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Measuring Access to Services of General Interest as a Diagnostic Tool to Identify Well-Being Disparities between Rural Areas in Europe

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Abstract: The gradual reorientation of rural policy paradigms away from competitiveness and economic growth and towards well-being and sustainability creates a need for more appropriate diagnostic tools to assess disparities and policy outcomes. One of the most cited determinants of rural well-being is access to Services of General Interest. Areas with relatively poor access to services can be described as "inner peripheries", and peripherisation literature provides helpful insights into the challenges faced and policy needs. This paper presents a methodology for modelling and mapping access to a suite of ten key services, covering all of Europe at a 2.5 km grid square level. The approach is intrinsically relative, comparing the travel time to services from each grid square with the average for surrounding regions. Maps are provided for 2017 and 2021, and changes between these dates are described. 'Inner peripheries' are found in every country, their configuration being influenced not only by geographical features, but also by service delivery practices. Further analysis explores patterns of risk, identifying areas in which service provision is in a precarious position. The results presented are rich in practical policy implications, not least the suggestion that, in terms of patterns of well-being, local roads are at least as important as trunk infrastructure.

Keywords: territorial disparities; inner peripherality; access to Services of General Interest; enclaves of low accessibility; service provision; rural areas; rural policies; rural development; regional development; transport policy; local roads

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1. Introduction

Access to Services of General Interest (SGIs)[1] has recently become a very important European rural and regional policy issue. An apparent shift in the policy vision for peripheral areas towards well-being and territorial inclusion has given rise to questions of aspects of fairness and equity such as the right to basic services. Arguably, this has involved a change in "zeitgeist" away from a neo-liberal concentration on quantified improvements to competitiveness, especially in the context of entrepreneurship, innovation, and the labour market, towards less-easily quantified goals associated more directly with the well-being of the populace [1]. This shift in goals brings with it a raft of implications for policy implementation, driving a reorientation away from infrastructure investment, and embedding innovation and entrepreneurship in place-based processes which capitalise on the full range of territorial assets, including social, human and environmental capital. Smart specialisation [2] and the quest for 'smart villages' [3] are manifestations of this shift, as is the Community Led Local Development (CLLD) programme. This overall development approach is in the DNA of high-level policy statements such as the OECD's Rural Policy 3.0 [4] and the European Commission's Long-Term Vision for Rural Areas [5]. In addition, the recent COVID-19 crisis has shown that living standards and quality of, and access to, services are important factors that determine whether areas are resilient or vulnerable to health crises.

In rural and peripheral areas, levels of (physical) accessibility to Services of General Interest are both determined by the existence of nearby facilities and by the transport infrastructure leading to them. However, providing fair and balanced service provision still has significant challenges such as geographical location (distance from centres), limited transport infrastructure, demographic factors (ageing and out-migration of the population), unfavourable market conditions for service providers (to establish and maintain services), limited political will to invest in those areas and reduced access to technology (high-speed internet). Although addressing those challenges is crucial for rural and peripheral areas, information on the location of facilities, at a European scale, is not readily available, making it difficult to evaluate the expected effects of policy intervention [6].

This paper seeks to address this evidence gap by demonstrating how Geographical Information System (GIS) methods and spatial reference data can form the basis of a diagnostic indicator of access to services at a micro grid-square level and with continental coverage of Europe. This approach has emerged from the context of spatial planning/policy interest in the concept of 'inner peripheries' (IPs), which is, in turn, associated with shifting concepts of peripherality and peripherisation. This work aims at providing a broad view of rural peripherisation, which is best understood in the context of two strands of related research: transport and infrastructure approaches to regional development, and well-being in rural development (assessed using SGI accessibility mapping). To provide a comprehensive introduction to these aspects, the following sections provide an overview, firstly, of recent transport policies, and secondly, of the recent policy shift towards access to SGIs as a means to improve rural well-being.

1.1. Transport Policy as an 'Engine' for Regional Development?

Over the last 30 years, many studies have shown an increase in regional inequality due to the growing spatial concentration of economic activities. Meanwhile, differences between countries have steadily decreased. Particularly, during the period 2005–2012, there was a significant increase in within-country inequality, which has remained fairly stable since then [7]. Simple comparisons of regional, rural or urban (per capita) averages tend to obscure the reality that many parts of rural Europe continue to experience economic decline and population decrease, contributing to a further reduction in the level of service provision. Despite numerous studies on uneven development patterns and causes, signs of peripheralisation processes in non-remote areas and metropolitan core regions have remained largely unnoticed and are still not fully understood [8–10]. Polarisation across regions is especially significant in Central, Eastern [9,11] and Southern Europe [12].

Improving high-level transport infrastructure has, in many parts of the world, been a preferred approach to reducing economic disparities and achieving balanced spatial development. In Europe, Regional and Cohesion policies have invested heavily in infrastructure investment, particularly in (trunk) transport networks. Specific transport interventions financed by the European Regional Development Fund (ERDF) and Connecting Europe Facility (CEF) have ranged from improving within-region infrastructure to the improvement of large-scale transport through the trans-European networks (TEN-T) initiative. The underlying logic is that improved accessibility reduces transportation costs of goods and people and offers people and businesses in less developed regions the possibility to seize the opportunities offered by world markets.

Infrastructure development has been recognised as an 'engine' for economic growth in various regions around the world. In the United States, yearly public investment in new transportation infrastructure has ranged between 90 and 131 billion dollars between 1999 and 2015 (at real prices) [13], while international organisations have funded infrastructure projects, including the World Bank, which has invested around 20% of its lending in transport infrastructure projects worldwide [14]. The World Bank Report of 2020 highlights the importance of "Improving transportation and communications infrastructure and introducing competition in these services" to address the disadvantage of remote locations' participation in Global Value Chains [15] (p. 4).

Since the beginning of the 21st century, the focus has shifted towards understanding the influence of transport initiatives on agglomeration benefits and productivity. The assumption is that geographical proximity enhances connectivity and facilitates learning, knowledge externalities, innovation [16,17] and labour mobility. Additionally, concerns about sustainability have led to a push for improving public transport and developing electric mobility [7,18]. Despite this shift, improving accessibility remains a key objective in land-use and planning policy, and it is commonly used as an indicator for policy evaluation [6].

Assessing the economic returns of investing in transport infrastructure remains a controversial issue, both in the light of theoretical and empirical findings [14,19]. While some see it as an investment with high multiplier effects at the macro level [20,21], others argue that increased market access can bring economic convergence at the national level while, at the same time, increasing regional disparities [22,23]. Studies have shown that the benefits of infrastructure investments are often localised and do not contribute to equal economic growth across territories [24,25]. Highways can stimulate economic activity in some areas but have adverse effects in neighbouring ones [26,27]. In addition, although improved accessibility can benefit firms in less developed areas, it may also make it easier for external firms to supply peripheral regions from a distance, displacing local activities [28,29]. Firms in peripheral regions may be in a weaker position to compete (unless having other advantages) due to lower economies-of-scale [30,31]. This apparently contradictory evidence at the national and local level is sometimes referred to as the 'two-way' road effect or the 'pump' effect [32–34].

Thus, the spatial implications of transport infrastructure improvements are complex and may increase local disparities. Current high-level (and high-speed) transport policies still carry the risk of increasing the socio-spatial polarisation and peripheralisation of disadvantaged areas (due to disinvestment or centralisation of service provision). One of the key limitations of assessing transport infrastructure investment is how to measure 'displacement' effects, as it is difficult to know if positive effects are the result of diverting economic activities from one area to another [28,34] and it is hard to measure the effects on quality of life resulting from changes in travel time and costs.

Previous studies assessing the regional socio-economic effects of trans-European transport networks, such as the TEN-T, have used accessibility models to measure their impact on economic indicators, or in reducing trading costs, as a way to quantify the social return [35–37]. Similarly, in the ESPON TRACC project, Spiekermann et al. [19] have shown the importance of regional accessibility on core–periphery patterns.

Road projects are often designed to benefit local communities by reducing travel time, increasing population, improving access to services or boosting economic activity in areas with challenges. Despite being a key consideration in policy-making, the evaluation of the local effects of transport infrastructure on local areas is rare. A review of 29 evaluations of the local economic impact of transport projects found that most evaluations show no or mixed effects on employment, with some positive impacts on wages, income and productivity [28]. In Norway, [34] a study of ten new road projects found no significant positive local impacts of reduced travel time in most cases, including access to labour markets, population growth, creation of new firms and employment. Furthermore, improving roads in sparsely populated areas did not have a positive impact on population trends. In contrast, Gibbons et al. [38] found strong evidence of the positive impact of new road infrastructure, showing an increase in the number of new firms and employment.

While some studies [28,34] have contributed to our understanding of the impact of highways on economic activity and long-distance transportation and have illustrated the rural–urban divide and the importance of localised effects, they have mostly focused on primary inter-regional networks. However, economic models and studies that assess the importance of local and intra-regional accessibility patterns are not as prevalent in the regional and rural development literature[2]. It is important to note that secondary and local networks, as well as public transportation, may be more crucial for the daily life of rural communities. Local roads may play a significant role in improving the quality of life by providing access to proximity services, such as health care, education and shops, and facilitating local economic development, including tourism and recreation activities. Improving access to services in rural areas can contribute to promoting territorial cohesion. The following section reviews some of the existing literature that has dealt with the importance of services from a territorial development perspective.

1.2. From Quantitative Growth towards Quality of Life

In addition to acknowledging well-being and inclusion (as distinct from economic competitiveness) as important objectives for rural and regional development, increasing attention is paid to access to SGIs as a tangible and measurable indicator of scope for intervention. Thus, the Long-Term Vision for Rural Areas devotes a section of its review to "Local Infrastructure", whilst the OECD argues that one of three dimensions of well-being requires that "households have access to a broad set of services" [4] (p. 21).

Within the academic rural development literature, the potential of SGI accessibility to capture pertinent spatial inequalities is demonstrated by analytical advances, which tend to focus upon specific types of service. These include primary health care [39–42], education [39,43], financial services [44], retailing [45,46] and internet access [47–49]. Other approaches have mapped service accessibility, but typically study access to only two or three different service types with different degrees of centrality. Papaioannou and Wagner [50] focus on access to primary schools and hospitals at the city level, while Milbert et al. [51] explore accessibility to airports, railway stations and primary schools. Kompil et al. [6] have produced an 'ideal' map of accessibility to services in Europe (for a generic type of local, subregional and regional service), but even though their approach could be useful to fill the gap of available data on the location of facilities for ex-ante policy evaluation, its results are highly simplified, and validation for health services shows significant differences with actual service provision in some countries. The ESPON SeGI project has explored how different levels of service provision contribute to economic development but does not provide an overview of geographical patterns of accessibility [52,53].

The ESPON PROFECY project employed an integrated approach using Open Street Map data to analyse accessibility to financial, cultural, health, education, transport and commercial services in Europe. The project also considered peripherality as a multi-faceted concept by combining accessibility to SGIs with economic potential and other demographic indicators. Ortega et al. [54] have recently updated these findings, identifying areas with poor access to SGIs as inner peripheries. See Noguera et al. [55] and Ortega et al. [54].

As already noted, improving service accessibility is not as simple as reducing transport travel times, as this may have unintended consequences in some areas. Furthermore, comparing service accessibility data is challenging due to differences in minimum coverage of service provision as well as different provision solutions (public, private or mixed solutions) among countries, which require a more localised perspective than is customary [6]. The tendency of academic analyses to be limited to a single type of service within a national context is no accident; it reflects the risks implicit in international comparisons due to contextual differences in social mores/expectations, welfare regimes, history and geography.

1.3. Dealing with the Challenges of Identifying 'Relative' Peripheries and 'Dynamic' Spatial Patterns

Accessibility to services is crucial for reducing disparities between rural and urban areas. Mapping access to services is a valuable tool for territorial analysis, providing a more direct measure of well-being implications than other common socio-economic indicators, whose coverage at a lower spatial scale is limited, especially in countries with large NUTS 3 regions.

