmermann, 2008). Trade fairs and conferences allow firms to link up to nonlocal knowledge pools, to get access to new ideas, and to identify potential partners (Bathelt, 2017; Bathelt & Gibson, 2015; Bathelt & Henn, 2014; Maskell, 2014). As such, these temporal events are especially promising for peripheral firms in terms of benefiting from what is called *global buzz* to compensate for the absence of *local buzz*.

The importance of nonlocal connections for peripheral firms has not only been outlined theoretically but has also been confirmed by empirical research. However, studies have found that this might not hold true for all firms, since size, industry, and culture play an important role (Beugelsdijk & Cornet, 2002; Fitjar & Rodríguez-Pose, 2011a, 2011b; Lorentzen, 2007; Virkkala, 2007). Furthermore, firms located in such regions do not necessarily have more international ties (Rodríguez-Pose & Fitjar, 2013). Still, there is evidence that peripheral firms focus on formal collaboration to compensate for the lack of spontaneous regional knowledge exchange and local spill-overs (Dubois, 2015; Grillitsch & Nilsson, 2015; Jakobsen & Lorentzen, 2015). Consequently, the significance of high-level internal competence and extra-regional knowledge networks as well as *global* and *virtual buzz* is evident and is considered to be crucial for innovative activities in the periphery.

2.2 | Innovation benefits of the periphery and exploitation strategies

The prevailing view in the literature is that innovators in the periphery face more challenges than their urban counterparts do. This perception as well as the urban bias in innovation studies (Shearmur, 2017) underpin the compensation perspective highlighted above. However, this view neglects that peripheral environments might also have to offer something to their innovators, both in the innovation process and in terms of classical location factors. These regions might provide opportunities for *harnessing the protective environment* that these areas often provide. Such an environment allows for the undisturbed search for and experimentation with novel solutions (Cattani, Ferriani, & Lanza, 2017; Doloreux, 2003; Glückler, 2014; Petrov, 2011), which may later be adopted on a larger scale. A case study by Glückler (2014) on the global chemical corporation BASF provides interesting findings in this regard. A controversial new business model was developed in the organisational and geographical periphery by a small subsidiary, namely BASF Argentina. At first, neglected by their headquarters in Germany, the new approach was later rolled out globally. Grabher (2018) also demonstrates how a new style in architecture was developed in the periphery, leveraging the region's location to shield itself from the capital region.

The protective role of the periphery was found to be vital for innovations that formed the basis for the emergence of the Danish wind power industry (Simmie, 2012). The first wind turbines were developed to provide electricity to the Danish periphery, which was not connected to the grid. Theoretically, these examples can also be seen from a multi-level perspective (Markard, Raven, & Truffer, 2012; Smith & Raven, 2012), with the periphery providing a protective space for the niche development. Examples exist for this combination of natural resources and niche strategies resulting in high specialisation and innovative behaviour, which would not have been possible in urban environments (Fløysand & Jakobsen, 2011; Giuliani & Bell, 2005; Hall, 2017; Isaksen, 2015). Further, a firm might be the only employer in a specific industry in a region, providing few options to the workforce of leaving the company. Though a stable workforce and too much cognitive proximity bear the dangers of lock-in (Broekel & Boschma, 2012), it also results in higher loyalty and allows firms to build strong internal expertise in niches (Isaksen, 2015; Isaksen & Karlsen, 2016). Arguably, the periphery may not only serve to protect firms from fierce competition over skilled labour but also from knowledge leaking out easily to competitors (Grillitsch & Nilsson, 2017).

There are strong reasons for assuming that the relationship of a peripheral firm with its home region differs fundamentally from such relationships found in urban centres (Schoenberger, 1999).

Innovative firms in the periphery often attract a great deal of attention and support from regional stakeholders. This might provide them with opportunities for shaping their regional environment to fit their needs. An example of exploiting this advantage and *capitalising on institutional leeway* are firms cooperating with local universities of applied sciences and professional schools in training the future workforce according to their requirements. In addition, if regional policy makers recognize the significance of the few innovative firms in their regions, this should increase the likelihood of tailor-made policies, addressing their specific needs (Meili & Shearmur, 2019; Polèse & Shearmur, 2002). Such support of formal institutions has been found to positively influence entrepreneurship in peripheral regions (Müller, 2016).

Further, *deploying soft locational factors* such as regional traditions and a certain image of rural and peripheral areas during the innovation process can be beneficial for the marketing of products that are later sold in urban areas (Dinis, 2006; Mayer, Habersetzer, & Meili, 2016). Another soft factor would be a high quality of life, often in a laid-back natural environment far from urban congestion. For some workers—especially for those originally coming from these regions—such an environment might be appealing. Hence, these factors can also be leveraged in the recruiting process of skilled labour (Brydges & Hracs, 2019; Copus & Skuras, 2006; Shearmur, 2017). This challenges the dominant focus in the literature on urban amenities for attracting talent (Florida, 2004) and there is even evidence that certain firms are relocating to rural areas due to natural amenities (Rupasingha & Marré, 2018).

Other potential advantages of peripheries with roots in traditional location theory are *financial and cost incentives*. One can distinguish between public subsidies and lower factor costs in this regard. On the one hand, conventional measures like public subsidies from regional and federal governments or supranational funding bodies like the EU structural funds still play a role (Müller, 2016). Since they aim to reduce regional disparities, subventions are usually higher in such areas. On the other hand, lower wages and land prices are a common benefit of peripheral regions, which might gain relevance if a firm does not only conduct R&D at its peripheral location but also maintains manufacturing functions. It might allow firms to have R&D and production at the same location in high-wage countries, too, which is seen as beneficial when, for example staff do not have to travel overseas for prototype testing (Meili & Shearmur, 2019).

