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

Jakob Eder [a,b]

[a]Institute for Urban and Regional Research, Austrian Academy of Sciences, Vienna, Austria; [b]Department of Geography and Regional Research, University of Vienna, Vienna, Austria

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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Innovation; periphery; peripheralization; knowledge bases; regional policy; Austria

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

CONTACT Jakob Eder jakob.eder@oeaw.ac.at Institute for Urban and Regional Research, Austrian Academy of Sciences, Postgasse 7/4/2, Vienna 1010, Austria; Department of Geography and Regional Research, University of Vienna, Vienna, Austria

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, & Trippl, 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 & Trippl, 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 multiscalar 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 Trippl (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.

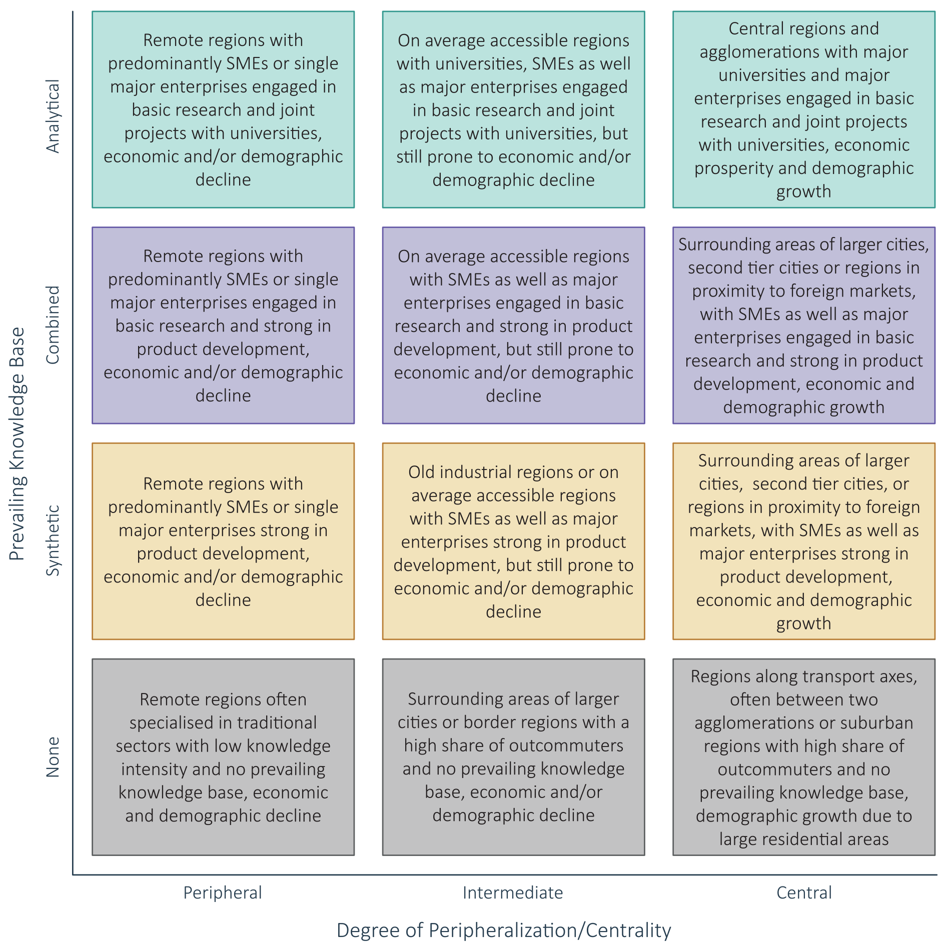

Figure 1. Conceptual framework for the analysis of regions according to peripheralization/centrality and knowledge bases.

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 (*Bundeslaender*) 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 (*Bundeslaender*). 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, Speringer, 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:

$$ZI^i_{j,r} = \frac{I^i_{j,r} - \bar{I}_{j,r}}{s_{j,r}}$$

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.