The main challenge in addressing inner peripherisation is its 'relative' nature, as the local delivery structure of services varies between countries and affects spatial distribution. Population distribution is also influenced by historical, socio-economic and geographical factors. To identify areas of poor access to services (also called 'inner peripheries'), a relative and local approach is needed to compare them to neighbouring areas. Otherwise, there is a risk of neglecting the role of geography and locality in influencing development processes. Furthermore, assessing access to multiple service types would provide a broader perspective of well-being and quality of life from a rural resident's point of view. Service provision is constantly changing and influenced by policies, economic crises and infrastructure development. Analysing these changes in accessibility to services can be useful to distinguish between areas with severe (and more structural) problems of access to services from areas with moderate problems, allowing targeted measures to prevent decline.

Against this background, there is a clear need to:

1. Improve methods to identify areas with poor access to SGI, taking into account its 'relative' component.
2. Find methods that embrace the multi-dimensional complexity of IPs and the importance of SGIs (acting both as cause and consequence) on peripherisation processes.
3. Better understand SGI provision and interrelated policy-making processes.

To achieve this, the paper focuses on improving accessibility to SGIs in 'relatively' disadvantaged areas, which requires integrating the overlapping and multi-scale nature of service provision. The approach emphasises the importance of assessing a combination of SGIs rather than using sectoral approaches. This provides a more comprehensive view of the problem, which could help in the identification of areas for policy focus. This methodology can be used as a diagnostic tool, providing a starting point for place-specific intervention logic, and allowing for a more comprehensive assessment of interlinked processes and potentials.

Following this introduction, section two briefly outlines the concept of inner peripheries and how they can be used to assess accessibility to SGIs. Subsequently, section three presents empirical results on accessibility to SGIs in Europe. The implemented approach helps in the identification of:

- Enclaves of poor access to SGIs (in 2021) and their evolution between 2017 and 2021.
- Areas under severe pressure to become inner peripheries in the future.
- How inner peripheries changed between 2017 and 2021.

An example of how this indicator can be used to answer specific policy questions is provided through the assessment of the impact of the COVID-19 health crisis on the accessibility of SGIs in European border regions.

In section four, the approach is reflected upon and discussed as a tool to improve development policies.

2. Theoretical Considerations and Methodology

2.1. Relation between Service Provision and Transport Infrastructure Development

The provision of SGIs is very dynamic. New facilities are opened, existing ones merged or closed or services provided at a certain facility are amended in scope or nature every day. Changes have many reasons, reflecting the expansion of settlement areas, demographic developments (i.e., changing demands as a result of growing or shrinking population), technical progress (replacement of offices by digital services), operational and commercial decisions of private services providers and political decisions of public service providers (such as merging schools).

At the same time, governments and public authorities are constantly working to improve and expand road networks to enable shorter travel times and thus guarantee better access to services and facilities.

However, there is also a causal relationship between these two developments. Better access to city centres may encourage service providers to close facilities on the outskirts or in the rural hinterland (due to increased competition from facilities in the centres, which usually benefit from higher economies-of-scale). The closure of a facility may then be compensated, in whole or in part, by shorter travel times to the same facilities in the cities. In addition, road construction also triggers relocation decisions of private households, which, in turn, affect the demand for services, and thus, the spatial allocation of service facilities. A merging or closure of facilities due to improved accessibility may be a rational business decision of a service provider, as costs are saved. Macro-economically, however, costs are not saved but shifted to customers, who—as a result of these decisions—either have to accept longer travel times, receive lower service quality or invest in and pay for digital infrastructures in order to continue enjoying a service[3]. Which of these effects predominate in individual cases cannot be generalised; it depends on the specific conditions in the regions.

What is certain, however, is that because of these processes, the boundaries of the inner peripheries are just as constantly in flux. Sometimes the decision to close or open one specific facility has a major impact on accessibility surfaces and thus on the delineation of the inner peripheries. Still, as this paper will show, despite these complex processes, basic patterns of IP are remarkably constant throughout Europe.

2.2. What Are Inner Peripheries?

Inner peripherality is a multidimensional phenomenon which compounds the effects of various socio-economic processes that cause disconnection from external territories and networks [56]. The notion of Inner peripheries (IP) derives from the conventional concept of 'peripherality', which focuses just on the geographic position of a region in relation to all centres of economic activity in Europe. By way of consequence, studies analysing 'peripheral regions' often focus on geographically remote regions, see, for example, [57,58]. Much more complex, the IP concept includes a wider sense of 'disconnection' in relation to core areas and global economic circuits. The general performance, levels of development, access to services or the quality of life of IPs are relatively worse when compared with neighbouring territories. This approach tries to quantitatively identify disadvantaged rural regions that are relatively central, geographically, in their countries.

Three theoretical concepts explaining the process of inner peripherality can be differentiated [55]:

1. The formation of ***enclaves of low economic potential***, due to geographical distance from centres of economic activity. These are localities that have relatively high levels of 'conventional' peripherality (low accessibility to centres of economic activity), but which are not 'on the edge' of Europe.
2. ***Poor access to Service(s) of General Interest***. Processes leading to poor access to SGIs because of geographical distance, changing service delivery technologies, austerity or other changes in provision such as privatisation.
3. Aspatial peripheralisation processes that result in a ***lack of socio-political interaction***. This driver is a consequence of disconnection from the centres of political power, manifesting in a lack of stakeholder interaction, exclusion from 'the mainstream' of economic activity and lack of influence in terms of governance due to social and institutional characteristics of individuals, groups, firms or organisations, rather than geographic features.

The ESPON PROFECY study translated these three concepts into four operational IP delineations, (Figure 1):

- ***Delineation 1*** defines areas which are not on the physical edge of Europe but are surrounded by areas of greater centrality and have ***low economic potential***.
- ***Delineation 2*** identifies IPs based on ***higher car travel time to regional centres***, which are the centres for SGI provision and for most social and economic activities.

- ***Delineation 3*** identifies those areas with ***poor car accessibility to Services of General interest*** compared to surrounding areas and/or the region.
- ***Delineation 4*** identifies IPs on the basis of ***negative development processes***. These are areas that have entered into a negative downward spiral due to increased unemployment, population loss and negative GDP development.

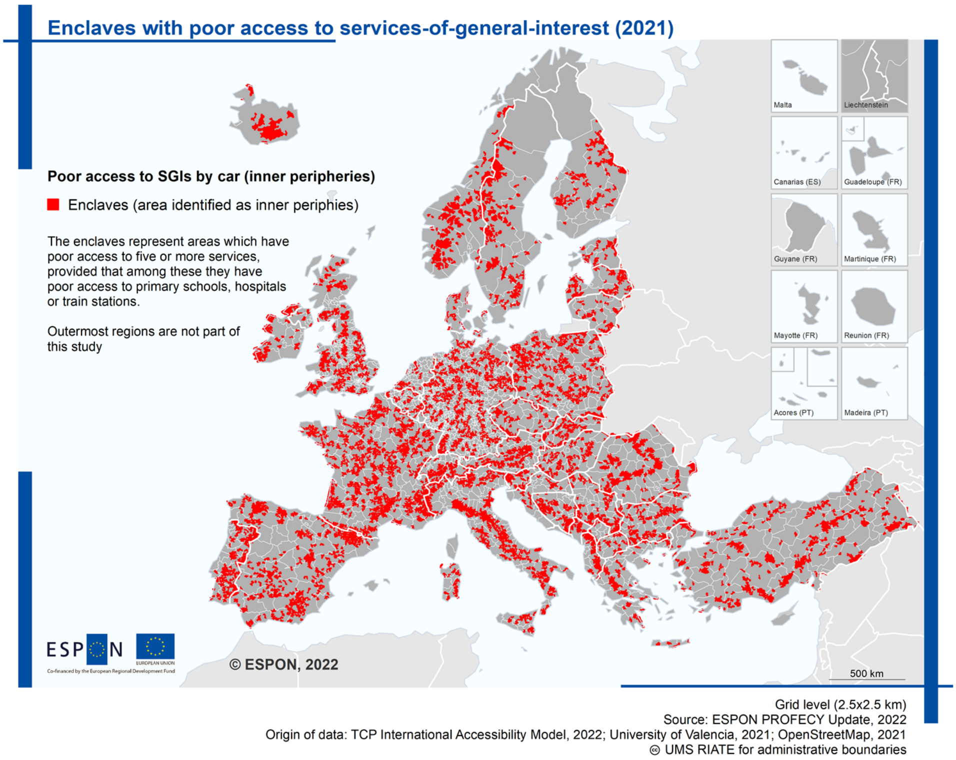

Figure 1. Enclaves with overall poor access to services.

While the first three approaches are based on different drivers of regional development, the last delineation is based on concrete outcomes. In reality, inner peripheries usually appear as a result of all these processes, since the drivers and outcomes are interconnected.

What is particularly important and new to the IP approach is that the different types of disadvantages are not analysed in absolute terms or against the average of all regions in Europe, but relative to the areas immediately surrounding them.

Since good access to a broad range of public services appears to be a major factor of well-being for residents in rural areas all over Europe, this paper focusses on presenting the results of Delineation 3 for two years, 2017 and 2021, thereby demonstrating the capabilities of the methodology as a diagnostic tool for policy-makers[4].

2.3. Methodological Implementation

To delineate inner peripheries in Europe with poor car access to public and private services, a raster-based approach was implemented that involved the following steps:

1. Subdivision of the study area into a seamless system of uniform grid cells with a resolution of 2.5 × 2.5 km (covering populated as well as unpopulated places).
2. Calculation of car travel times from each grid cell to the nearest SGI facility for each of the ten service types (specified below).
3. Standardisation of the car travel times using the average of the surrounding NUTS 3 regions[5].
4. Delineation of inner peripheries individually for all ten service types. All grid cells with standardised car travel times of 150 or higher are considered as inner periphery[6].

5. Extraction of grid cells identified as IPs, merging of neighbouring grid cells, elimination of small sliver polygons and smoothing of boundaries. A minimum size of 100 km^2 was applied for an area to become an inner periphery. Smaller patches have been removed as artefacts of the modelling approach.
6. Combination of the results for the ten individual service types to identify areas that—overall—represent IPs across all ten services.
7. In addition to this, areas at risk of becoming IPs in the future were also delineated. Areas at risk are regions which, to date, are not considered an IP, but may become one in future if one, two or three services close. For this, two additional steps were implemented:
8. Calculating the availability of facilities of a service type within certain car travel times.
9. Identifying all areas for which only one facility is reachable, and which are not IPs to date.

Ten public and private services to which consumers travel were considered in the study: these were banks, primary schools, secondary schools, shops (supermarkets, convenient stores), pharmacies, doctors (general practitioners), cinemas, places of work (jobs)[7], hospitals and railway stations[8].

The study area comprised all European Union Member States, candidate countries of the European Union, all EFTA states, remaining Balkan countries and Turkey, as well as the United Kingdom, excluding the outermost regions.

Road networks were compiled from OpenStreetMap (OSM) data for 2017 and 2021. Similarly, the location of service facilities for the aforementioned service types were also based on OSM data for 2017 and 2021; however, because OSM had gaps in the coverage of service facilities for some countries, additional national sources were consulted to fill these gaps, ref. [60] gives a detailed overview of which additional sources were used.

3. Results: Areas with Poor Access to Services in Europe—Not Only Geographically Remote Areas

3.1. Enclaves of Poor Access to Individual Services

Based on the results of the travel time calculations[9], enclaves of poor access to services are found in all European countries for all service types (Figure A2). These areas can, across all service types, generally be characterised as:

- Mountain areas (examples: parts of the Alps, Pyrenees, Apennines, mountains in southern Norway and the Carpathian Mountains);
- Rural areas off the main roads in all countries;
- Interstitial areas between agglomerations in all countries;
- Areas along national borders (examples: Portuguese–Spanish border, Bulgarian–Romanian border, Norwegian–Swedish border).

Urban areas (city centres) were not identified as enclaves with poor accessibility, but peripheral areas of larger metropolitan regions or parts of functional urban areas (FUAs) were. Still, these patterns vary in terms of quantity, size, shape and fragmentation in different parts of Europe:

- In Nordic countries (Iceland, Finland, Norway, Sweden) and Turkey, the enclaves with poor access to services are few but large. This is because these countries have generally lower accessibility levels, but they are more evenly distributed. In other words, there are only a few distinct areas with high accessibility, but a rather extensive territory with low accessibility, so that inner peripheries only partially emerge.
- In Spain and in Eastern European countries (Bulgaria, Romania, Hungary), the enclaves with poor access to services are usually larger compared to those in Austria, Germany and Benelux countries (Belgium, Luxembourg, Netherlands). In other words, the latter countries exhibit a higher small-scale fragmentation between accessible and non-accessible areas, indicating significant differences in access to services at a very small regional scale.