Finally, for some industries, short geographical distance to specific natural resources might be an important asset. This is especially true for traditional sectors which are often overlooked in innovation studies (Davies, Michie, & Vironen, 2012) and which are located close to resources like timber, ore, or hydroelectric power (Lundmark & Pettersson, 2012). Innovation in fishery (Fløysand & Jakobsen, 2011), oil and gas (Fitjar & Rodríguez-Pose, 2011a), wine production (Doloreux, Shearmur, & Guillaume, 2015; Giuliani & Bell, 2005), and mining (Hall, 2017) are all linked to the occurrence of natural resources or a specific climate, which are both not ubiquitous. Therefore, innovation in these sectors requires a certain understanding of the issues and challenges related to peripheries, which is usually not available to urban innovators (Cooke, 2011; Petrov, 2011; Shearmur, 2015). Due to the predominant focus on high-tech sectors in innovation studies (Shearmur, 2015, 2017), the potential for innovation through *leveraging natural resources* available in the periphery is often neglected.

2.3 | Compensation and exploitation strategies: Variations across firms and regions

The literature review in the previous section has helped to identify various compensation and exploitation strategies of innovative firms in the periphery (see Table 1).

TABLE 1 Compensation and exploitation strategies

Compensation strategies	Exploitation strategies
Peripheral firms are...	Peripheral firms are...
<i>...building high-level internal competences by</i>	<i>...harnessing the protective environment, as the remote location</i>
<ul style="list-style-type: none"> • creating tacit knowledge through internalisation (Flåten et al., 2015, p. 109) • developing a high absorptive capacity to identify and internalise external knowledge sources (Grillitsch & Nilsson, 2015, p. 305) • internalising tasks that are usually externalized in core regions (Doloreux & Shearmur, 2012, p. 85) • recruiting staff from abroad to create the necessary diversity (Meili & Shearmur, 2019, p. 503) 	<ul style="list-style-type: none"> • might impede the market entry of external competitors (Doloreux, 2003, p. 73) • can offer the potential to position new ideas against a dominant regime (Glückler, 2014, p. 912; Grabher, 2018, p. 1788) • limits undesirable knowledge spillovers, for example, through labour poaching (Grillitsch & Nilsson, 2017, p. 1222)
<i>...maintaining trans-regional collaboration (global pipelines), as they are</i>	<i>...capitalising on institutional leeway, as</i>
<ul style="list-style-type: none"> • relying more on formal collaborations than on local knowledge spillovers (Grillitsch & Nilsson, 2015, p. 314) • using purpose-built searches for partners if agglomerations for buzz-driven innovation are not available (Fitjar & Rodríguez-Pose, 2017, p. 37) • exhibiting a special form of transnational entrepreneurship, relying more on social capital and networks (Dubois, 2016, p. 10) 	<ul style="list-style-type: none"> • smaller jurisdictions can adapt faster to the needs of regional economic actors (Polèse & Shearmur, 2002, p. 182) • there is a closer connection between regional policy makers and firm directors (Meili & Shearmur, 2019, p. 505)
<i>...participating in temporal and virtual buzz to</i>	<i>...reaping financial and cost incentives, like</i>
<ul style="list-style-type: none"> • ensure the influx of external knowledge (Bathelt & Schuldt, 2010, p. 1958) • participate in multiple digital communities to share their ideas (Grabher & Ibert, 2014, p. 105) 	<ul style="list-style-type: none"> • cheap labour and available sites for large enterprise complexes (Gripaios, Bishop, Gripaios, & Herbert, 1989, p. 156), which allows to maintain R&D next to production in a high-wage country (Meili & Shearmur, 2019, p. 505) • higher public subsidies to spur innovation in peripheral areas (Oughton, Landabaso, & Morgan, 2002, p. 105)
	<i>...deploying soft locational factors, for</i>
	<ul style="list-style-type: none"> • marketing of certain products, using the image and tradition of their region (Dinis, 2006, p. 15; Mayer et al., 2016, p. 8) • recruiting skilled labour keen to the amenities of rural places (Brydges & Hracs, 2019, p. 518)
	<i>...leveraging expertise on innovation relating to natural resources, like</i>
	<ul style="list-style-type: none"> • food processing, renewable energy, or tourism (Davies et al., 2012, p. 121)

It is contended that the exact composition, combination, and intensity of both practices differ, depending on the characteristics of the firm and the regional constraints and benefits. First, whether a firm pursues compensation and/or exploitation practices is rooted in its individual perception of the location. Firms unsatisfied with the environment will focus on the compensation of disadvantages, those seeing advantages will try to leverage them. Second, a footloose industry such as IT might focus on connectivity to global knowledge hubs, while firms with large production sites would be spatially bound to the region, increasing the potential for close collaboration with regional stakeholders (Polèse & Shearmur, 2002; Vonnahme, Graffenberger, Görmann, & Lang, 2018). Third, firms relying on the open innovation paradigm (Chesbrough, 2003; Huizingh, 2011) might compensate for a peripheral environment by maintaining multiple external connections. Other firms, which place a high value on secrecy, might rather prefer to exploit the protective environment of such regions (Malecki & Poehling, 1999; Meili & Shearmur, 2019; Shearmur, 2015). Fourth, an increase in firm size usually also increases the internal resources available. Major enterprises should, therefore, have more leeway to create endowments, while SMEs might need to build upon those resources that are available regionally. Finally, firms can be distinguished according to their regional commitment. Headquarters and family-owned firms usually possess strong ties to the region, which increases the likelihood of interaction with regional actors. Branch offices might see little room for the development in this regard (Meili & Shearmur, 2019; Vonnahme et al., 2018).