		Weight		
Dimension of peripheralization	Direction	Dimension	Indicator	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]
Synthetic knowledge base	1	1.00	0.33	15. Employees [FTEs] of private firms in R&D with less than a bachelor's degree per 1000 persons aged 15–64 [2015]
	1		0.17	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]

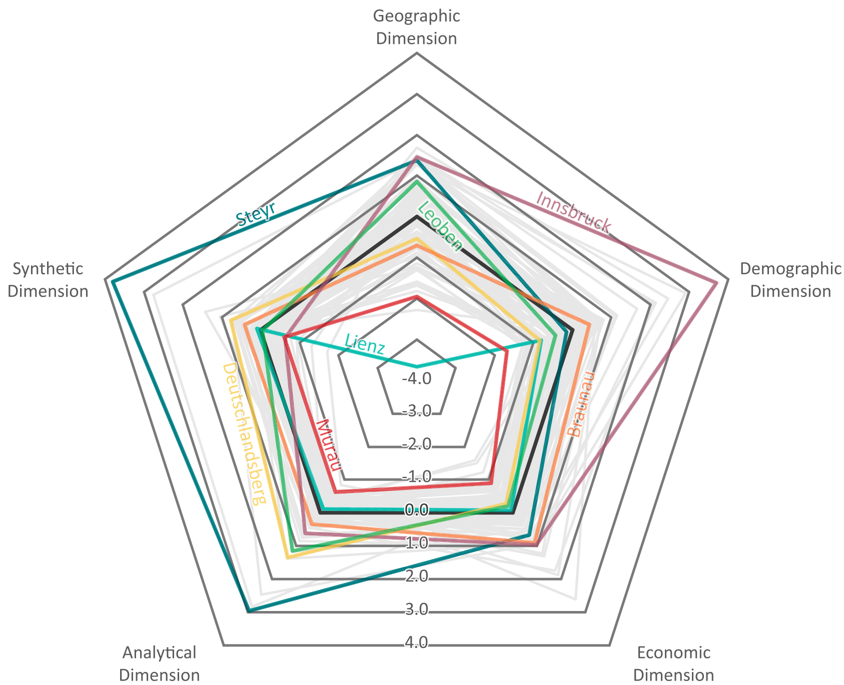

Figure 2. Scores of the index dimensions for all 95 districts.

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 (*Bundeslaender*). 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 & Trippl, 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

