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The Rise of Megaregions: Delineating a new scale of economic geography

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The Rise of Megaregions:

Delineating a new scale of economic geography



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ABSTRACT

The rise of megaregions: Delineating a new scale of economic geography

The concept of megaregions is increasingly put forward among academics and policy makers as a new scale of economic co-ordination and social organisation. A megaregion is most commonly understood as an economic unit that comprises an agglomeration of cities and its less dense hinterlands, which are linked through infrastructure, economic connections, settlement patterns and land use, topography, an environmental system or a shared culture and history that together shape a common interest for the wider region. While there is an extensive literature on the potential benefits of a megaregion, work has been more limited in terms of identifying megaregions in an international context. This paper introduces an approach to delineate potential megaregions in the OECD.

JEL classification: O18, R10, R12

Keywords: Megaregions, new economic geography, urban geography, mean-shift algorithm

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1. The rise of megaregions

Across the world, regions are facing a continuous transformation shaped by economic, technological and social developments that affect residents' activity and spatial patterns. Globalisation has increased the central role of urban areas in the competitiveness of regional and national economies due to their potential for reaping agglomeration economies. As such, urban areas have developed as economic hubs and attracted more and more people over the last century (OECD, 2015[1]). Continued growth of urban areas is resulting in cities becoming economically interdependent with their surrounding settlements. In addition, new technologies allow for increased mobility and linkages between cities creating the new geographic scale of megaregions.

Increasing connectivity between cities and regions not only provides new opportunities but may also confront local policy makers with challenges that affect their cities and neighbourhoods, which cannot be solved by action taken only at the city or metropolitan scale (Regional Plan Association, 2006[2]). Examples include the efficient provision of infrastructure and services, enabling economic development and creating inclusive and resilient regions, protecting public watersheds that span across multiple administrative boundaries, and moving goods from coastal ports through congested metropolitan areas to reach inland destinations. Addressing challenges at the appropriate geographic scale can increase the benefits associated with economies of scale. Not only do economies of scale relate to the most common advantages resulting from shared transport infrastructure, co-ordinated land use planning or economic development strategies, but may also support local strategies in an increasing globalised world. For example, areas where smaller cities are the norm are facing increasing pressure to remain visible and competitive in a global market. Co-operation and pooling resources between neighbouring regions and cities is therefore an increasingly important factor for global success.

The concept of megaregions as new economic scale has therefore found its way into the academic literature and discussions among policy makers. As Ross puts it: "Increasingly, the most appropriate unit of social organisation and economic coordination is not the city, not even the metropolitan area; it is the city-region or the region-wide network of cities" (Ross, 2009, p. 1[3]). A megaregion can therefore be understood as an economic unit that comprises an agglomeration of cities and its less dense hinterlands, which are linked through infrastructure, economic connections, settlement patterns and land use, topography, an environmental system or a shared culture and history that together shape a common interest for the wider region (Regional Plan Association, 2006[2]). Recognising potential megaregions can enable co-operation across administrative boundaries in order to support economic competitiveness and address common challenges at the appropriate scale.

To understand the benefits that emerge from megaregions, the appropriate geographic scale needs to be identified. In practice, megaregions are often identified by a "bottom-up" approach, where local stakeholders see common ground to act with neighbouring cities and regions. This may work well for selected cases, but for analytical purposes there are only few proposed frameworks to identify megaregions across countries. In this paper, a procedure to delineate megaregions is proposed that borrows much from the concept of network theory, which allows to examine systems of cities based on their connections to one another. Potential megaregions are identified based on their location in space and their

distances to each other. This has the advantage, that the identification of potential megaregions can be applied without heavy data requirements.

The remainder of this paper will start with a literature review of megaregion, followed by an overview of methods that are currently applied to identify megaregions. Section 3.1 proposes an analytical framework to delineate megaregions across OECD based on network analysis methods. Section 4 concludes by outlining future research possibilities.

2. What are megaregions?

2.1. Literature overview

The term megaregion is commonly used to describe areas with two or more interrelated urban systems. In its simplest form, cities are blending into each other as a result of population growth. As such, the megaregion idea owes much to French geographer Gottmann's "Megalopolis" (1961[4]), in which he describes the growth of the interconnection between the urban agglomerations of Boston and Washington. He observed that within this corridor, a unique cluster of metropolitan areas was formed that bypassed traditional and political borders. In a more sophisticated form, megaregions are expected to also have external and internal functional linkages as determining attribute. For example, Burton (1963[5]) describes the concept of a network of cities under the term "dispersed city" which he defines as "a number of discrete or physically […] separate urban centres in close proximity to each other and functionally interrelated" (Burton, 1963, p. 286[5]). Despite the similarities, the megaregion terminology is used differently depending on the actors and their contexts and the goals followed (Harrison and Hoyler, 2015[6]). In the following, an overview of the literature relating to megaregions and their definition is provided.