Beside firm characteristics, the peripheral environment is also expected to bear influence on the adoption of compensation and exploitation strategies. Peripheries come in many shapes and vary in terms of innovation challenges and benefits (Eder, 2019b; Rodríguez-Pose & Wilkie, 2019). Constraints to innovation may be manifold in some peripheral areas, whilst other peripheries might be better endowed with assets that are valuable for innovative firms.

Hence, the exact portfolio of compensation and exploitation strategies will depend on the needs and potentials of the firm as well as on regional preconditions. If firms perceive a peripheral location as rather neutral, they might see little need for compensation and little room for exploitation. In contrast, if innovation constraints prevail, compensation strategies should be frequent. If peripheral regions have certain endowments, it is likely that firms also rely on exploitation strategies. Consequently, whether innovators in the periphery take up (combinations of) compensation and exploitation strategies ultimately is the individual decision of these firms and contingent upon a number of firm and regional characteristics. To test these theoretical assumptions, the remainder of this paper investigates the nature of both compensation and exploitation strategies employed by innovative firms in the Austrian periphery.

3 | DATA AND METHODS

The empirical analysis draws on 20 in-depth qualitative interviews with innovative firms located in different peripheral areas in Austria. As such, it deliberately adopts an exploratory research design in order to unravel the underlying mechanisms of the locational choices and the individual perceptions of firms. These are often overlooked in the dominant literature that relies on quantitative analyses. Our intensive approach seems especially suitable for an emerging field like the research on innovation in the periphery, since theorising in space has thus far been dominated by an urban bias (Shearmur, 2017). Hence, the paper also aims to complement the existing literature and to indicate directions for future work, both quantitatively and qualitatively.

The case study regions were selected on the basis of delimitation by Statistics Austria (2016) and recent studies (Eder, 2019b). These peripheral regions are understood in a functional way, that

is, they share some common characteristics like below-average accessibility, but particularly weak performance in terms of demographic and economic developments as well as knowledge intensity. However, they are far from being uniform (Eder, 2019b), which allows for the incorporation of different compensation and exploitation strategies resulting from different regional contextual conditions (see Figure 1). First, alpine tourism regions (ATRs) in the western part of Austria show a dominant specialisation in winter tourism. Coupled with the mountainous landscape, this results in limited land reserves, driving land prices to levels comparable to those found in central regions. In addition, the focus on tourism to a certain extent results in a lock-in, but also leads to relatively good levels of economic performance. However, a certain degree of outmigration and brain drain can be observed.

Second, firms operating along the Czech border in northern border regions (NBRs) are located in areas that are still trying to recover from their situation of isolation during the iron curtain era. Accessibility as well as demographic and economic developments are below-average. However, they are in vicinity to cities like Vienna and Linz. This offers the potential for collaboration with centrally located partners within a daily commute. It also means that these regions still benefit from high-ranking infrastructure like the Vienna airport, making it easier to participate in international innovation networks.

Third, south-eastern border regions (SEBRs) are ultimately the most challenged ones, also suffering from brain drain, poor economic performance, and comparatively low accessibility, since no larger urban areas or high-ranking airports are located close by. Here, challenges are piling up and consequently, policy makers are especially supportive, trying to strengthen these regions. For example, Burgenland was the only region in Austria eligible for the Objective 1 programme of the EU.

As the analysis aims to provide a comprehensive inventory of compensation and exploitation strategies, it does not focus on a single case study region, but includes peripheries with different