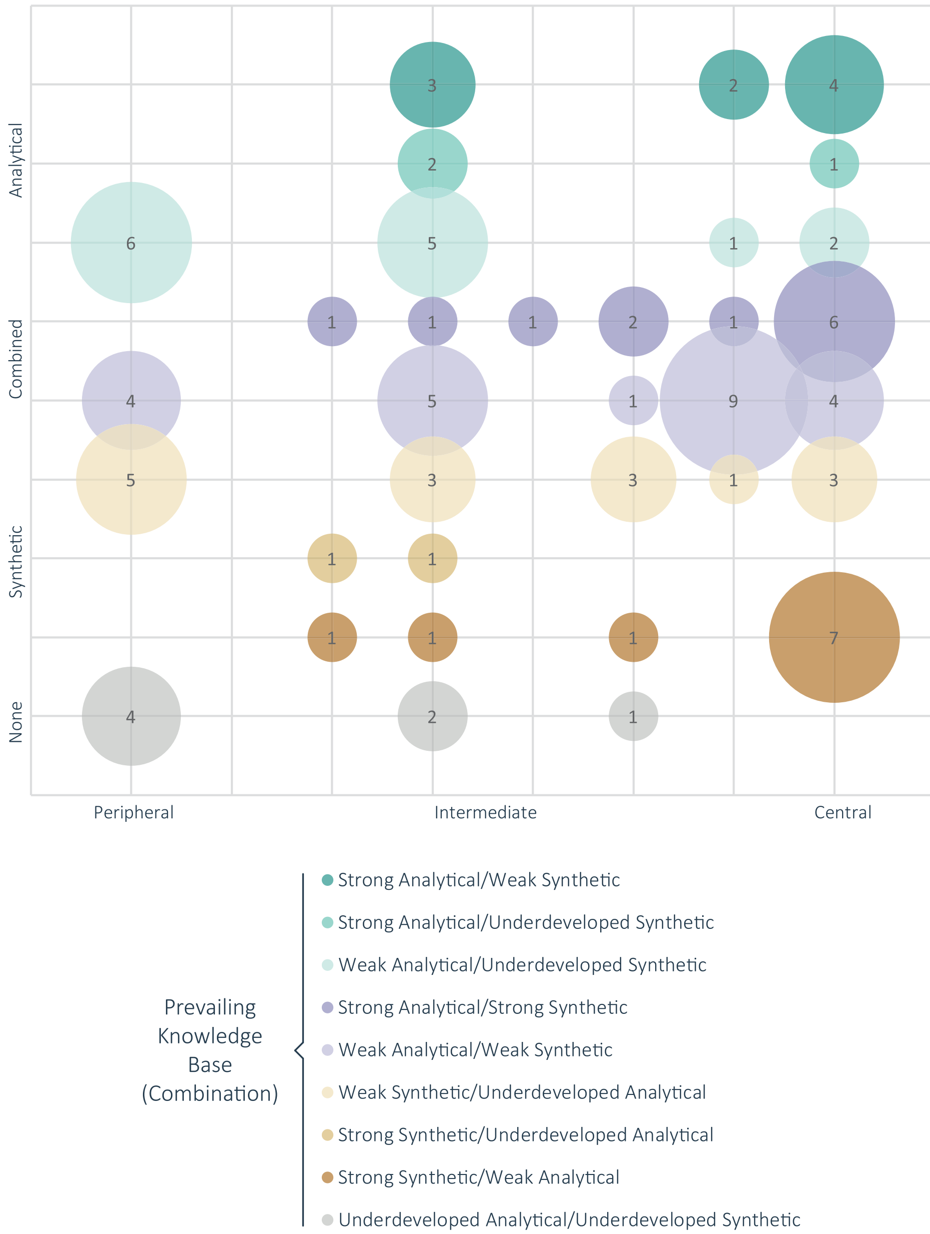

Figure 3. Districts of Austria classified according to the conceptual framework.

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.

		Peripheralization dimension		
Prevailing knowledge base (Combination)	*n*	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%

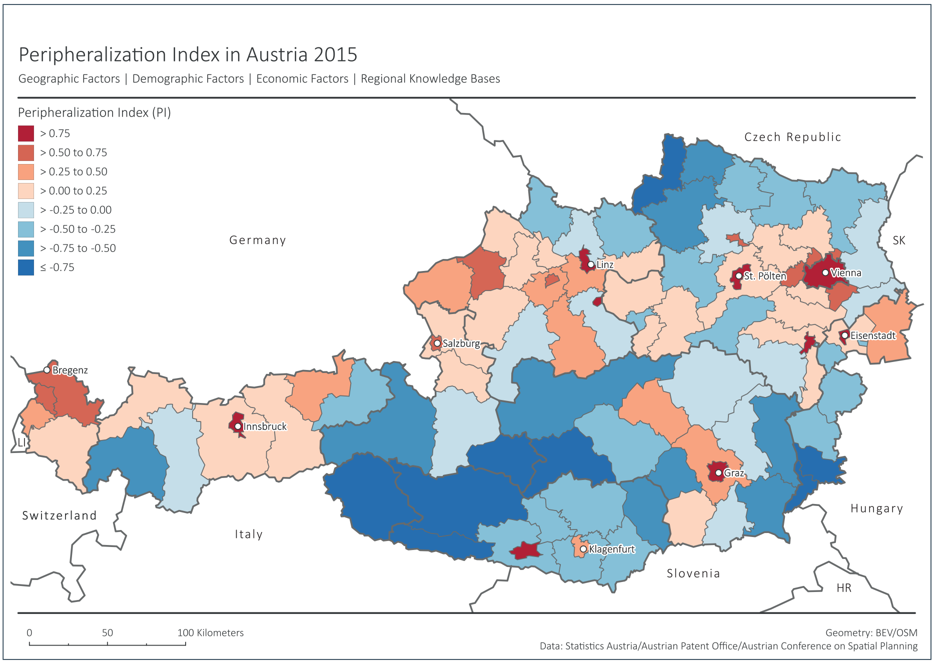

Figure 4. Peripheralization index (PI) in Austria 2015.