Upon comparing the results for 2017 and 2021 (as shown in Table A1), statistical analysis indicates that:

- With the exception of jobs, poor access to all services has significantly increased in 2021, with poor access to doctors almost doubling. For jobs, the area stabilised.
- The number of patches has increased, except for retail and jobs, with some showing a slight increase (such as hospitals and stations) and others exhibiting significant increases (including cinemas, doctors and secondary schools). However, the average size of the patches has only slightly increased for hospitals, secondary schools and stations, while for cinemas, it has even decreased.
- Therefore, by 2021, an increased number of patches with stable average size led to a greater spatial fragmentation of enclaves with poor access to services.
- The higher fragmentation is the result of the expansion of road infrastructures combined with facility closures. While the accessibility of centres and facilities along new and upgraded roads has increased, the areas not directly connected to these upgraded roads have remained further behind (in relative terms).
- From an analytical perspective, a higher fragmentation is neither good nor bad in itself. For smaller enclaves, there may be hope of access improvement in the future. However, from a political standpoint, focus is mainly given to larger enclaves, which generally face further disadvantages, while smaller enclaves are seldom on the political agenda.

3.2. Identification of Areas with Poor Access to All Ten Services

The enclaves identified up to this point can already be considered as inner peripheries in relation to the specific service concerned. when evaluating service quality in a region, it is important to consider the sum of all services available rather than just one. If access to one service is poor in a certain location, but access to nine other services is excellent, then the overall service quality in that location is still good. The significance of a particular service to households and families is dependent on their life cycle stage. For example, families with children prioritise access to kindergartens, schools and doctors, whereas elderly people may be more interested in theatres, cinemas and retirement homes.

Inner peripheries could therefore be defined as areas that experience poor access to a majority of services, specifically five or more, according to this analysis. Figure 1 depicts the results. Inner peripheries can be found in all European countries except for Cyprus and Malta. The spatial characteristics mentioned earlier remain applicable, where these areas are commonly located in mountainous regions, rural areas off the main roads, interstitial areas between urban areas and along national borders. However, the number and overall size of these areas both vary considerably between countries.

After comparing the 2021 results with those of 2017 (as shown in Figure 2), the following trends can be observed:

- ***Core areas of inner peripheries***, where poor access to services persists, exist in all European countries.
- Large areas that previously had IP status have improved their accessibility and ***lost their IP status***. These areas are often located adjacent to the core IP areas and are mainly found in Spain and Poland, with fewer occurrences in Germany and France, and to a lesser degree, in Italy, Bulgaria, Greece and the UK.
- ***New IP areas*** have emerged either due to the closure of facilities or to worsened relative accessibility (mostly where road infrastructures in the neighbouring regions were improved). Such areas are mostly found in southern Portugal, western and northern France, Germany, Poland and the Nordic countries. These new IP areas are typically smaller in size than core IP areas.
- There are ***Opposing developments*** in different parts of some countries, such as Poland, Germany or France, where areas with receding IP status contrast with others where new IPs have emerged. In contrast, hardly any changes could be observed in other countries such as Croatia, Greece, Finland, Ireland, Belgium or Bulgaria.

- Consequently, the ***net result*** is that the share of IP areas in the national territory has decreased in some countries, such as Spain, the Netherlands, Austria, Slovakia or the Czech Republic, while it has increased in others, including Portugal, Lithuania, Denmark and Estonia.

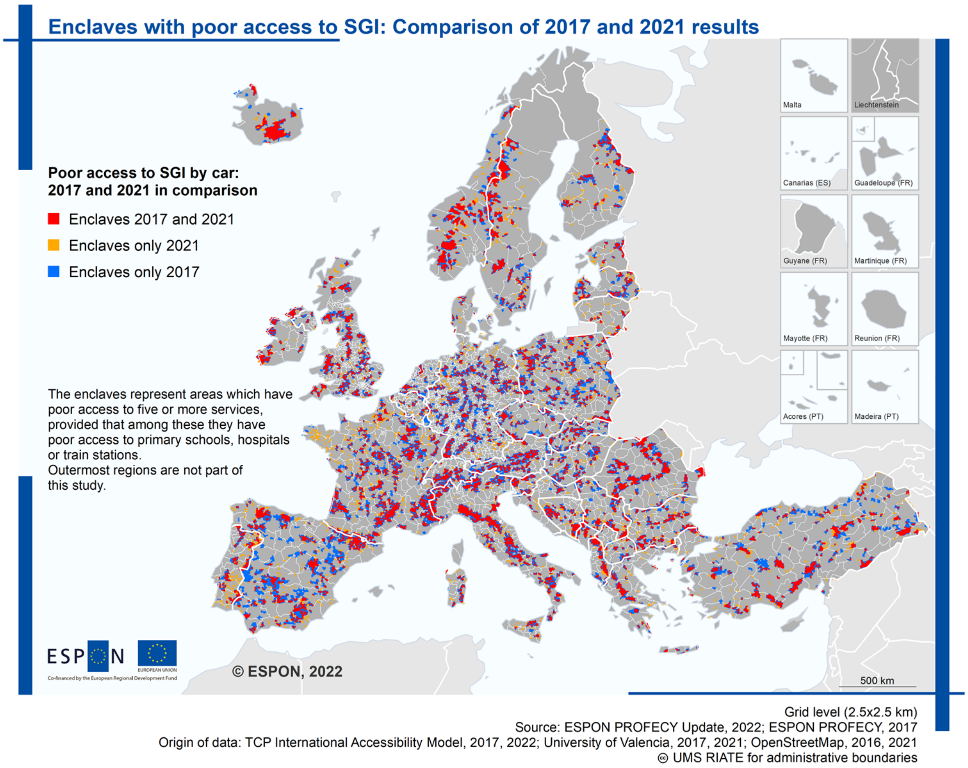

Figure 2. Enclaves with poor access to services: Comparison of 2017 and 2021 patterns.

Figure 3 and Table A2 show the percentages of IPs in each country[10]. In 2021, the lowest percentage (11%) was in Finland and the highest (57%) in Andorra. Although this is quite a large range, the range has significantly decreased compared to 2017, when Andorra had 94% of its territory classified as IP. Most countries have IP shares ranging from 20 to 40%. Nordic countries have even lower shares (Finland: 11, Norway: 13, Sweden: 15), while small countries tend to have larger ones (Slovakia: 41, Macedonia: 45, Albania: 46, Switzerland: 46, Slovenia: 50, Andorra: 57). Small shares of IPs in the Nordic countries or Turkey do not mean that they are less rural, but rather that the disparities in spatial structures are less pronounced, there is less fragmentation and, overall, service provision in the rural regions is at a comparable level. In contrast, spatial disparities (between cities and rural areas, but also within the latter) and fragmentation are more pronounced in central Europe (for example, in Poland, the Czech Republic) and Western European countries such as Germany. This fragmentation ultimately leads to a higher proportion of IPs.

As described above, the development of IPs between 2017 and 2021 was different for each country. In four countries, (Belgium, Bulgaria, Croatia and Greece), the overall pattern remained stable. The IP territory enlarged slightly in two countries (Finland, Slovenia), increased moderately in three (Bosnia-Herzegovina, Estonia and Denmark) and increased more substantially in two more (Lithuania with 8 and Portugal with 12 percentage points). For the remaining countries, the share decreased more or less strongly.

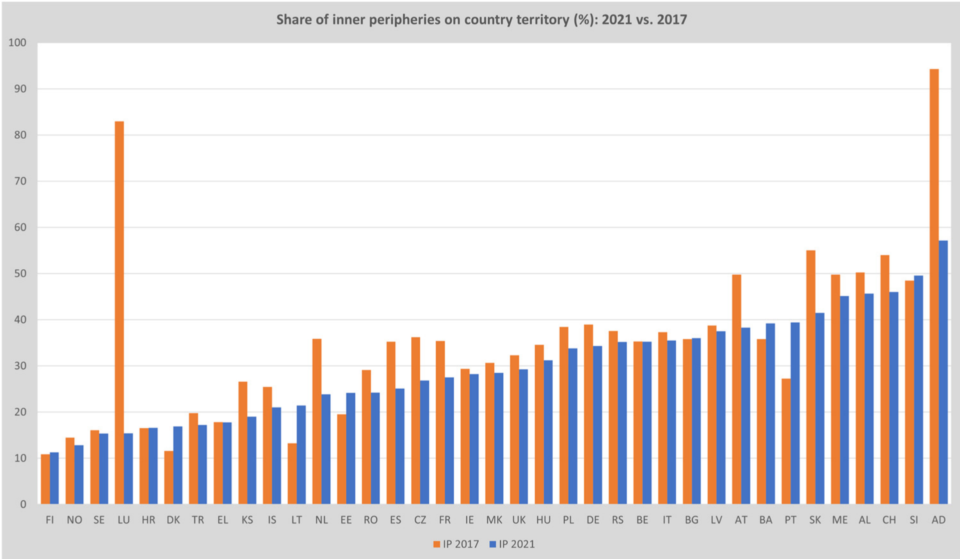

Figure 3. Share of inner peripherality on country territory.

Although the analysis of the individual services indicates a clear deterioration, this observation cannot be confirmed for the indicator regarding overall access to all services combined. For most European countries, the proportion of their total area defined as inner peripheries decreased or was constant, with only a few countries showing an increase. This suggests that the development of different services is varied and affects different parts of the studied area. For instance, if an area becomes an inner periphery in terms of bank accessibility due to the closure of a bank office, this does not necessarily extend to the other nine services, nor does it imply that the entire affected area is classified as an IP across all ten services. The overall indicator of 'IP to all ten services' relativises and thereby puts the developments in individual services into perspective; on the contrary, across all ten services, the positive effects of expanding road infrastructures appear to offset the negative effects of individual branch closures at the overall state level.

3.3. Areas of Risk to Become Future IPs

As described, inner peripheries are dynamic and subject to change over time. They may expand, and new enclaves may emerge when services are shut down. Conversely, they may also shrink in size and number when new facilities are established and the road networks are updated and expanded.

Areas with good access to services today may become IPs tomorrow. In this analysis, areas that are at risk of becoming inner peripheries are defined as those where only one facility per service type is available within reasonable driving time. For instance, if there is only one secondary school accessible within a 60 minute car travel time, or just one store within 15 minutes or one bank within 30 minutes[11], the closure of just one facility would compromise service quality for the affected regions. While the closure of one of these facilities may not have a severe impact on daily life, if multiple facilities for different service types were to close, regions would quickly become disconnected from further development[12].

The number of accessible facilities within a reasonable travel time is therefore a sound basis to perform risk assessment. Figure A3 provides a map series for all ten service types. By comparing areas with only one accessible facility with the present IP, areas of risk to become enclaves with poor access to SGIs in future are revealed (Figure A4). This risk analysis is especially valuable because in many countries, the planning and provision of SGIs are handled by various private and public actors, often with little coordination between them.

When comparing the results with those from 2017, it can be observed that there has been minimal change in the most affected countries (Figure 4). The Nordic and Eastern European countries (including Turkey) have the highest number of at-risk areas for all services. Spain and Portugal, Scotland, parts of the Baltic States and north-eastern Poland, as well as the core areas of the Alps, also have a significant number of risk areas for many services (Figure 5). However, for the remaining countries, the risk areas are limited in scale and only become noticeable when the map is zoomed in.