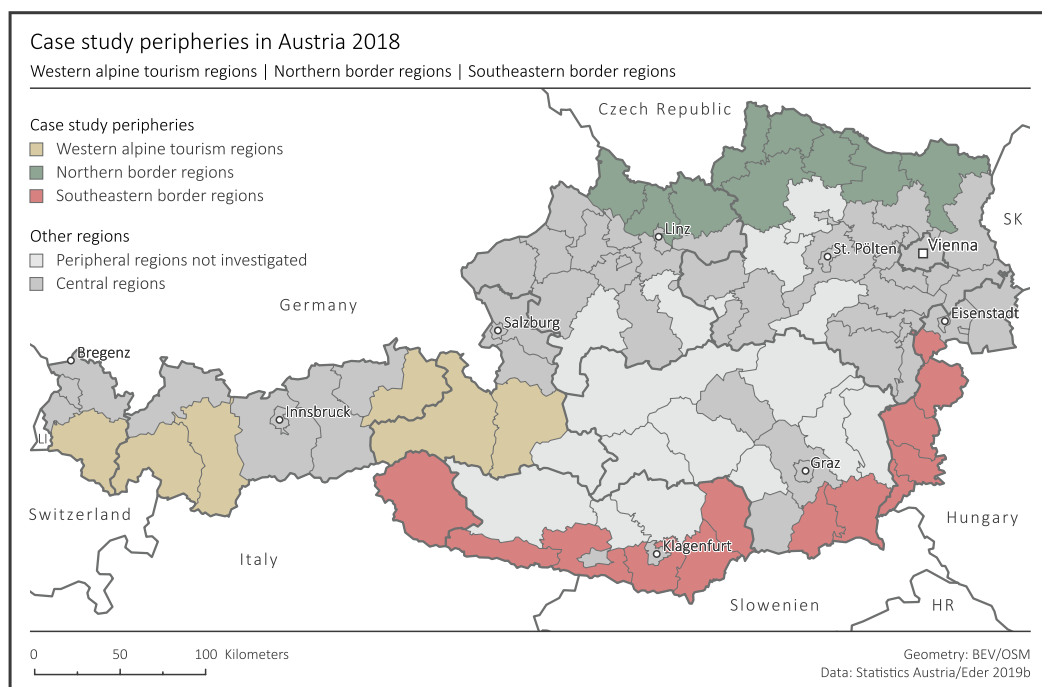


FIGURE 1 Case study peripheries in Austria 2018

characteristics. This allows for a deeper analysis of firm practices and strategies that seek to overcome constraints and reap benefits encountered in peripheries. It also provides a sound basis for a qualitative and exploratory analysis in which the focus lies on complex connections (Schoenberger, 1991). In a similar vein, no restrictions were imposed concerning industries, in order to grasp differences between sectors. This was also a pragmatic choice, as the number of innovative firms in the periphery is limited by definition, especially in a small country like Austria. Consequently, in the absence of peripheral clusters and individual register data, it seemed doubtful that a sufficient number of peripheral firms from specific industries—also willing to participate in the survey—could have been identified. The paper, therefore, rather aims to provide the basis for further analyses with larger samples and includes firms from industries such as food technology, optoelectronics, machinery, and IT (see Table 2).

Nevertheless, our analysis does take other characteristics into account, namely firm size, firm type, and the period of firms presence at the current location. This allows for the distinction between large enterprises and SMEs (firm size), between headquarters, branch plants, and start-ups (type) as well as between well-established firms and recent movers or start-ups, that is, those firms that have been at the location for a maximum of 10 years. Hence, conclusions on the portfolio of both compensation and exploitation strategies according to firm size and firm type can be drawn. It also provides insight into the motives of recent movers and company founders (Habersetzer, 2017).

Hence, innovators from peripheral regions all over Austria were contacted, according to the following criteria. First, receivers or nominees of innovation prizes from the federal states (*Bundesländer*) or the nation-state over the last years were approached, ensuring a high orientation of the firms towards innovation. In this initial phase, 15 interviews were conducted. Second, leading firms at the

TABLE 2 Surveyed firms by industry, periphery, type, age, and number of employees

Firm	Industry	Type	Periphery	At location	Employees
1	IT	Start-up	ATRs	Since 2008 or later	10–49
2	Optoelectronics	Headquarters	SEBRs	Prior to 2008	10–49
3	Food technology	Branch plant	NBRs	Prior to 2008	250+
4	IT	Headquarters	ATRs	Prior to 2008	1–9
5	Medical technology	Start-up	ATRs	Since 2008 or later	1–9
6	Transport technology	Headquarters	NBRs	Prior to 2008	250+
7	Plant engineering	Headquarters	SEBRs	Prior to 2008	10–49
8	Surveying technology	Headquarters	ATRs	Prior to 2008	10–49
9	Printing technology	Branch plant	SEBRs	Prior to 2008	50–249
10	Building technology	Branch plant	SEBRs	Since 2008 or later	50–249
11	Surface technology	Start-up	ATRs	Since 2008 or later	10–49
12	Automotive	Branch plant	NEBRs	Prior to 2008	250+
13	Cooling systems	Branch plant	SEBRs	Prior to 2008	250+
14	IT	Start-up	NEBRs	Since 2008 or later	1–9
15	Aviation	Headquarters	NEBRs	Prior to 2008	250+
16	IT	Start-up	NEBRs	Since 2008 or later	50–249
17	Optoelectronics	Start-up	ATRs	Since 2008 or later	50–249
18	Machine construction	Branch plant	SEBRs	Prior to 2008	250+
19	Plastics technology	Headquarters	ATRs	Prior to 2008	250+
20	Textiles	Headquarters	ATRs	Prior to 2008	250+

regional level with own R&D departments and start-ups were invited to partake in the study in order to gather cases from those peripheries where no firms participated in the initial phase, which led to a sample of 20 interviews. These firms can be considered as innovative, as they have recently introduced products new to the firm and/or new to the market. In total, 43 firms have been invited for an interview in the course of the study, resulting in a success rate of 47%. However, it is important to state that the focus on innovation prizes and new products led to a sample of predominantly high-tech firms. The empirical results on compensation and exploitation strategies have to be interpreted with this in mind. The picture might look different for innovators that are not product or technology orientated.

The interviews were predominantly conducted at the peripheral locations of the firms, usually with CEOs, their deputies or with heads of R&D departments within firms. Due to difficulties in arranging an appointment, one interview was conducted via Skype and another firm could only respond to the questionnaire in written form. The interviews focused on four main parts. First, the relevance of innovation for the firm and the development of a common product were discussed in order to get an understanding of the innovation activities and processes of the firm. Second, interview partners reflected on the advantages they especially value at their location. Third, the interviews included questions about the local challenges for the innovation process. Finally, interviewees reported on their general perception of the location and on their view on regional and national innovation policy.

With these responses, theoretical saturation was achieved, implying that the significance of new information decreased with the number of interviews and eventually became marginal. The semi-structured interviews lasted for 48 min on average, with a minimum of 26 and a maximum of 70 min. They were carried out in German during the second half of 2018. Thereafter, they were fully transcribed and coded according to the conceptual framework.

4 | RESULTS: COMPENSATION AND EXPLOITATION STRATEGIES OF INNOVATIVE FIRMS IN PERIPHERAL REGIONS IN AUSTRIA

All 20 firms were willing to reflect upon their individual perception of their location and therefore on regional innovation constraints and benefits. As most of the firms in the sample are winners of innovation prizes, all respondents stated that innovation would be a key component of the firm's strategy. This ensures insights into the significance of both compensation and exploitation practices in the innovation process. Hence, the following section examines the relative importance of both strategies. In the next step, their relationship is analysed, especially considering firm size and location.