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 (*Bundeslaender*) 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, Tödtling, & 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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ORCID

Jakob Eder http://orcid.org/0000-0002-8922-1525

References

Asheim, B. T. (2007). Differentiated knowledge bases and varieties of regional innovation systems. *Innovation: The European Journal of Social Science Research*, *20*(3), 223–241. doi:10.1080/13511610701722846

Asheim, B. T., Boschma, R., & Cooke, P. (2011). Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases. *Regional Studies*, *45*(7), 893–904. doi:10.1080/00343404.2010.543126

Asheim, B. T., & Coenen, L. (2005). Knowledge bases and regional innovation systems: Comparing Nordic clusters. *Research Policy*, *34*(8), 1173–1190. doi:10.1016/j.respol.2005.03.013

Asheim, B. T., & Coenen, L. (2006). Contextualising regional innovation systems in a globalising learning economy: On knowledge bases and institutional frameworks. *The Journal of Technology Transfer*, *31*(1), 163–173. doi:10.1007/s10961-005-5028-0

Asheim, B. T., Coenen, L., Moodysson, J., & Vang, J. (2007). Constructing knowledge-based regional advantage: Implications for regional innovation policy. *International Journal of Entrepreneurship and Innovation Management*, *7*(2–5), 140–155. doi:10.1504/IJEIM.2007.012879

Asheim, B. T., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670. doi:10.1068/c0648

Asheim, B. T., & Gertler, M. S. (2005). The geography of innovation. Regional innovation systems. In J. Fagerberg, D. C. Mowery, & R. R. Nelson (Eds.), *The Oxford handbook of innovation* (pp. 291–317). Oxford: Oxford University Press.

Asheim, B. T., Grillitsch, M., & Trippl, M. (2017). Introduction: Combinatorial knowledge bases, regional innovation, and development dynamics. *Economic Geography*, *93*(5), 429–435. doi:10.1080/00130095.2017.1380775

Asheim, B. T., & Hansen, H. K. (2009). Knowledge bases, talents, and contexts: On the usefulness of the creative class approach in Sweden. *Economic Geography*, *85*(4), 425–442. doi:10.1111/j.1944-8287.2009.01051.x

Blažek, J., & Kadlec, V. (2018). Knowledge bases, R&D structure and socio-economic and innovation performance of European regions. *Innovation: The European Journal of Social Science Research*, 1–22. doi:10.1080/13511610.2018.1491000

Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies*, *39*(1), 61–74. doi:10.1080/0034340052000320887

Cooke, P. (2012). From clusters to platform policies in regional development. *European Planning Studies*, *20*(8), 1415–1424. doi:10.1080/09654313.2012.680741

Cooke, P., Heidenreich, M., & Braczyk, H.-J. (Eds.). (2004). *Regional innovation systems: The role of governances in a globalized world* (2nd ed.). London: Routledge.

Copus, A. K. (2001). From core-periphery to polycentric development: Concepts of spatial and aspatial peripherality. *European Planning Studies*, *9*(4), 539–552. doi:10.1080/09654310120049899

Crone, M. (2012). Re-thinking 'peripherality' in the context of a knowledge-intensive, service-dominated economy. In M. Danson & P. de Souza (Eds.), *Regional development in Northern Europe. Peripherality, marginality and border issues* (pp. 49–64). London: Routledge.

Danson, M., & de Souza, P. (2012). Periphery and marginality: Definitions, theories, methods and practice. In M. Danson & P. de Souza (Eds.), *Regional development in Northern Europe. Peripherality, marginality and border issues* (pp. 1–15). London: Routledge.