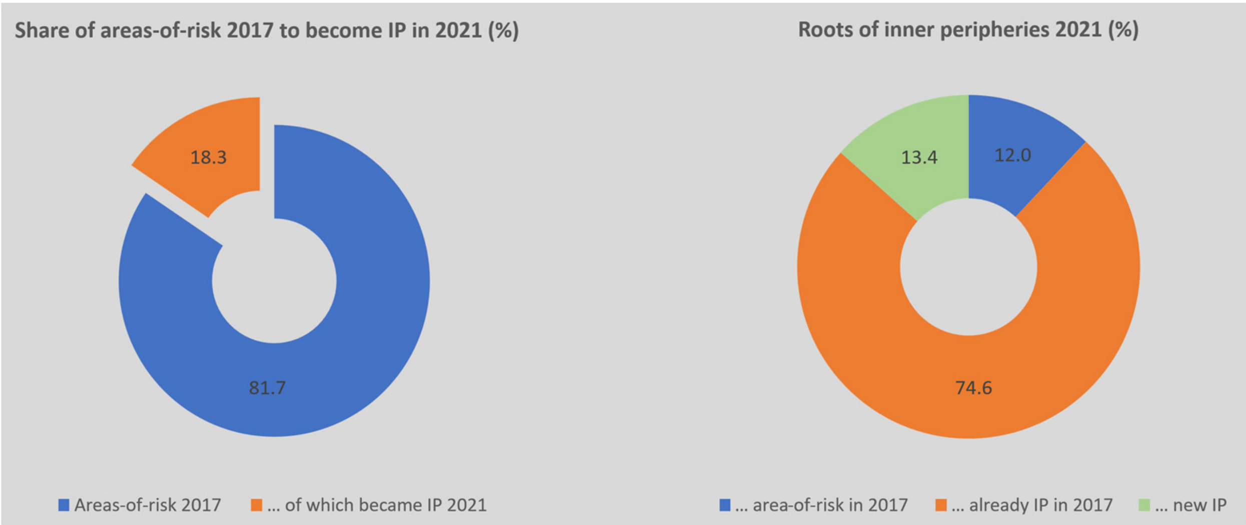

Figure 4. Development of areas of risk and inner peripheries 2017–2021. Note: The proportions of 18.3% and 12% in the two figures are not identical because the respective parent populations are different (parent population on the left: total area of risk 2017; on the right: total area of inner peripheries 2021).

An interesting observation is that for public services (schools, hospitals), the risk areas seem to be smaller and ultimately the number of countries affected is also smaller, whereas the risk areas for privately operated services (e.g., stores, banks, cinemas) are larger and affect more countries. This suggests that state planning, particularly for schools and hospitals, may lead to more homogeneous conditions within the states.

However, the assessment of risk areas must be approached differently. While in the affected areas in the Nordic countries, Scotland, the Alps and partly also in Spain, a lack of demand and thus a low density of facilities must be assumed (many uninhabited areas), the problem in the affected areas of Eastern Europe is the lack of accessibility resulting from low density and poor-quality road networks.

Finally, the areas under severe pressure to become inner peripheries in the future are those with poor accessibility to four or more services (Figure 6). Based on the previous analyses, these areas are, unsurprisingly, found in the Nordic countries, Eastern Europe including Greece and Turkey, the Baltic States, the Iberian Peninsula, Italy (Sicily, Sardinia), the Alpine region, Scotland, north-eastern Poland and Ireland.

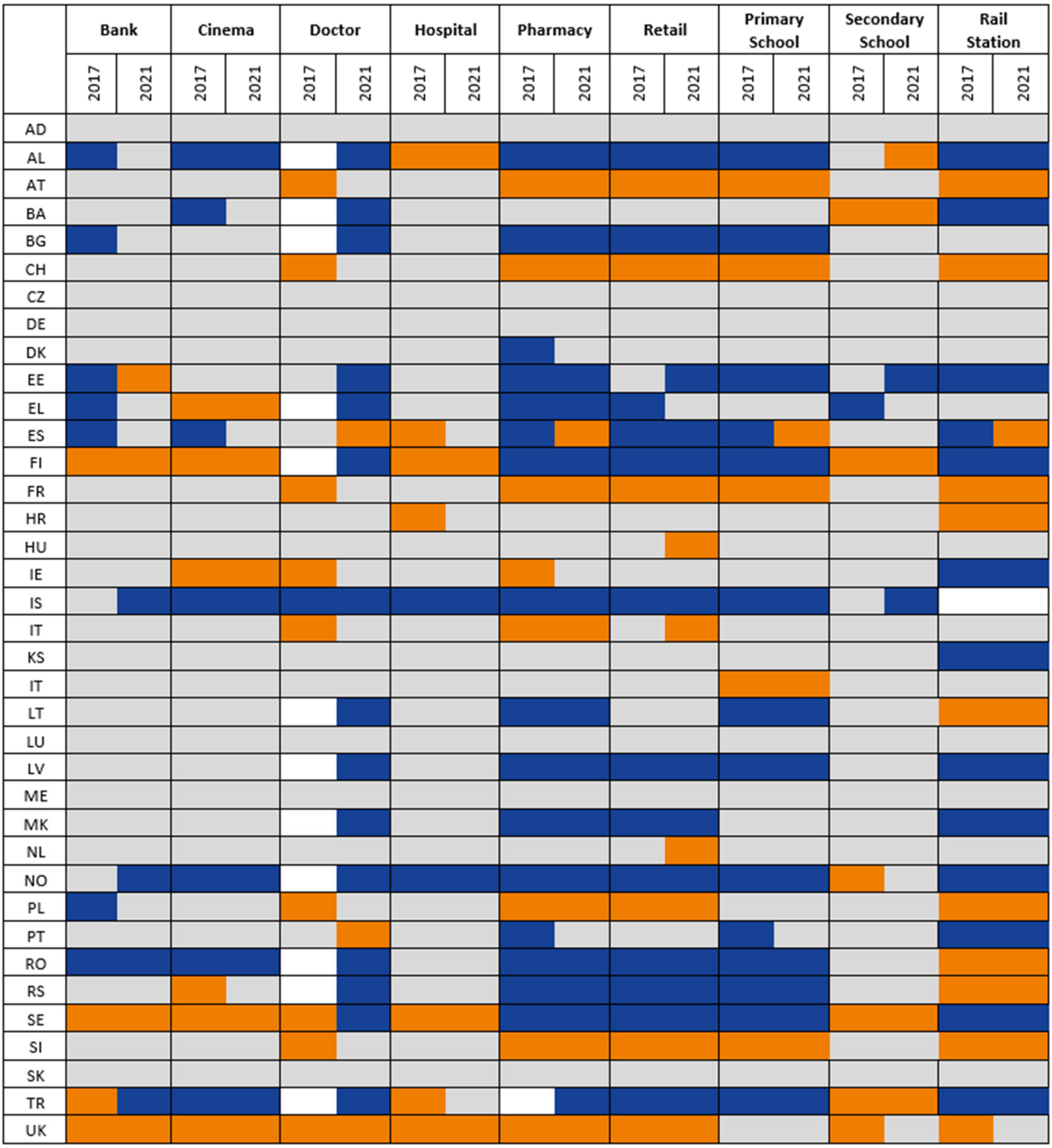

Figure 5. Areas of risk by country: 2017 vs. 2021. Grey cells = small proportion of areas-of-risk on country territory, orange cells = areas of risk in certain parts of the country, blue cells = large number and extent of areas of risk on country territory, white cells = not applicable.

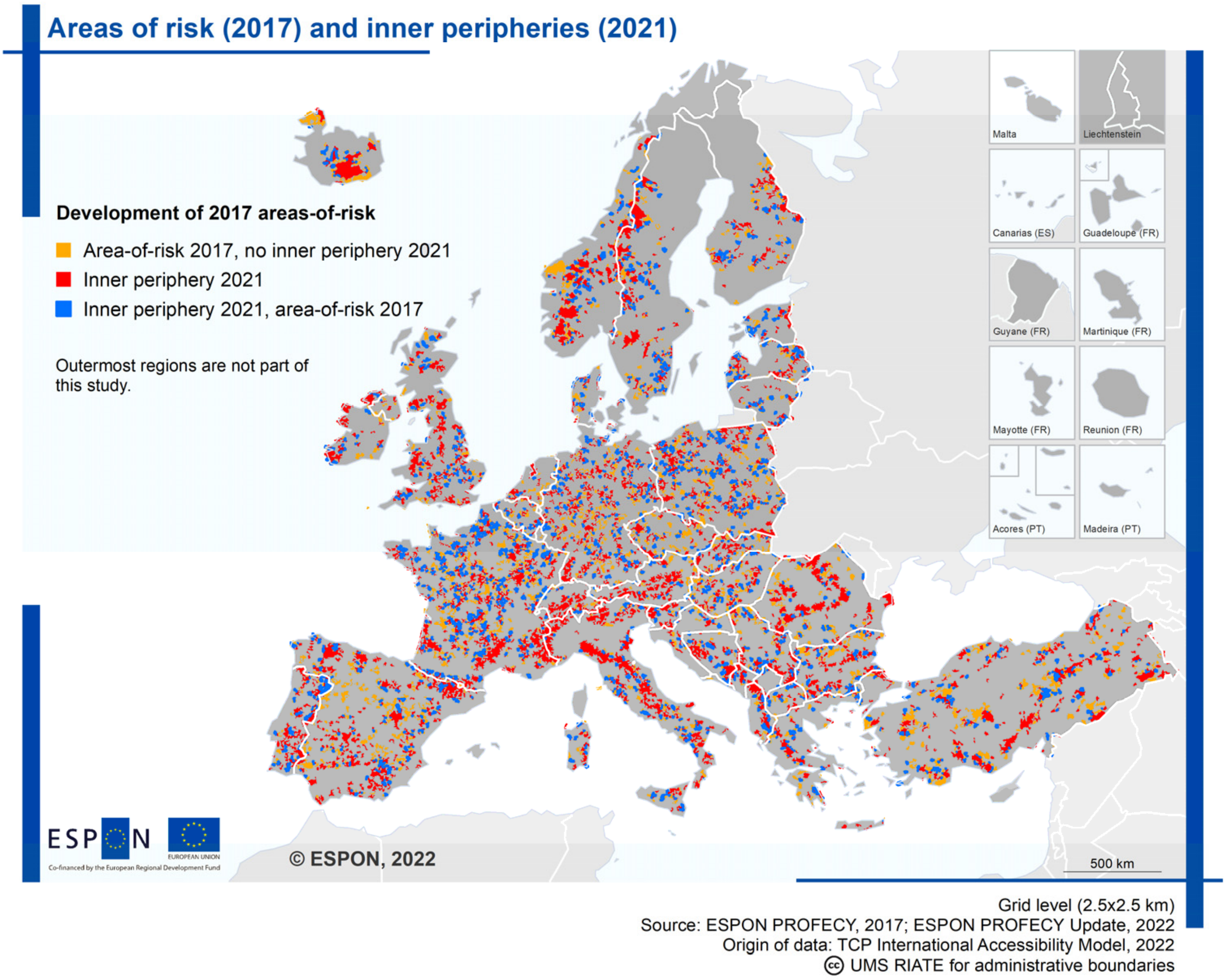

Figure 6. From areas of risk to inner peripheries.

In 2021, around 18% of the areas of risk in 2017 have further 'downgraded' and become Inner Peripheries (Figures 4 and 6)[13]. This means that almost one-fifth of the initially identified at-risk areas became inner peripheries in a relatively short period of time. Conversely, 12% of inner peripheries in 2021 were previously identified as at-risk areas in 2017, and approximately 75% of the 2021 IPs were already inner peripheries in 2017 (Figure 6). Only 13.4% of the 2021 IPs were neither areas of risk nor IPs before. Geographically, the areas that were considered at-risk in the 2017 areas of risk and became Inner Peripheries in 2021 are spread throughout Europe, with higher concentrations in France, Poland, Sweden and Germany (Figure 7). In contrast, there are almost no such cases found in Austria, the Netherlands and Switzerland. These findings highlight the risk of a downward spiral once an area is designated as a 'risk area', emphasising the need for early implementation of appropriate measures to stabilise the situation in at-risk areas.