4.1 | Dealing with regional innovation constraints: Compensation strategies

Most firms see the limited supply of skilled labour as major innovation constraint in the Austrian periphery. All respondents report that they build upon an efficient organisation and a strong internal knowledge base, as was suggested by Flåten et al. (2015). In this regard, the relevant knowledge consists both of the professional experience and the industry-specific knowledge that is acquired over time. Firms often undertake great efforts to provide an attractive work environment and to continuously upskill their staff, offering, for example, incentives for those who choose to study after their first years of professional experience and are willing to return to the firm afterwards. Many respondents claim that firms now once again more frequently engage in training their own apprentices in order to strengthen their relevant competences early in their careers.

Skilled employees are crucial, everything depends on them. Therefore, we started last autumn, for the first time, to train our own apprentices, engineering draftsmen and designers. [Firm 6]

Strong reliance on the expertise of their employees prevents firms from applying another compensation strategy, namely relocation. A handful of younger firms that considered moving to a more stimulating environment did not realise such plans, confirming an observation by Isaksen (2015) that many peripheral innovators would probably not survive the shift to an urban environment. This indicates that after a certain point, relocation of young firms to more central locations is not an option any longer:

Indeed, we have given relocation some thought. In the end, the problem was that we were uncertain if we would have managed the knowledge transfer. ... We knew that from the staff, 80% would not join us, or maybe even 98%. Hence, for relocation the firm is too small and too specialized that we could manage this. [Firm 17]

With the exception of a few firms that rely more on secrecy and therefore on their internal capacities, most firms have established long-standing nonlocal formal connections to universities, customers, suppliers, and service providers to ensure the influx of external knowledge. As was found in other studies too, these (*global*) *pipelines*, referring here to trans-regional, national, and international connections, have the potential to complement internal capacities (Fitjar & Rodríguez-Pose, 2011a; Huggins & Johnston, 2009). It is furthermore seen as a fruitful compensation strategy in cases where the internal knowledge base lacks certain competences for further product development or where inputs from specialised KIBS located in urban centres are necessary. Collaboration with universities is often of an exploratory nature and is pursued to broaden the horizons of firms and to see where industries might be heading in the future. Many firms choose to work with suitable partners mainly in Austria and Germany, but also globally if specific knowledge is needed. Expertise (cognitive proximity) and social proximity seem to be the most relevant factors in this regard, with geographic proximity being convenient but not essential:

Competences are the crucial factor, not whether someone is close by (...). Maybe the right chemistry is even more important. If the chemistry is right, you can go through ups and downs together. [Firm 9]

In conjunction with formal connections, most of the surveyed firms leverage the potential of global and virtual buzz to obtain access to knowledge and to establish links to international partners and customers. This confirms other theoretical and empirical works, indicating that trade fairs and conferences serve as a welcome opportunity to form temporal clusters and to get known in the global market place (Bathelt, 2017; Bathelt & Henn, 2014; Maskell, 2014). Some firms employ modern communication technologies to benefit from *virtual buzz*. Intensity of their usage varies between the investigated firms but one can observe that video conferences, webinars, and virtual product trainings have become more and more frequent over the past few years. This is especially important for firms located in the south of Austria, where geographic distances to airports and urban agglomerations are reported to be a major constraint, since travel times are higher than in the western and northern peripheries of the country. Hence, these firms value ICT tools as a way to save travel costs and to deal with disadvantages emanating from their distant location:

During the last six to twelve months, this has been rapidly increasing within our firm. We successively try (...) to save travel expenses, since we now have these great technologies. We also already do a lot of product training online. [Firm 2]

Some firms report, though, that *global pipelines* as well as *global* and *virtual buzz* do not suffice to get access to all external knowledge and qualifications required for their innovation endeavours. Almost half of the surveyed firms complement these strategies by establishing branch offices in urban areas in Austria and abroad. While branches in other countries are often used for sales and marketing purposes, those in Vienna and other major cities serve to employ people with specific qualifications, which are hardly found in the periphery. This ensures that peripheral firms are not entirely cut off from the diverse and skilled labour markets of agglomerations. They furthermore constitute a means of binding highly qualified workers to the firm. Not all firms state that this would work for them, especially those who see the colocation of R&D and production as fundamental. In contrast, others claim that it is a vital strategy to broaden and strengthen the internal knowledge base, particularly when a new field of business is developed:

We have a small development company there in the city (...) for a very, very specific segment. Historically, the expertise is there and we went there specifically to hire people, or also to lure them away. [Firm 9]

Moreover, high engagement in terms of employer branding is evident especially in larger enterprises, with firms claiming that their efforts have to be stronger compared to those of their urban counterparts. This is needed in order to attract talent to their location and to create the diversity necessary for innovation, as indicated by Meili and Shearmur (2019). Some even actively engage in regional development processes to maintain the quality of life for their employees, as Vonnahme et al. (2018, p. 40) have observed for Germany. In the future, this is likely to become even more important in those regions where the regional workforce is projected to decrease. Some firms offer housing or flexible work schedules to new recruits. Others try to recreate elements of an urban lifestyle, for example, by establishing own restaurants with a creative cuisine:

We offer a lot: great career opportunities due to the international setting, our own top-restaurant, flexible work schedules, etc. [Firm 16]

To summarise, apart from the frequently-mentioned in-house knowledge creation, the formation of *global pipelines* and participation in *global* and *virtual buzz*, there is strong evidence for two compensation strategies that have thus far hardly been addressed in the literature, namely the establishment of central branch offices and employer branding. The composition of the entire portfolio of compensation strategies varies widely across the studied enterprises, with firm size being the most influential factor. Large firms often have more resources to maintain external connections or to engage in professional employer branding activities and they have learned how to deal with regional innovation constraints. Start-ups have more limited capacities in this regard and struggle to become known in the region, implying that the challenges which are encountered vary over the life cycle of a firm. The next subsection explores whether this also holds true for exploitation strategies and their role in the innovation processes of firms.