Doloreux, D. (2003). Regional innovation systems in the periphery: The case of the Beauce in Québec (Canada). *International Journal of Innovation Management*, *7*(1), 67–94. doi:10.1142/S1363919603000738
Eder, J. (2018). Innovation in the periphery: A critical survey and research agenda. *International Regional Science Review*. Advance online publication. doi:10.1177/0160017618764279
Grillitsch, M., Martin, R., & Srholec, M. (2017). Knowledge base combinations and innovation performance in Swedish regions. *Economic Geography*, *93*(5), 458–479. doi:10.1080/00130095.2016.1154442
Grillitsch, M., & Nilsson, M. (2015). Innovation in peripheral regions: Do collaborations compensate for a lack of local knowledge spillovers?. *The Annals of Regional Science*, *54*(1), 299–321. doi:10.1007/s00168-014-0655-8
Hedlund, M. (2016). Mapping the socioeconomic landscape of rural Sweden: Towards a typology of rural areas. *Regional Studies*, *50*(3), 460–474. doi:10.1080/00343404.2014.924618
Heintel, M., Speringer, M., Schnelzer, J., & Bauer, R. (2017). Multipler Benachteiligungsindex. Fallbeispiel Oberpinzgau [Multiple deprivation index. Case study Oberpinzgau]. *Mitteilungen der Österreichischen Geographischen Gesellschaft*, *159*, 173–198. doi:10.23781/moegg159-173
Hirschman, A. O. (1958). *The strategy of economic development*. New Haven: Yale University Press.
Humer, A. (2018). Linking polycentricity concepts to periphery: Implications for an integrative Austrian strategic spatial planning practice. *European Planning Studies*, *26*(4), 635–652. doi:10.1080/09654313.2017.1403570
Isaksen, A., & Karlsen, J. (2012). Combined and complex mode of innovation in regional cluster development: Analysis of the light-weight material cluster in Raufoss, Norway. In B. T. Asheim & M. D. Parrilli (Eds.), *Interactive learning for innovation. A key driver within clusters and innovation systems* (pp. 115–136). Basingstoke: Palgrave Macmillan.
Isaksen, A., & Trippl, M. (2017a). Exogenously led and policy-supported new path development in peripheral regions: Analytical and synthetic routes. *Economic Geography*, *93*(5), 436–457. doi:10.1080/00130095.2016.1154443
Isaksen, A., & Trippl, M. (2017b). Innovation in space: The mosaic of regional innovation patterns. *Oxford Review of Economic Policy*, *33*(1), 122–140. doi:10.1093/oxrep/grw035
Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. Å. (2007). Forms of knowledge and modes of innovation. *Research Policy*, *36*(5), 680–693. doi:10.1016/j.respol.2007.01.006
Kronthaler, F. (2005). Economic capability of East German regions: Results of a cluster analysis. *Regional Studies*, *39*(6), 739–750. doi:10.1080/00343400500213630
Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, *99*(3), 483–499. doi:10.1086/261763
Kühn, M. (2015). Peripheralization: Theoretical concepts explaining socio-spatial inequalities. *European Planning Studies*, *23*(2), 367–378. doi:10.1080/09654313.2013.862518
Kühn, M., & Weck, S. (2012). Peripherisierung – Prozesse, Probleme und Strategien in Mittelstädten [Peripheralization – processes, problems and strategies in mid-sized cities]. *disP - The Planning Review*, *48*(2), 14–26. doi:10.1080/02513625.2012.721600
Laestadius, S. (1998). Technology level, knowledge formation and industrial competence in paper manufacturing. In G. Eliasson, C. Green, & C. McCann (Eds.), *Microfoundations of economic growth. A schumpeterian perspective* (pp. 212–226). Ann Arbor: University of Michigan Press.
Leick, B., & Lang, T. (2018). Re-thinking non-core regions: Planning strategies and practices beyond growth. *European Planning Studies*, *26*(2), 213–228. doi:10.1080/09654313.2017.1363398
Lorentzen, A. (2012). The development of the periphery in the experience economy. In M. Danson & P. de Souza (Eds.), *Regional development in Northern Europe. Peripherality, marginality and border issues* (pp. 16–29). London: Routledge.
Manniche, J. (2012). Combinatorial knowledge dynamics: On the usefulness of the differentiated knowledge bases model. *European Planning Studies*, *20*(11), 1823–1841. doi:10.1080/09654313.2012.723423
Manniche, J., Moodysson, J., & Testa, S. (2017). Combinatorial knowledge bases: An integrative and dynamic approach to innovation studies. *Economic Geography*, *93*(5), 480–499. doi:10.1080/00130095.2016.1205948