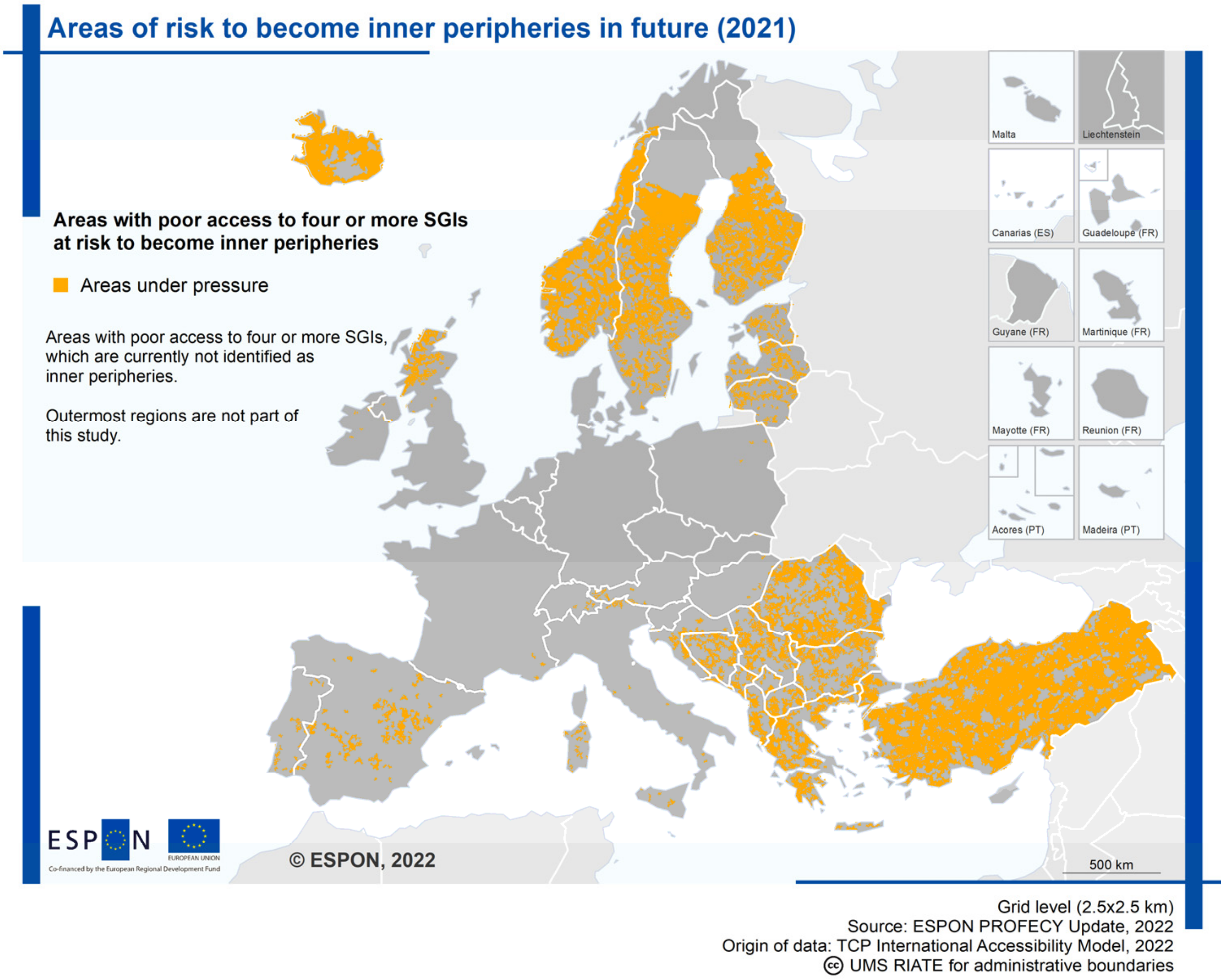

Figure 7. Areas under severe pressure to become IPs in future.

3.4. Using this Methodology as a Tool to Answer Specific Policy Questions: Impact of COVID-19 Border Closures on Access to Services in Border Regions

Rural regions often coincide with border regions, which have been particularly affected by the COVID-19 pandemic border closure measures implemented by national governments. In these regions, the nearest service point is often located across the border, making it inaccessible during periods of closure. To account for this, the areas of risk analysis has been modified to assess the impact of border closures on access to essential services such as banks and shops[14]. The model results reveal that the impact of border closures is highly uneven across Europe, with some regions experiencing more severe consequences than others. The magnitude of these effects depends on several factors:

- ***Availability and density of border crossings***: Border areas that have limited or no border crossings are expected to be less impacted as people already face difficulties in crossing borders even when they are opened. Therefore, these regions do not suffer from additional burdens compared to the current situation.
- ***Quality and density of the road networks***: Border areas with well-developed arterial roads (motorways, expressways) are expected to experience broader impacts from border closures as compared to areas where crossings are only provided through secondary or tertiary roads. Additionally, the density of roads is a determining factor in the extent to which the effects of closures spread into the hinterland.
- ***Spatial distribution of facilities in the border area***: Service facilities need to be in place close to the national borders; in the absence of such facilities, border closures

would have no adverse effects. If facilities are available only on one side of the border, the impact of border closures would be one-sided, affecting only the side of the border without services.

Model results, expressed as the number and percentage of facilities that no longer can be reached after closing the borders, reflect these factors.

Generally, the impact of border closures on shops affects a corridor of up to 20 km from the border crossings (Figure 8). For banks, the affected corridors can reach up to 50 km (Figure 9). The largest impacts are observed along the borders of the Benelux countries, Germany and the Eastern borders of Austria, as well as the Portuguese–Spanish border. In Eastern Europe and between the Baltic States, strong and weak effects occur sporadically. However, almost no impacts can be seen between the Nordic countries or along borders in the Alpine space (France–Italy, Italy–Switzerland, Austria–Italy).

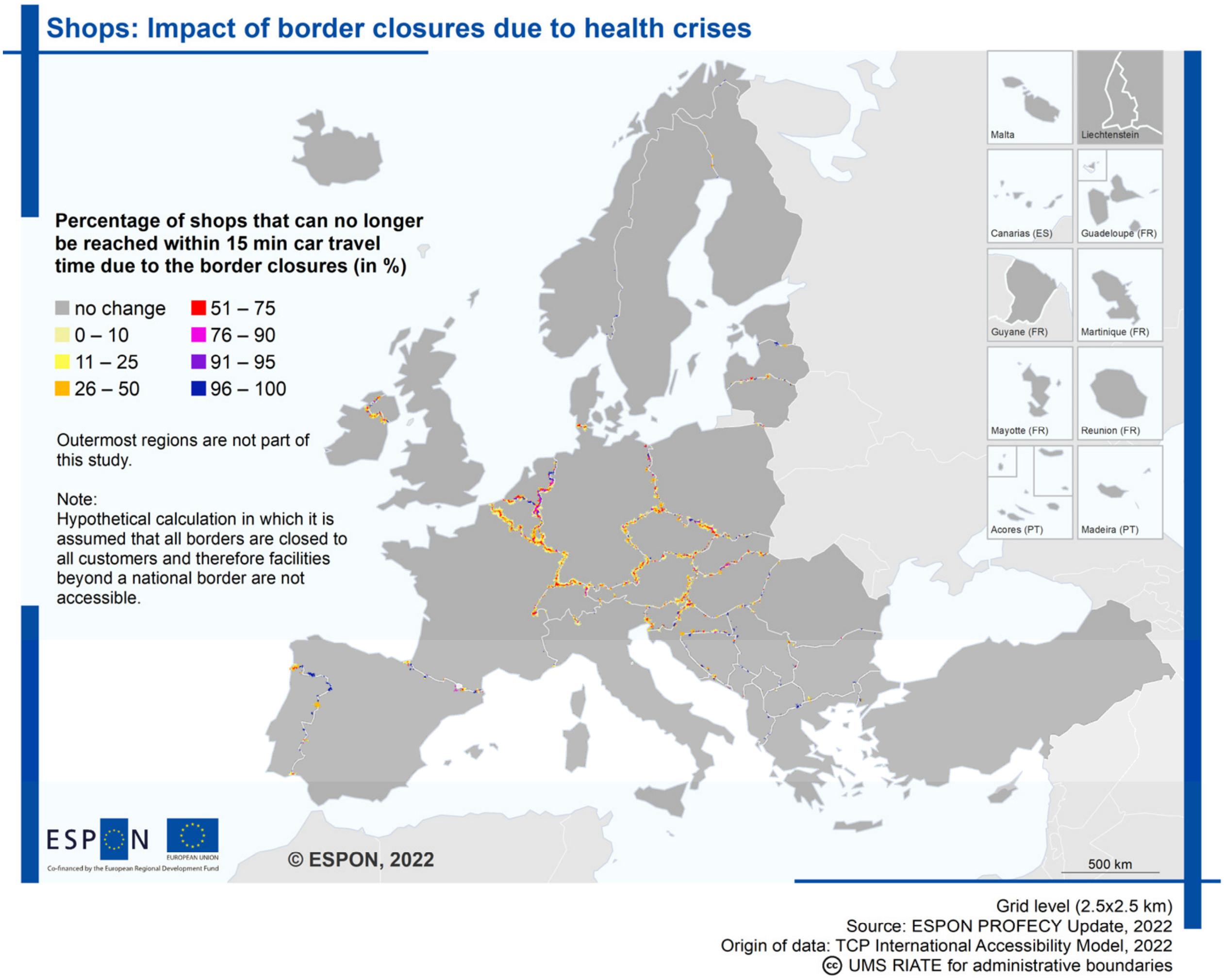

Figure 8. Percentage of stores not reachable after border closures.

Significant decreases in the number of facilities (more than 10, 25 or 50) do not necessarily lead to major losses in service quality. However, when the percentage of inaccessible facilities reaches a certain threshold (Figure 8), the supply situation deteriorates significantly. For instance, in the case of retail, the percentage of accessible facilities drops more than 75% or 90% along the Dutch–German, Belgian–Dutch and partially the Portuguese–Spanish borders, as well as in small border sections in Eastern Europe. In these areas, the border corridors will be severely impacted by border closures. Conversely, along other borders such as the Upper Rhine Area between France and Germany and Germany and Switzerland, or the Austrian borders, the percentages are less than 50% or 25%, resulting in less severe impacts. Regions with declines of more than 90% or 95% in accessible facilities face a complete decline in service provision, as (almost) no facilities can be accessed within a reasonable time. In such cases, people from these areas would have to travel long distances into the hinterland to reach the nearest bank or shop.

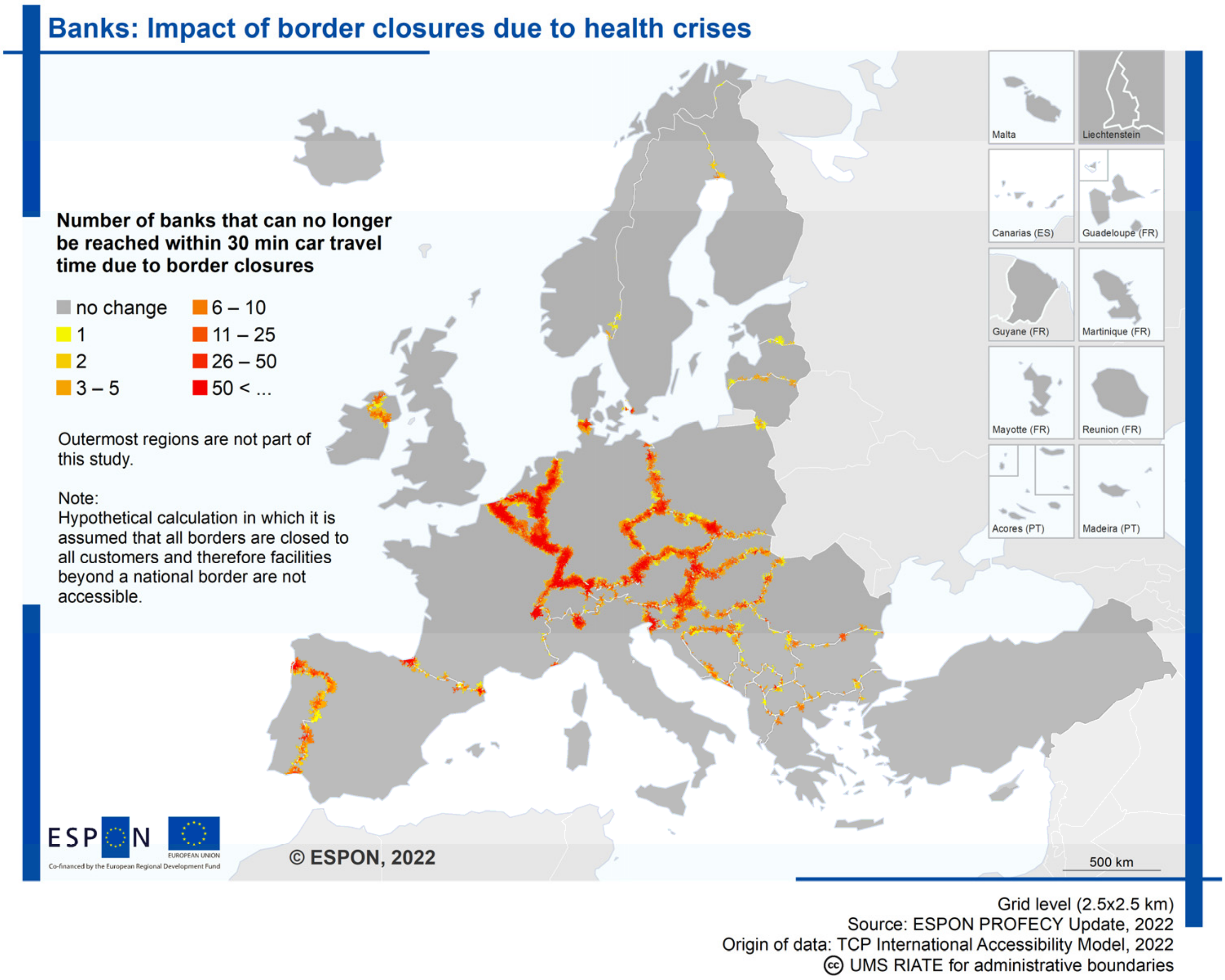

Figure 9. Number of banks not reachable after border closures.