4.2 | Leveraging regional innovation benefits: Exploitation strategies

As discussed in Section 2, peripheries might provide benefits for innovators and the interviews largely confirm this assumption. Most of the investigated firms value the protective environment of peripheral regions, especially concerning labour poaching. Our results thus confirm findings from other recent studies (Grillitsch & Nilsson, 2017). Many respondents point to a high loyalty of the workforce (especially in R&D departments) and highlight its advantages: It limits undesirable knowledge spill-overs, protects tacit knowledge, and strengthens the internal knowledge base (Flåten et al., 2015; Isaksen,

2015). It also allows for lower wages (particularly in those cases where the danger of headhunting is low), which can be a decisive factor in a high wage country like Austria. One start-up believes that this loyalty saved the firm during difficult times at the early stage of its development:

They [co-workers] were only employed part-time, but were working full-time for a whole year, the loyalty is enormous. And I know it from my partner in Vienna, he says that in Vienna that would not work. There, everybody immediately has a new job. [Firm 14]

A few firms state that their peripheral location would protect them from industrial espionage and monitoring by competitors, though this increasingly occurs online and at customer locations, which is why this function is losing significance.

Evidence exists that some firms capitalise on institutional leeway. This particularly holds true for larger firms, while start-ups often struggle to get through with their needs. The larger the workforce and the weaker the regional economy, the more support they get from policy makers on all levels. As also was observed by Polèse and Shearmur (2002), some investigated firms have the feeling that policy actors pay particular attention to branch companies in this regard in order to minimise the risk of relocation:

If we want to enlarge our premises (...), this is much easier than in Vienna (...). We are the biggest employer here, this helps if we need something from the municipality. [Firm 15]

Additionally, those firms with large production units also favour their location because sites for expansion are usually easily available, particularly in the Eastern and Southern peripheries. A few respondents stated that they maintain close relationships to local education institutions by sponsoring classrooms and equipment or using their influence to adjust the curricula to their needs. Some firms actively set up tertiary educational institutions in the region, trying to specifically strengthen the regional knowledge base. Many respondents highlight that this would not be possible in an urban area, where the firm would have to compete with many other companies, which seek to adopt similar strategies:

We have a close cooperation with the local polytechnic institute, based on a contract. We also know each other, so, if I have an open position, I contact the teaching staff and they provide me with a list of highly qualified candidates. They are also cooperative in terms of courses offered. [Firm 18]

Soft location factors like image and quality of life are benefits that are valued by the investigated firms. Some respondents state that these factors help to recruit workers from elsewhere. In addition, many business partners seem to appreciate the change of scenery and combine a business trip with a short vacation. This contradicts research that has predominately focused on urban amenities, ignoring the appeal of rural places to some innovators. Only a few other studies share our perspective (Brydges & Hracs, 2019; McGranahan, Wojan, & Lambert, 2011). Further, the investigated firms stress their existing workforce highly appreciates the fact that they have attractive jobs in the countryside, making a long commute obsolete, and avoiding traffic jams. There are firms in the sample, which use the image of their location for marketing purposes, either because the product aligns with the regional attributes or in order to actively distinguish themselves from competitors in urban locations (Mayer et al., 2016). As such, this function might be more significant for innovative firms operating in fields such as tourism or outdoor equipment, but can be leveraged in other sectors as well:

Customers have to remember us (...), and they connect me with the high mountains. I do that very deliberately, I always say, we are the firm from the high mountains (...). That is one of our distinctive features. [Firm 8]

Furthermore, financial incentives and low factor costs—a typical feature of peripheral regions—still play a role in the strategic decisions of some of the surveyed firms. Especially start-ups or recently established branch companies report that lower land prices and wage levels as well as public subsidies played a role in their location decisions. One firm, for instance, stated that the increased competition for engineers in urban areas has driven wages significantly, leading to a group-wide strategy of establishing R&D departments in peripheral locations, which until recently served merely as production sites. Especially in a high wage country like Austria, this can provide a comparative advantage, but one also needs to note that firms' views on the role of these benefits are highly diverse. For example, firms from western peripheries report that plots are limited in mountainous regions and that those available are often reserved for tourism, which drives land prices to levels comparable to those in urban areas. Consequently, not all firms in our sample benefit from low-cost advantages. Another issue is that public subsidies are often tied to firm size. Larger enterprises are usually not eligible for public funding, while SMEs more frequently reported that federal or EU funds are an asset of their location:

Here, I have to say, in terms of subsidies, the location is attractive, this is definitely positive. Usually, when we apply for national subsidies, we receive co-financing from the federal state. [Firm 2]

Finally, in the past, geographical proximity to natural resources played a role in attracting firms to peripheral regions in Austria. One example is the Plansee Group, a world market leader for powder metallurgical materials, whose founder relocated from Berlin to Breitenwang in Tyrol in 1921 due to the easy and cheap access to hydro electrical power (Gebhardt, 1990, p. 157). However, with the extensive availability of electricity, better transport infrastructure, and few remaining mining operations, there is hardly any evidence that natural resources continue to matter for the locational choices of the investigated innovative firms in Austria. Hence, none of the respondents highlighted them during the interviews.