Martin, B. (2016). Twenty challenges for innovation studies. *Science and Public Policy*, *43*(3), 432–450. doi:10.1093/scipol/scv077

Martin, R. (2012). Measuring knowledge bases in Swedish regions. *European Planning Studies*, *20*(9), 1569–1582. doi:10.1080/09654313.2012.708022

Martin, R., & Moodysson, J. (2013). Comparing knowledge bases: On the geography and organization of knowledge sourcing in the regional innovation system of Scania, Sweden. *European Urban and Regional Studies*, *20*(2), 170–187. doi:10.1177/0969776411427326

Martin, R., & Trippl, M. (2014). System failures, knowledge bases and regional innovation policies. *disP - The Planning Review*, *50*(1), 24–32. doi:10.1080/02513625.2014.926722

Mattes, J. (2012). Dimensions of proximity and knowledge bases: Innovation between spatial and non-spatial factors. *Regional Studies*, *46*(8), 1085–1099. doi:10.1080/00343404.2011.552493

Myrdal, G. (1957). *Economic theory and underdeveloped regions*. London: Duckworth.

ÖROK. (2007). *Erreichbarkeitsverhältnisse in Österreich 2005. Modellrechnungen für den ÖPNRV und den MIV* [Accessibility in Austria 2005. Model calculations for public and for motorised private transport]. Vienna.

Rodríguez-Pose, A., & Di Cataldo, M. (2015). Quality of government and innovative performance in the regions of Europe. *Journal of Economic Geography*, *15*(4), 673–706. doi:10.1093/jeg/lbu023

Shearmur, R. (2011). Innovation, regions and proximity: From neo-regionalism to spatial analysis. *Regional Studies*, *45*(9), 1225–1243. doi:10.1080/00343404.2010.484416

Shearmur, R. (2012). Are cities the font of innovation? A critical review of the literature on cities and innovation. *Cities*, *29*(Suppl. 2), S9–S18. doi:10.1016/j.cities.2012.06.008

Shearmur, R. (2015). Far from the madding crowd: Slow innovators, information value, and the geography of innovation. *Growth and Change*, *46*(3), 424–442. doi:10.1111/grow.12097

Shearmur, R., & Doloreux, D. (2016). How open innovation processes vary between urban and remote environments: Slow innovators, market-sourced information and frequency of interaction. *Entrepreneurship & Regional Development*, *28*(5–6), 337–357. doi:10.1080/08985626.2016.1154984

Stöhr, W. B. (1982). Structural characteristics of peripheral areas: The relevance of the stock-in-trade variables of regional science. *Papers in Regional Science*, *49*(1), 71–84. doi:10.1111/j.1435-5597.1982.tb00780.x

Strambach, S., & Klement, B. (2012). Cumulative and combinatorial micro-dynamics of knowledge: The role of space and place in knowledge integration. *European Planning Studies*, *20*(11), 1843–1866. doi:10.1080/09654313.2012.723424

Tödtling, F., & Grillitsch, M. (2015). Does combinatorial knowledge lead to a better innovation performance of firms? *European Planning Studies*, *23*(9), 1741–1758. doi:10.1080/09654313.2015.1056773

Tödtling, F., Lehner, P., & Kaufmann, A. (2009). Do different types of innovation rely on specific kinds of knowledge interactions? *Technovation*, *29*(1), 59–71. doi:10.1016/j.technovation.2008.05.002

Tödtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research Policy*, *34*(8), 1203–1219. doi:10.1016/j.respol.2005.01.018

Trippl, M., Asheim, B. T., & Miörner, J. (2016). Identification of regions with less-developed research and innovation systems. In M. D. Parrilli, R. D. Fitjar, & A. Rodríguez-Pose (Eds.), *Innovation drivers and regional innovation strategies* (pp. 23–44). London: Routledge.

Trippl, M., Tödtling, F., & Schuldner, R. (2013). Creative and cultural industries in Austria. In L. Lazzeretti (Ed.), *Creative industries and innovation in Europe: Concepts, measures and comparative case studies* (pp. 86–102). New York: Routledge.