The COVID-19 pandemic has underscored the significance of cross-border service provision for inhabitants of border regions. The above analysis aids in identifying border areas that heavily depend on cross-border services and should therefore be included in vulnerability assessments. In such areas, closures or openings of service points due to national policies will affect the provision of services and the welfare of residents beyond the border. Hence, collaboration across borders should be sought to plan and provide public services, for instance, through formal cross-border public services (CPS) [61].

3.5. The Geography of Inner Peripheries and Areas of Risk

Changes in accessibility between 2017 and 2021 are influenced by both shifts in service provision and in transport infrastructure. The changes in service provision reflect the evolution of territorial organisation at a detailed level. However, the impact of service improvement in some areas is not directly and straightforwardly translated into improved access to services, and vice-versa. Time-accessibility to services varies greatly within regions. Similarly, improvements in road and transport networks have heterogeneous effects on different areas.

In 2021, enclaves with poor access to services continue to be present in almost every European country. Yet, the variation of time-accessibility to services (in relative terms) shows significant disparities and different services affect different parts of the territory. Due to the functional organisation of service provision, enclaves often arise around administrative NUTS 3 boundaries. In this sense, traditional indicators such as service density at the NUTS 3 level may have a limited explanatory power to deal with inner peripherality. Nonetheless, areas with low population density are generally more vulnerable to peripheralisation processes, just like shrinking areas. When the population decreases (due to natural decrease or outmigration), maintaining service provision becomes difficult, which further encourages population outflow. In Eastern Europe, in addition to low population density, low-quality transport networks also exacerbate the problem.

Comparing the inner peripheries in 2021 with the results from 2017 reveals that inner peripheries have fluid boundaries that respond to aggregated changes in service provision. Although statistical analysis of individual services indicates a clear decline (Appendix B), when these changes are combined to identify areas with poor access to services, the total area of inner peripheries remains relatively stable. This may be explained by the fact that service changes affect different regions in different ways and that public services are provided more homogenously and react more slowly to changes in demand than private service provision. Despite the fluidity of IP borders, some core areas persist: 75% of the 2021 IPs were already inner peripheries in 2017. Improving the availability of facilities in those core areas will then be an effective way to address inner peripherality, and measures taken in core areas could also have positive spillover effects on their surroundings.

It is generally presumed that road infrastructure improves territorial cohesion and benefits peripheral regions. However, the comparison between 2021 and 2017 reveals that inner peripheries behave in a more intricate manner, as road infrastructure improvements do not necessarily lead to a decrease in IP areas but result in higher fragmentation. In cases where services are unavailable in IP areas, the expansion of transport infrastructure may reduce commuting time and compensate, in the short term, for the negative effects for residents. Nevertheless, when IPs appear due to infrastructural improvements in neighbouring areas, it is worth noting that the opening of a new road affects only a small strip of the territory and nearby municipalities, thus amplifying small-scale differences between areas. Consequently, the neighbouring areas that are not directly connected to the upgraded roads become smaller but remain further behind (in relative terms). In the long term, new transport infrastructure may also impact population distribution, access to jobs and business activities. Although better access to centres of economic activity is vital to sustaining a population, there are also some back-wash effects on the areas bypassed by road improvement. In inner periphery areas resulting from cumulative factors such as low population density and weak economic activity, people may choose to move to better-connected areas, thus further endangering service provision.

In terms of areas at risk of becoming inner peripheries, it is worth noting that around 18% of the areas identified as such in 2017 have since deteriorated and become inner peripheries in 2021. Therefore, the identification of areas of risk to become IPs in the future, characterised by poor access to SGIs, has proven to be a valuable tool for policy-makers. In these areas, the further closure of facilities of any kind should be avoided as this could lead to the areas becoming less attractive. This highlights the significance of adopting appropriate measures early on to stabilise service provision and prevent further deterioration in these areas.

4. Discussion

In this penultimate section, we reflect upon the added value associated with the methodology and results presented above, firstly in terms of its utility as a diagnostic policy support tool, and secondly in terms of the potential for further research and refinement.

4.1. The Utility of SGI Accessibility Mapping as a Diagnostic Tool to Support Policy

The maps and diagrams presented in this paper show that SGI accessibility mapping has obvious potential to improve our understanding of the role of access to services in macro-scale patterns of well-being across Europe. However, the relative nature of the indicator means that it is particularly helpful for policies targeting and design at a meso (national) and micro (local and regional) level. It allows the places with the poorest access to services to be identified, without being (directly) influenced by administrative boundaries. Furthermore, disaggregation by individual services is likely to highlight issues of incoherence, unintended interactions between the strategies of different delivery agencies and to point to specific priorities for tailored, place-based remedial interventions. The methodology and indicator presented above are especially helpful in highlighting the need for greater coherence between the strategies of different service provision agencies. These characteristics are particularly welcome in the context of the widespread issue of rural (demographic) shrinking, which is often locked into a two-way causal relationship with service provision.

However, the implications of the analysis are not confined to adjustments to service delivery strategies and structures. Just as the gravity modelling of "economic potential" at the turn of the century was used as a justification for inter-regional transport network infrastructure investment such as the TEN-T programme, relative SGI accessibility mapping raises questions about the priority given, within rural policy, to intra-regional networks and local 'public' transport. The recent rural development literature abounds with examples of innovative solutions to local transport needs, often delivered by the third sector, or as community enterprises [62]. The findings above suggest that the quality of local road networks and public transport should be a key priority both for place-based rural/local development and in the context of urban–rural and cross-sectoral cooperation initiatives.

4.2. Suggestions for Further Research and Refinement

Opportunities for further development of the approach presented in this paper range from specific methodological 'tweaks' to exploring more fundamental issues associated with the wider policy context.

Examples of detailed methodological issues include:

- The implications of the configuration of NUTS 3 regions for the standardisation of travel times. This is an interesting manifestation of the modifiable area unit problem (MAUP) [63]. It is a well-known fact that NUTS 3 regions are, on average, much larger in some member states (such as the Nordic countries or Spain) than others (Germany and the BENELUX countries). Furthermore, in some Member States, NUTS 3 regions are broadly 'functional', in that they incorporate both large cities and their more rural hinterlands. There are also examples of NUTS 3 regions which are tightly bound around cities, surrounded by more rural NUTS 3 regions. Clearly, these contrasting arrangements will have different effects on the standardisation of the accessibility index for constituent grid squares. For example, instead of using neighbouring NUTS 3 units, certain radii (e.g., 50 km radius) could also be used for standardisation.
- Another specificity of the available data is the fact that some grid squares, especially in the north of the Nordic Countries, parts of Spain and so on, are unpopulated. Thus far, these are nevertheless included in the analysis. Further research should be carried out to explore the effect this has on the configuration of the inner periphery patches in these countries.
- The analysis above effectively treats each of the ten services as of equal importance to well-being. Clearly, this is an assumption that should be explored, with implications for the mapping outcomes. The approach could also be extended to other service types[15] that could not be considered here.

More fundamental issues relating to the wider policy context include the implications of both the Digital and Green Transitions. In the case of the former, it will be important to explore the implications of the changing service access travel behaviour of online access, and various kinds of hybrid delivery. Good examples are found in the primary health care sector. Already, some parts of Europe have invested heavily in virtual consultations, often as a form of triage, thus reducing the need for service-user travel to access diagnosis or treatment. This ongoing change, with progress varying considerably between Member States, and even between regions, adds a layer of interpretational complexity to the path-dependent patchwork of strategies and practices across Europe.

In terms of the Green Transition, questions about car use and the role of public transport must be taken into account when evaluating variations in service access travel times. Broadly speaking, a more local provision of services with shorter travel times might suggest both greater well-being and smaller carbon footprints, a win–win situation. Psychologically, this would also lead to greater satisfaction for the residents, because maintaining services on-site gives a feeling of "being taken care of" and "security", while closures of facilities create a feeling of "disconnectedness". Again, this would point to the need for rural policy to carefully consider the potential to improve intra-regional networks and coordination, and to improved public transport provision.

5. Conclusions

The contribution of the analysis reported above is two-fold: it represents, firstly, a significant methodological advance—the successful utilisation of a novel data source to measure accessibility to services as an indicator of well-being. Secondly, these empirical innovations respond to, and support, high level conceptual refinements which have weighty implications for practical policy.

The analysis delivers a range of advances over previous attempts to generate an indicator of accessibility, including:

(a) Use of the latest and most detailed spatial data and GIS modelling techniques, within an easily replicable procedure, allowing exploration of changes through time, the behaviour of different services, boundary effects and so on.
(b) The switch of 'destination' from proxies for centres of economic activity, such as GDP or city population size, to the location of specific service delivery points.
(c) Micro (grid-square) definition of the estimation of the accessibility index.
(d) 'Disaggregated' analysis of access to multiple service types, followed by combination as a second stage.
(e) Standardisation of travel times according to the regional average, allowing 'relative' accessibility to be 'baselined' within the various macro-regional contexts across Europe.
(f) The methodology not only monitors past developments and illustrates present spatial structures but facilitates the identification of areas at risk that may run into service provision problems in the near future. In this sense, the methodology can be used as a proactive diagnostic support tool by regional policy-makers.
(g) The impact of border closures due to COVID-19 presented here demonstrate how this diagnostic tool can also be used to analyse impacts on the local service provision of different policies or development scenarios.

As mentioned in the introduction, the significance of the challenge of developing an objective indicator of relative access to services of general interest lies in the broader context of the recent evolution of the European rural development discourse, its overarching goals and the implications for intervention logics. This paradigm shift away from the neo-liberal focus of the EU's Lisbon Agenda of 2000 and towards what has been termed the 'post-Lisbon' approach [1], accommodating well-being and sustainability goals, has not been pioneered by a single strand of policy or academic school of thought, but has taken place in a distributed way in different disciplines and in various policy environments. For example, awareness of the constraints on demographic change implied by long-term trends in fertility and mortality together with the questions increasingly raised about the primacy of economic growth as the ultimate goal for all places and times [64–66] have both contributed to a widespread down-playing of (market-driven) expansionist narratives for rural policy. Even allowing for the opportunities for new economic activities exploiting territorial assets in pursuit of the Green Transition, there has been increasing acceptance that ameliorating disparities between urban and rural areas, and between different kinds of rural places, can best be assessed on the basis of more holistic and 'direct'—though qualitative/subjective—metrics of well-being, rather than more measurable—but 'instrumental'—conventional economic indicators, such as GDP, entrepreneurship or employment rates.