4.3 | Discussion: The relationship and significance of compensation and exploitation strategies

As shown in the previous sections, most firms apply both compensation and exploitation strategies during the innovation process. Figure 2 provides insight into the relationship between these practices and their frequency and therefore into the innovation process of nonurban innovators. It is distinguished between larger enterprises and SMEs, because the firm size seems to be the most important factor in this regard. Similar depictions sorted by the firm type, case study peripheries, and the presence at location show discrepancies that are more limited. This indicates that the challenges firms need to compensate for and the potential for exploitation are rather homogenous across the field of headquarters, branch plants, and start-ups as well as across peripheries and viewed according to firm age. There are exceptions to this observation, but employing compensation strategies often requires substantial resources and the availability of these resources increases with firm size. In contrast, though the picture is not as clear-cut for exploitation strategies, the firm size also has an influence, especially in relation to adopting institutional leeway strategies.

The overall pattern suggests that high importance is attached to compensation strategies. Almost all firms build upon high-level internal competences, *global pipelines* as well as *global* and *virtual buzz*.

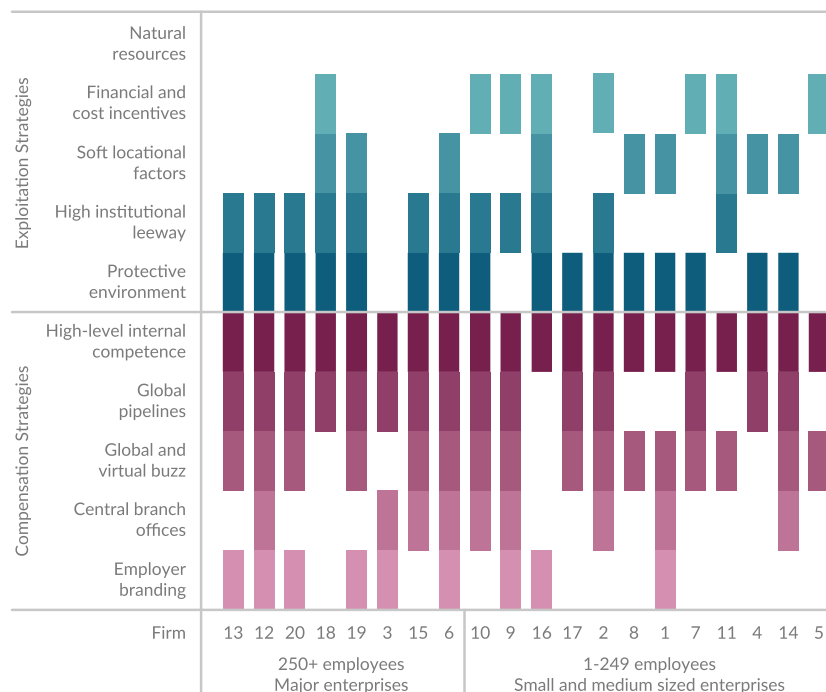


FIGURE 2 Compensation and exploitation strategies by firm size

However, there is also some evidence for the adoption of other compensation practices, namely the establishment of branch offices in major cities and employer branding activities. Moreover, reaping the benefits of the protective environment is the most frequent exploitation strategy. This particularly holds true for the limited danger of labour poaching. Other strategies are more scattered, especially in comparison to compensation strategies. Usually, firms rather use compensation than exploitation strategies. Two firms deviate from this pattern and pursue the opposite approach, indicating a particularly favourable match between their needs and the endowment of the peripheral region.

Overall, compensation strategies thus seem to be essential for innovation in peripheral areas, with exploitation strategies often being described by respondents as being complementary. As the picture is highly diverse, a more detailed analysis needs to be done with caution. In terms of compensation strategies, the influence of firm size on employer branding and global pipelines is evident. Larger enterprises seem to have more resources for undertaking these efforts. Surprisingly, central branch offices are also relatively frequent amongst SMEs, highlighting the importance of this approach. They can be observed especially amongst firms in the Northern periphery. This area constitutes the hinterland of Vienna, Austria's only metropolitan region, providing assets that firms do not want to forego. High-level internal competences and *global* and *virtual buzz* are equally distributed by firm size, which emphasises their importance (Fitjar & Rodríguez-Pose, 2011a, 2011b; Huggins & Johnston, 2009; Rodríguez-Pose & Fitjar, 2013).

For exploitation strategies, it is confirmed that institutional leeway is highly dependent on firm size and increases with the number of employees. Most firms emphasising this function are located in the southern peripheries, which are the most challenged regions in Austria. This explains why political support is particularly strong in these areas (Meili & Shearmur, 2019; Polèse & Shearmur, 2002). Financial incentives are more relevant for SMEs, while for soft location factors and advantages related to the protective environment, no conclusions can be drawn regarding the effect of firm size. However,

soft location factors for product marketing or the recruitment of highly qualified labour are more frequent in ATRs. On the one hand, the landscape is more impressive. On the other hand, regional brands like *Tyrol* or *Salzburger Land* are internationally known, making it easier to leverage them.

Again, the picture is highly diverse, underlining the significance of other factors such as industry and business cultures. A firm might want to focus on openness or secrecy, resulting in more external networks or protectionist behaviour (Malecki & Poehling, 1999; Shearmur, 2015). A few firms furthermore did not perceive their location as being too peripheral or as disadvantageous to their industry, implying that they did not recognise much need for compensation or potential for exploitation. An example here is firm 3, which only relies on compensation strategies. This confirms the theoretical assumptions, which indicate that the exact portfolio of both compensation and exploitation strategies of an innovative firm will not only depend on regional characteristics, but also on the individual perception of innovation constraints and the actual capacity and willingness to reap potential benefits. In this regard, investigations with larger samples and quantitative analyses might help to generalize the findings.