Zeller, C. (2003). Bausteine zu einer Geographie des Kapitalismus [Elements of a geography of capitalism]. *Zeitschrift für Wirtschaftsgeographie*, *47*(1), 215–230. doi:10.1515/zfw.2003.0018

Appendix 1

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

		Dimension											
		Geographic		Demographic		Economic		Analytical		Synthetic		Total	
District	Federal state	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	Lower Austria	70	−0.609	69	−0.519	27	0.304	85	−0.513	33	0.080	61	−0.251
Melk	Lower Austria	55	−0.127	51	−0.152	76	−0.485	49	−0.212	72	−0.301	62	−0.255
Mistelbach	Lower Austria	72	−0.635	63	−0.413	44	−0.046	73	−0.404	88	−0.605	74	−0.420
Mödling	Lower Austria	18	0.858	29	0.335	50	−0.114	33	−0.018	44	−0.061	29	0.200
Neunkirchen	Lower Austria	36	0.418	54	−0.189	46	−0.056	68	−0.343	56	−0.124	50	−0.059
Sankt Pölten (Land)	Lower Austria	31	0.563	36	0.159	79	−0.582	18	0.276	70	−0.279	47	0.027
Scheibbs	Lower Austria	81	−1.008	62	−0.400	7	0.981	30	0.013	3	1.426	28	0.202
Tulln	Lower Austria	46	0.127	20	0.516	23	0.357	38	−0.081	73	−0.320	32	0.120
Waidhofen an der Thaya	Lower Austria	91	−1.681	85	−0.940	65	−0.297	76	−0.416	62	−0.155	86	−0.698
Wiener Neustadt (Land)	Lower Austria	29	0.635	41	0.021	45	−0.053	40	−0.124	42	−0.050	37	0.086
Wien (Umgebung)	Lower Austria	27	0.661	11	0.751	4	1.308	29	0.062	58	−0.134	15	0.530
Zwettl	Lower Austria	82	−1.013	86	−0.961	60	−0.244	89	−0.557	83	−0.521	84	−0.659
Linz (Stadt)	Upper Austria	13	1.304	4	2.139	10	0.930	4	1.380	19	0.243	6	1.199
Steyr (Stadt)	Upper Austria	10	1.376	50	−0.150	14	0.677	1	2.961	1	3.803	1	1.733
Wels (Stadt)	Upper Austria	6	1.413	13	0.699	19	0.485	27	0.096	22	0.185	12	0.576
Braunau am Inn	Upper Austria	75	−0.702	23	0.435	11	0.903	16	0.340	15	0.418	25	0.279
Eferding	Upper Austria	39	0.381	45	−0.007	24	0.340	90	−0.562	32	0.081	43	0.047
Freistadt	Upper Austria	58	−0.220	61	−0.389	56	−0.187	13	0.462	92	−0.923	60	−0.251
Gmunden	Upper Austria	69	−0.593	56	−0.274	63	−0.271	23	0.214	60	−0.141	58	−0.213
Grieskirchen	Upper Austria	43	0.241	35	0.204	43	−0.037	45	−0.185	28	0.115	39	0.068
Kirchdorf an der Krems	Upper Austria	48	−0.002	55	−0.214	28	0.267	9	0.750	8	0.654	24	0.291
Linz (Land)	Upper Austria	24	0.796	24	0.419	37	0.102	24	0.181	27	0.123	22	0.324
Perg	Upper Austria	59	−0.235	39	0.085	16	0.667	60	−0.304	10	0.590	31	0.161
Ried im Innkreis	Upper Austria	49	−0.007	38	0.094	6	0.994	8	0.849	7	0.679	16	0.522
Rohrbach	Upper Austria	73	−0.681	75	−0.706	55	−0.173	65	−0.333	39	−0.038	70	−0.386
Schärding	Upper Austria	37	0.402	53	−0.186	40	−0.011	72	−0.403	12	0.560	38	0.072
Steyr (Land)	Upper Austria	38	0.397	60	−0.368	68	−0.311	78	−0.421	48	−0.076	55	−0.156
Urfahr (Umgebung)	Upper Austria	28	0.640	52	−0.165	71	−0.363	17	0.282	90	−0.644	49	−0.050
Vöcklabruck	Upper Austria	61	−0.360	30	0.324	52	−0.146	22	0.224	26	0.133	44	0.035
Wels (Land)	Upper Austria	22	0.837	33	0.273	25	0.311	50	−0.218	14	0.513	21	0.343
Salzburg (Stadt)	Salzburg	8	1.382	8	1.133	12	0.795	43	−0.159	53	−0.117	11	0.607
Hallein	Salzburg	40	0.319	17	0.564	51	−0.116	55	−0.245	66	−0.210	41	0.062
Salzburg (Umgebung)	Salzburg	34	0.480	26	0.399	78	−0.548	28	0.073	57	−0.132	42	0.054
Sankt Johann im Pongau	Salzburg	80	−0.951	43	−0.002	36	0.135	74	−0.416	20	0.238	57	−0.199
Tamsweg	Salzburg	90	−1.630	83	−0.854	73	−0.389	77	−0.416	86	−0.566	90	−0.771
Zell am See	Salzburg	94	−2.278	46	−0.012	69	−0.326	81	−0.441	45	−0.062	82	−0.624
Graz (Stadt)	Styria	12	1.319	2	2.904	9	0.936	3	2.467	6	0.726	2	1.670
Deutschlandsberg	Styria	68	−0.536	82	−0.838	62	−0.269	5	1.350	5	0.771	35	0.096
Graz (Umgebung)	Styria	33	0.537	34	0.247	29	0.247	10	0.723	9	0.637	18	0.478
Leibnitz	Styria	47	0.008	25	0.414	61	−0.247	66	−0.337	79	−0.454	52	−0.123