Nevertheless, the pragmatic requirement for objectivity in both allocation of policy resources and monitoring/evaluation of outcomes and impacts is a strong justification for a new generation of indicators which reflect well-being goals, of which the mapping of relative accessibility to SGIs presented in this paper is an example. Of course, as we have noted above, there is scope for 'fine tuning' of the methodology, improvements in data quality and standardisation and a need for careful scrutiny within a range of geographic and welfare regime contexts. Nevertheless, the analysis reported here illustrates both basic principles and practical solutions, for example in accommodating relativity, which deserve to be further explored and refined, with the goal of refurbishing the 'toolbox' to better serve the needs of 'post-Lisbon' evidence-based rural policy.

Author Contributions: Conceptualisation, M.O.-R. and A.C.; methodology, C.S.; software, C.S.; formal analysis, M.O.-R. and C.S.; data curation, C.S.; writing—original draft preparation, M.O.-R., C.S. and A.C.; writing—review and editing, M.O.-R., C.S., A.C. and A.F.M.; visualisation, C.S.; project administration, A.F.M.; funding acquisition, M.O.-R. and A.F.M. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: All quantitative study outputs can be accessed free of charge from the ESPON Database Portal in the form of geodata (Shapefiles) and statistical data (Excel files) accessible at https://database.espon.eu/ (accessed on 10 March 2023). The portal also provides comprehensive metadata descriptions of all datasets. In the search field select "project package" and then 'PROFECY—Inner Peripheries' or use this direct download link https://database.espon.eu/project-data-package/985/ (accessed on 10 March 2023). Furthermore, study reports can also be downloaded from the ESPON website for PROFECY (https://archive.espon.eu/inner-peripheries, accessed on 10 March 2023) and PROFECY —Data and maps update project (https://archive.espon.eu/projects/espon-2020/monitoring-and-tools/profecy-data-and-maps-update, accessed on 10 March 2023).

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Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Appendix A. Maps Series

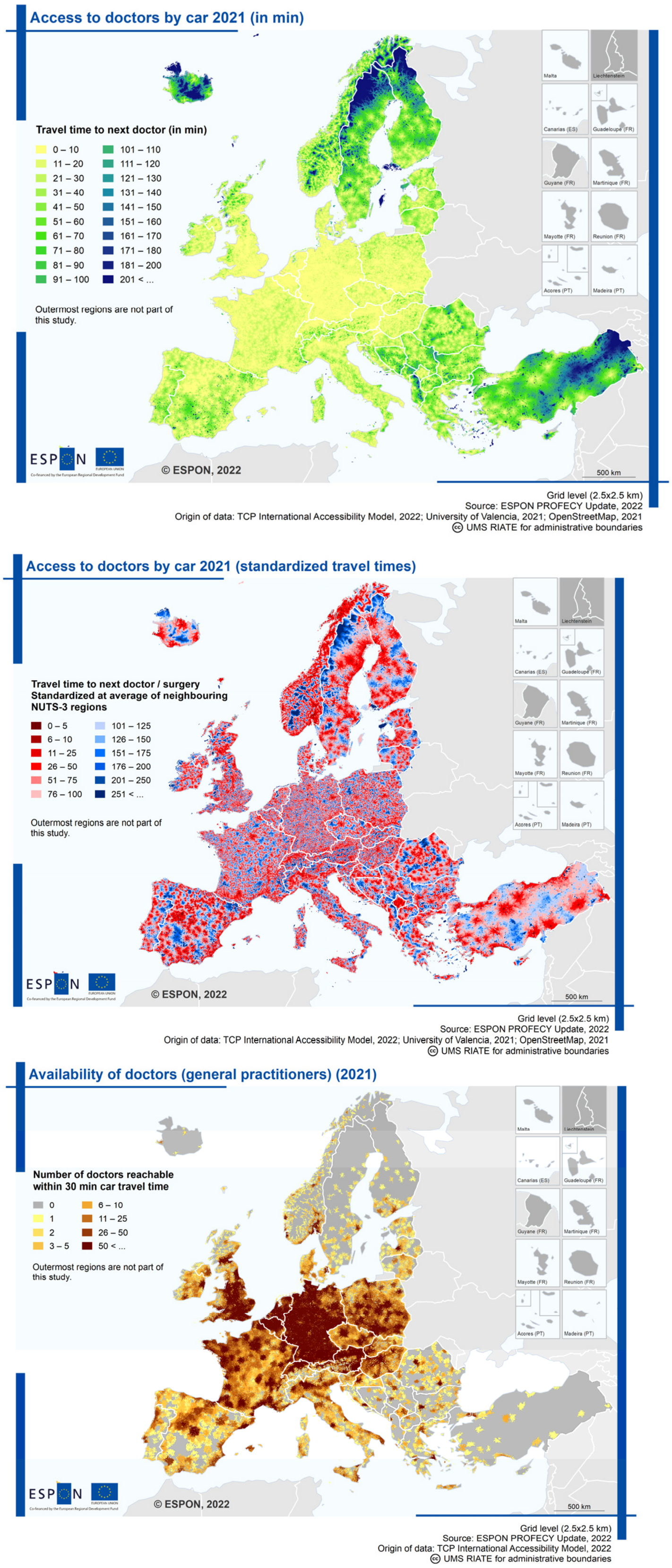

Figure A1. Access to doctors: car travel times (**top**), standardised car travel times (**middle**), number of doctors reachable within 30 min car travel time (**bottom**).

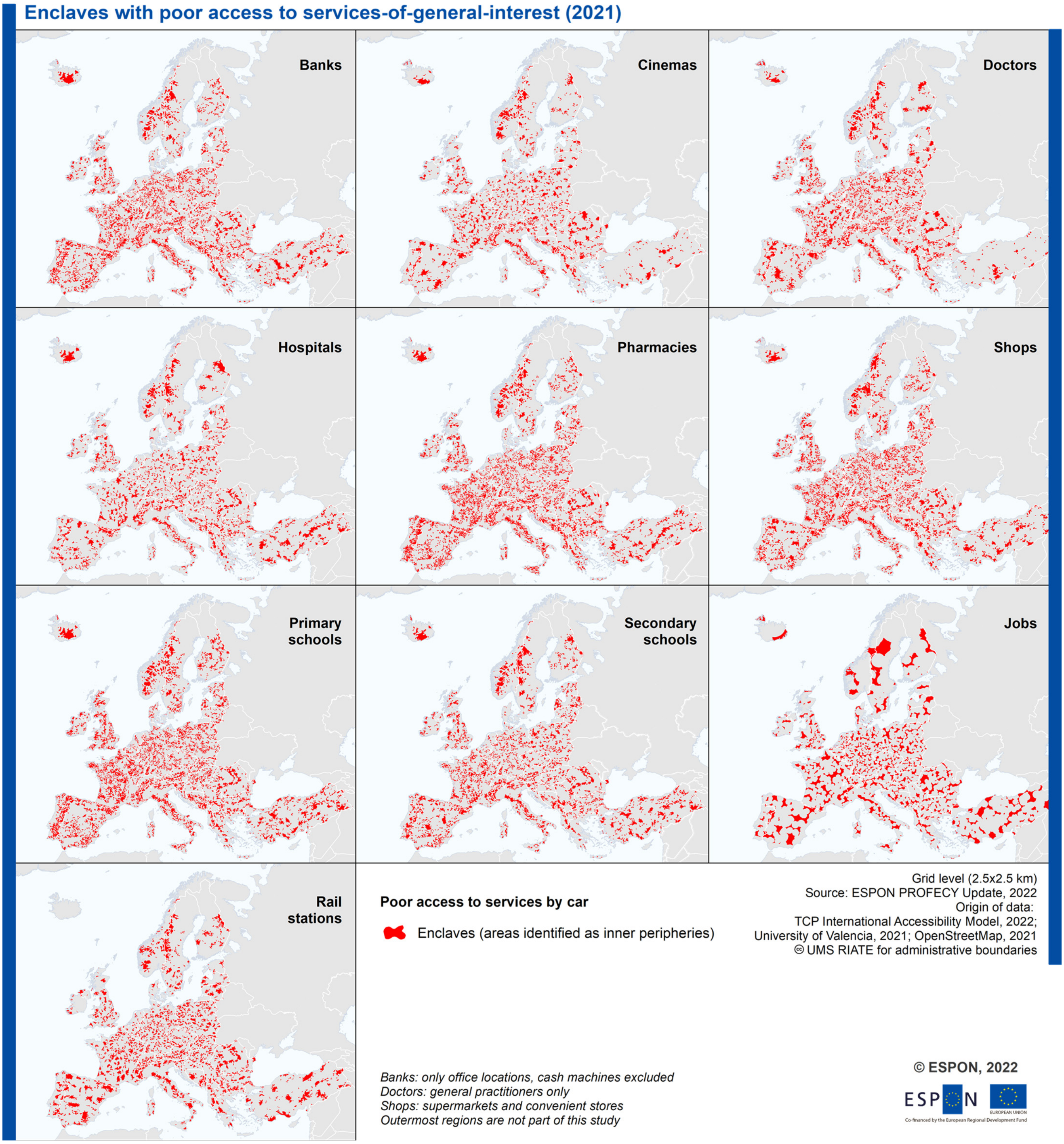

Figure A2. Inner peripheralities for ten different service types (from **top left** to **bottom right**): banks, cinemas, doctors, hospitals, pharmacies, shops, primary schools, secondary schools, stations, jobs.

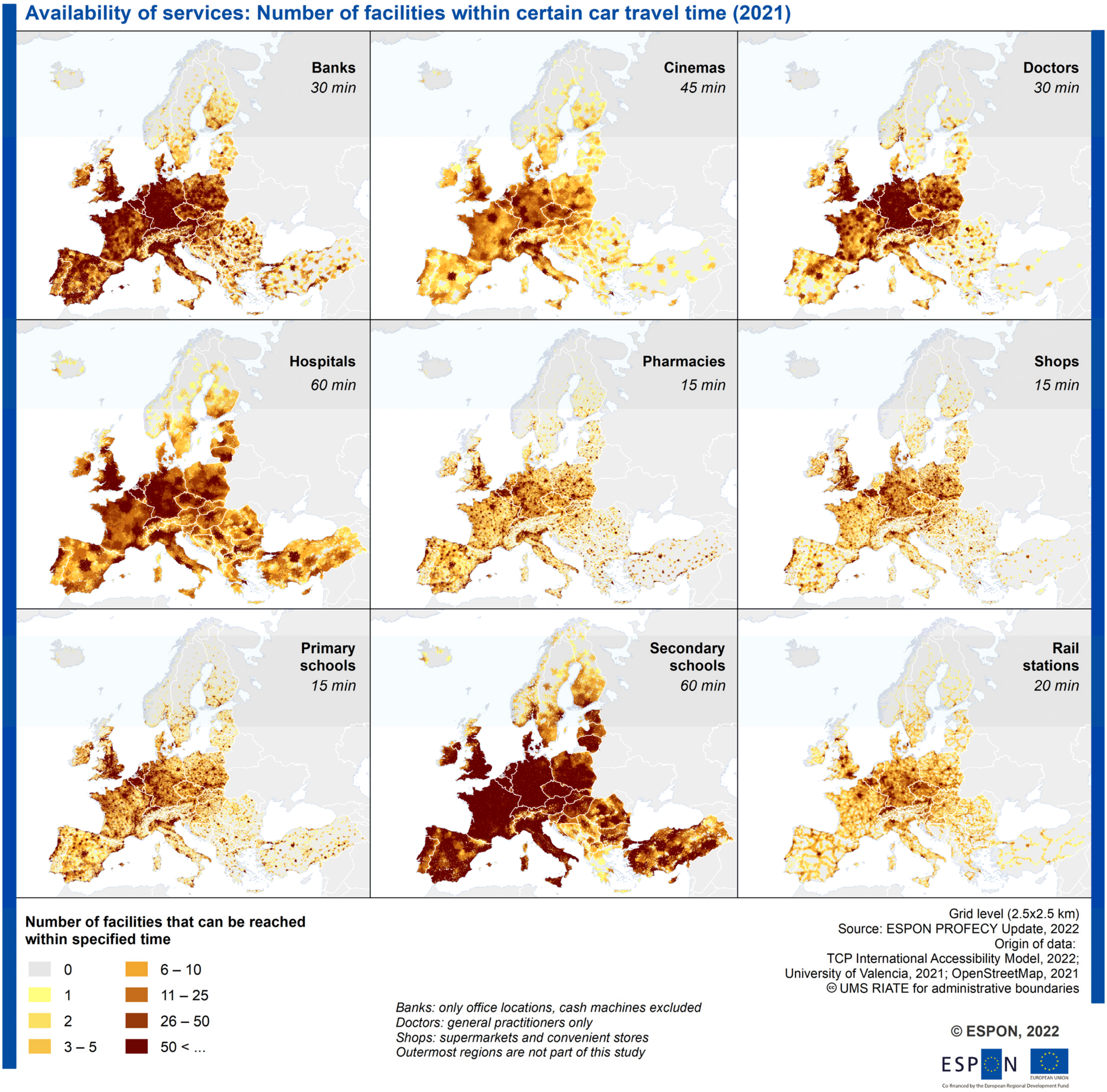

Figure A3. Number of facilities within reach by service types (from **top left** to **bottom right**): banks (30 min), cinemas (45 min), doctors (30 min), hospitals (60 min), pharmacies (15 min), shops (15 min), primary schools (15 min), secondary schools (60 min), stations (20 min).