5 | CONCLUSIONS

This paper seeks to move beyond the urban bias in innovation studies and contribute to a better understanding of the way in which innovation takes place in peripheral regions. Scholarly work on innovation in the periphery has thus far mainly centred on regional innovation constraints and on the ways in which firms overcome these challenges by adopting a variety of compensation strategies. This paper challenges this perspective by shedding light on potential innovation advantages of peripheral regions and investigating the exploitation strategies, which firms put in place to reap these benefits.

Drawing on 20 in-depth personal interviews with innovative firms in different peripheral regions in Austria, it is shown that compensation strategies go beyond building internal competence and securing external knowledge through formal collaborations, *global pipelines* as well as *global* and *virtual buzz*. Establishing branch offices in central locations and distinct employer branding strategies are found to be of importance too, factors which have hardly been addressed in the literature so far. Moreover, there also is evidence that innovators in the Austrian periphery leverage benefits of their region, especially in terms of protection from labour poaching and utilising institutional leeway. Moreover, the majority of firms are found to employ both practices, indicating that innovation in the periphery is the outcome of a combination of compensation and exploitation practices. However, our results also suggest that this pattern is variegated, depending on firm-level factors and regional characteristics. In this regard, the firm size seems to be most decisive, since larger firms usually have increased resources at their disposal. The portfolios of strategies based on case study regions or of those based on the firm type have revealed only little variation in this regard.

The findings also have implications for mainstream economic geography. In line with recent research (Fitjar & Rodríguez-Pose, 2011a; Grillitsch & Nilsson, 2015, 2017; Isaksen, 2015; Meili & Shearmur, 2019; Shearmur & Doloreux, 2016), this paper has shown that innovation studies must overcome their predominant focus on core regions to also include conceptual and empirical work on innovation in peripheral regions. Furthermore, these findings contribute to the policy debate, as they dismiss the dominant unfavourable view on peripheral locations. As such, policy makers should not be preoccupied with attempts to fix deficits or system failures, as they could also focus on enabling actors to exploit different innovation benefits encountered in peripheral regions. Since innovation is increasingly seen as a possibility to target market failures such as uneven regional development (McCann &

Ortega-Argilés, 2013), place-based approaches like smart specialisation strategies (S3s) for peripheral regions should not rely on urban experiences and best-practice examples. Taking account of insights into peripheral innovation processes and findings on the nature of such innovations is crucial to increase the likelihood of success for places beyond agglomerations. Our research does exhibit a number of shortcomings that should be addressed in the future research. While a qualitative approach seemed appropriate for our exploratory analysis, it also impedes generalisations (Schoenberger, 1991), which can be seen as the major caveat of this article. Hence, this paper is an invitation for economic geographers to conduct quantitative analyses in countries with different preconditions or better microdata. Such larger samples might provide further important insights into the ways in which compensation and exploitation strategies are related to firm size, industry, and life cycle of a firm as well as to regional factors.

This paper aimed to unravel innovation processes in the periphery. However, a comparative research design incorporating central and peripheral innovators, similar to the work by Vonnahme and Lang (2019), could further advance the understanding of compensation and exploitation strategies applied by firms. Since firms in urban areas are also likely to adopt compensation and exploitation strategies, it might be interesting to see how they overlap with or differ from those employed by peripheral innovators. In other words, the future work could focus on the peculiarities of central and peripheral compensation as well as exploitation efforts. Moreover, since we have predominately investigated high-tech firms, future research could zoom in on the practices of low-tech firms and of those operating in more traditional sectors.

Another key question for further inquiry could be the investigation of the ways in which innovative firms influence the development of their peripheral locations over longer periods. Our results suggest that many firms, particularly larger ones, extensively use institutional leeway strategies to shape their regional environment. Taking a dynamic perspective and examining the wider and long-term regional effects of such strategies should rank high on future research agendas. Under which conditions do such strategies lead to outcomes that benefit other firms as well? And what would the dark side of such strategies be (for example, that the regional environment might become increasingly fine-tuned to the needs of one or only a few firms)?

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Co-author declaration for the following joint paper

This declaration states the research contribution (e.g. research idea and – question; data compilation, manipulation and modelling; design and preparation of graphics, maps and tables; writing of text) of the candidate, the main supervisor (where he/she is an associate author) and the other authors.

If applicable, the contributions from other PhD and / or habilitation candidates who have or intend to include the paper in a thesis should be described. Contributions from master students should also be mentioned.

Research contribution details

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Jakob Eder, the PhD candidate had the initial idea for this paper and acted as first and corresponding author. Therefore, he managed the overall process, made suggestions for the conceptual framework, prepared the semi-structured questionnaire, conducted the data collection (qualitative interviews), transcribed these interviews, analysed the scientific material, and prepared the map and the table. In terms of writing, he has authored the sections on data and methods and results and was also involved in the other sections, i.e. introduction, literature review, and conclusions. Overall, the candidate contributed 80% of the work.

First author's contribution:

The candidate is the first author (for contribution see above).

Contributions of other authors:

Michaela Trippel, the co-author of this paper contributed mainly to the conceptual part. Together with the candidate, she developed the conceptual framework and provided guidance for the considered literature and the empirical work. In terms of writing, she was involved in authoring the introduction, the literature review, and the conclusions. Overall, the co-author contributed 20% of the work.



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A handwritten signature in blue ink that reads "Michaela Trippel".

Statutory Declaration

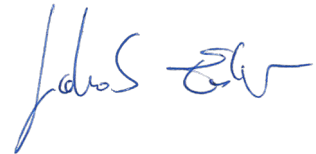
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