(*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
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
Schwaz	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

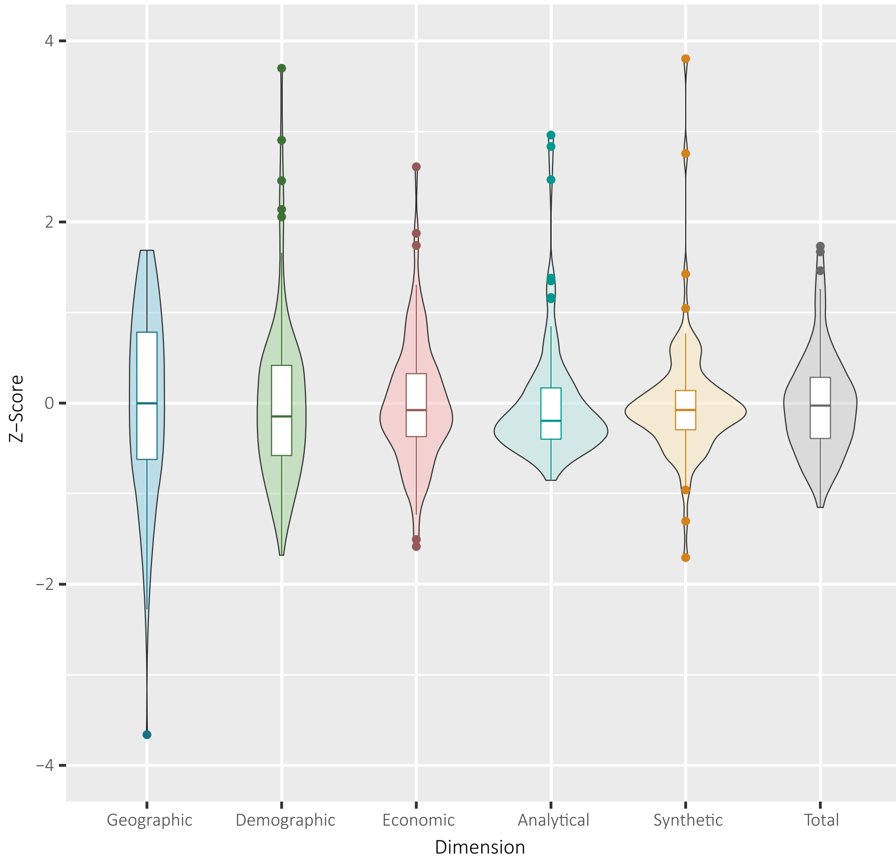

Figure A1. Distribution of peripheralization dimensions.