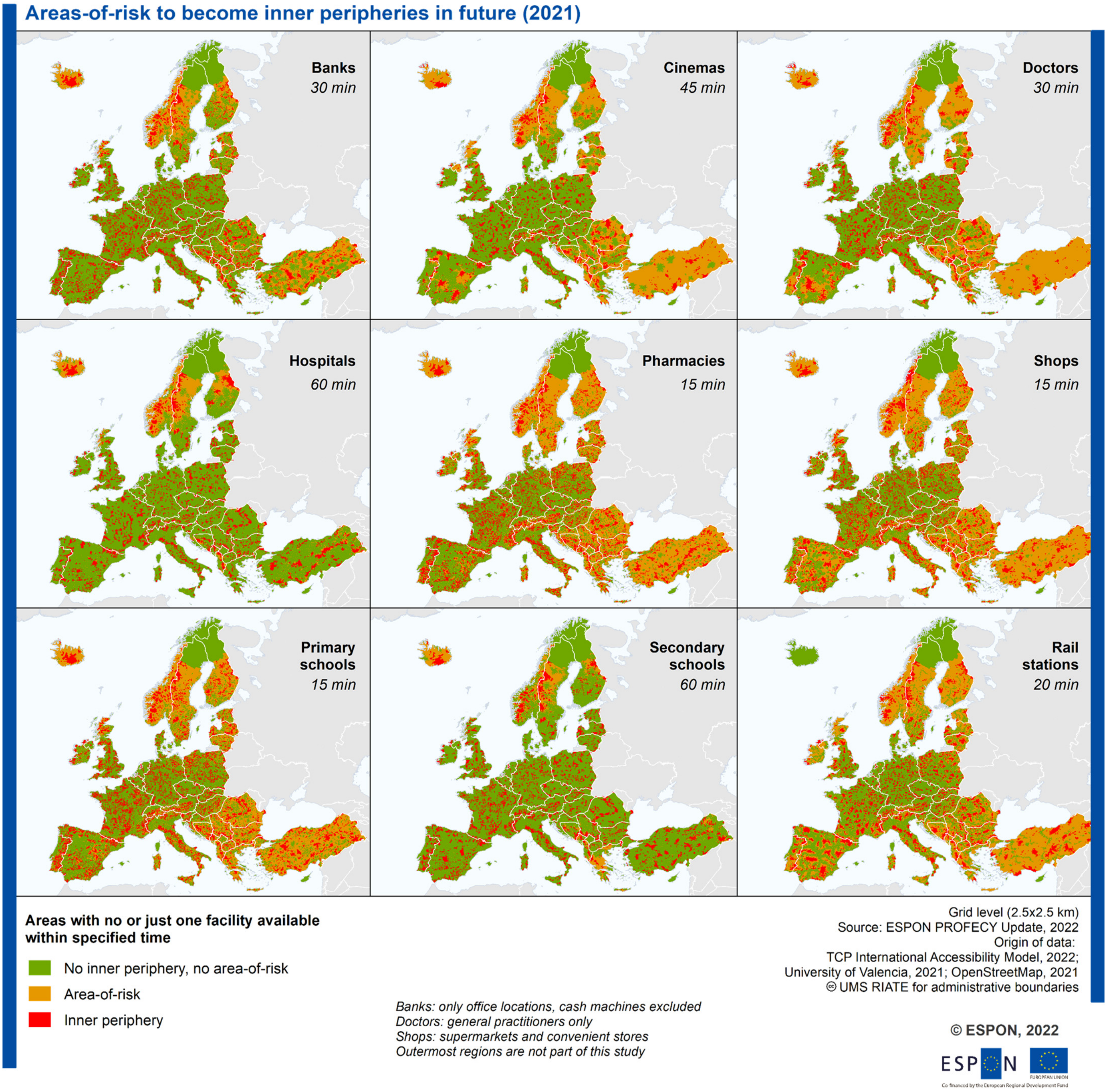

Figure A4. Areas of risk to become IPs in the future for individual services (from **top left** to **bottom right**): banks, cinemas, doctors, hospitals, pharmacies, shops, primary schools, secondary schools, stations.

Appendix B. Statistics on Inner Peripheries by Type of Service and Country

Table A1. IP statistics (grid level).

Service Type	Results 2017			Results 2021			Change 2017–2021 (%)		
	Number of IP Patches	Total IP Area (km^2)	Average Patch Size (km^2)	Number of IP Patches	Total IP Area (km^2)	Average Patch Size (km^2)	Numbers	Total Area (km^2)	Average Size
Banks	1231	714,488	580	1501	970,522	647	21.9	35.8	11.6
Cinemas	810	593,228	730	1050	710,703	677	29.6	19.8	−7.3
Doctors	774	434,169	600	1104	837,094	758	42.6	92.8	26.3
Hospitals	1102	635,559	695	1165	813,109	698	5.7	27.9	0.4
Pharmacies	1069	641,566	600	1484	1,027,100	692	38.8	60.1	15.3
Shops	1423	786,291	550	1433	985,863	688	0.7	25.4	25.1
Primary schools	1309	784,578	600	1537	1,102,472	717	17.4	40.6	19.5
Secondary schools	1046	680,009	650	1352	918,484	679	29.3	35.1	4.5
Stations	974	741,613	760	1135	917,459	808	16.5	23.7	6.3
Jobs	465	969,403	2085	441	1,031,316	2339	−5.2	6.4	12.2

Table A2. Share of inner peripheries on total country area.

Country	Share of IPs on Country Area (%)			Country (Cont.)	Share of IPs on Country Area (%)		
	2017	2021	Change		2017	2021	Change
Andorra	94.3	57.1	−37.1	Kosovo	26.6	19.0	−7.5
Albania	50.2	45.6	−4.6	Lithuania	13.2	21.4	8.2
Austria	49.8	38.3	−11.5	Luxembourg	83.0	15.4	−67.6
Bosnia-Herzegovina	35.8	39.2	3.4	Latvia	38.8	37.5	−1.2
Belgium	35.3	35.2	0.0	Montenegro	49.8	45.1	−4.7
Bulgaria	35.8	36.0	0.2	Makedonia	30.6	28.5	−2.1
Croatia	16.6	16.6	0.0	Netherlands	35.9	23.9	−12.0
Czech Republic	36.2	26.9	−9.4	Norway	14.5	12.8	−1.7
Denmark	11.6	16.9	5.3	Poland	38.4	33.8	−4.6
Estonia	19.5	24.1	4.6	Portugal	27.2	39.4	12.2
Germany	39.0	34.3	−4.6	Romania	29.1	24.2	−4.9
Greece	17.8	17.7	−0.1	Serbia	37.6	35.2	−2.4
Finland	10.9	11.3	0.4	Slovakia	55.0	41.5	−13.5
France	35.4	27.5	−7.9	Slovenia	48.5	49.6	1.1
Hungary	34.6	31.2	−3.4	Spain	35.2	25.1	−10.1
Ireland	29.3	28.2	−1.1	Sweden	16.1	15.3	−0.7
Iceland	25.4	21.0	−4.4	Switzerland	54.0	46.0	−8.0
Italy	37.3	35.5	−1.8	Turkey	19.8	17.2	−2.6

Notes

1. We use the term “Services of General Interest” (SGIs) with the aim to emphasise the specific nature and importance of services that are considered essential for the well-being of citizens and the functioning of society, such as healthcare, education, commercial and financial services. The use of this term is in line with the European Union’s framework for SGIs, which recognises their importance for social cohesion and economic development.

2 One can only speculate about the reasons for this. However, one point that should not be underestimated is that the transport and economic models that are used often only work at the regional level (e.g., NUTS 3 regions) for reasons of data availability, so that they, by design, are unable to depict effects within a NUTS 3 region, which, however, would be required to assess impacts on rural areas. With the method proposed in this paper, we also want to contribute to overcoming this weakness of the traditional approaches.

3 Moreover, these impacts affect different population groups such as elderly people, youth, vulnerable, disabled, etc., quite differently.

4 Results for the other three delineations are presented in full detail in [55].

5 Technically, this results in varying averages throughout Europe. However, these variations reflect people´s perspectives on daily life. For example, residents in rural parts of Germany do not compare their levels of SGI accessibility with rural regions in Scandinavia, but rather with neighbouring, more accessible areas of Germany. Therefore, even if in absolute terms they enjoy much better access to services than residents in the North of Sweden, in relative terms, they may consider themselves similarly disadvantaged.

6 In [59], various thresholds were tested, and in the end 150 was considered realistic.

7 Since a European-wide database on jobs and their workplaces is not available, settlement areas were used as a proxy, assuming that jobs are located within settlements.

8 Services that are delivered to the doors of the consumers such as waste collection, energy supply, internet, etc., have not been addressed in this study. Different national regulations regarding service provision (for example, access to health care or schools) are acknowledged, but their impacts on the study outcomes are minimised by the standardisation at the average of neighbouring regions in Step 3.

9 The map series in Figure A1 illustrates results of Steps 2 (car travel time), 3 (standardised car travel time) and 7 (number of facilities within reach) of the delineation process. Similar maps have been produced for all ten service types, presented in [54].

10 The main purpose of Figure 3 is not to compare countries, but to compare over time. It should be noted that the results of the small countries (e.g., Luxembourg, Andorra) are to a large extent dependent on the developments in the surrounding larger countries. If facilities are closed or opened there, this directly impacts the small country.

11 Different travel time thresholds were applied for the different services, but these were then applied uniformly for all countries to ensure comparability, knowing that different travel times are still considered acceptable in the countries for individual public services. The choice of travel time thresholds is described in detail in [55,59]. Shorter travel times were applied for services of daily need, longer travel times for less frequently visited services.

12 For some public services (such as schools, administration, etc.), services are provided at one discrete point and people may not have a choice between two or more service points. However, even if people do not have a choice, the analysis of areas-of-risk is meaningful in this case because, from the perspective of the residents, the travel time thresholds represent a measure of acceptable 'easiness' to reach the service points. The travel time threshold then represents the travel time beyond which residents are no longer willing to travel to visit a facility or beyond the point at which they feel disadvantaged because they do not feel cared for.

13 The detailed analysis results allow us to identify the reasons for the downgrades of a particular area, for instance, to identify the service(s) that closed. It is however not possible to present these details in this paper.

14 The indicator 'number of facilities within a certain car travel time' was calculated two times for banks and shops. In the first run, the model allows reaching facilities beyond a national border, and in the second run, the model does not allow for reaching facilities abroad, representing a situation with closed borders. The difference in the number of reachable facilities can be considered as the impact of a border closure on the SGI provision in border regions. This analysis is performed at the grid level. For shops, a 15-min, and for banks, a 30-min, travel time threshold was applied.

15 Such as kindergartens, administrations, emergency care, dentists, police, fire departments, other types of shops, retirement homes, maternity clinics, restaurants/snack bars, museums, fuel stations/charging stations, etc.

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