The topic of megaregions in a wider context gained momentum in the 1990-2000s. In the US, the concept of the city-region or megaregion was introduced, whereas the concept of city networks and polycentric urban regions gained momentum in the work relating to Europe. Regardless of the geographic scope, most work in this period focuses on the establishment of these concepts in the academic and policy debate, as well as defining their characteristics and on research agenda-setting (see for instance Batten (1995[7]); Camagni and Salone (1993[8]); Dieleman and Faludi (1998[9]) and Kloosterman and Musterd (2001[10])). While Scott (2002[11]) follows the concept introduced by Gottmann and uses the term "city-regions" as spatially overlapping or convergent urban areas with surrounding hinterland for the United States, a broader definition taking into account geographic and economic connectedness has been coined under the term "megaregion" within the America 2050 project. Within this concept – which is the foundation for most research on megaregions – megaregions are defined as areas that comprise multiple, adjacent metropolitan areas that are connected by commuting patterns, business travel, environmental landscapes and watersheds, linked economies, and social networks (Regional Plan Association, 2006[2]). Build on that definition, Florida et al. (2008[12]) define megaregions as an "integrated set of cities and their surrounding suburban hinterland across which labour and capital can be reallocated at very low cost" (Florida, Gulden and C, 2008,

p. 459[12]). They further note that megaregions are not "just a bigger version of a city or a metropolitan region […] It is a polycentric agglomeration of cities and their lower density hinterlands. Similarly, Ross defines megaregions as "networks of metropolitan centres and their surrounding areas […] spatially and functionally linked through environmental, economic, and infrastructure interactions" (Ross, 2009, p. 1[3]).

Focusing on European regions, the relevance of city networks has been analysed in terms of their relevance to economic growth and sustainability. Hall and Pain (2006[13]) defined a mega-city region based on contiguity criteria of functional urban areas in Europe as main building blocks. They identify eight mega-city regions using this approach that not only differ with respect to the number of cities they comprise (from 10 to 50 cities) but also to total population size, which ranges from about 19 million (South East England) to less than 2 million (Grater Dublin) in 2000. One of the identified mega-city regions is the Randstad in Netherlands on which much research on European city networks is focused on. Thus area consists of four metropolitan areas: Amsterdam, Utrecht, Rotterdam and The Hague, which are all located in close proximity to each other. Camagni and Salone (1993[8]) for example, refer to the Randstad as an example of a complementary network made up of specialised and complementary centres. Since then, the Randstad has been studied with respect to functional integration, governance arrangements and agglomeration benefits (Meijers, 2005[14]; Priemus, 1994[15]; van Oort, Burger and Raspe, 2010[16]).

In a worldwide context, the term megaregion is often used to reflect large areas – both in terms of population size and area. UN-Habitat (2014[17]) identifies megaregions as one of three types of new urban configurations, along with urban corridors and city-regions, and characterize them as "several cities integrated with each other within the orbit of the overall region, surpassing mega- or meta-cities in terms of population, economic output and that further combine large markets, skilled labour and innovation" (UN-Habitat, 2014, p. 36[17]). Examples are China's Pearl River Delta (around 120 million people), Japan's Tokyo-Nagoya-Osaka Kyoto-Kobe megaregion (about 60 million people). These regions are thus significantly larger than the ones analysed in the North American or European context.

The various concepts of megaregions or city networks have in common that they refer to an integrated system of cities and their surrounding suburban hinterland. A comprehensive overview of megaregion definitions is provided in Harrison and Hoyler (2015, pp. 9-10[6]), highlighting not only the geographic areas covered in the literature, but also the significant differences regarding population size that is considered to form a megaregion reflecting the different types of city present in different parts of the world. For example, out of the 79 cities worldwide with more than five million inhabitants, only four are located in Europe with about 16% of city residents live in them. In contrast, about 30% of city residents in Asia and 28% of city residents in North America live in such large cities (European Union; UN-Habitat, 2016[18]). A megaregion that includes at least two cities is therefore likely to be larger in areas where cities have on average larger population numbers. Throughout this paper:

A megaregion is defined as an integrated system of cities[1] and their surrounding region, which one can visit within a day using ground transport.

[1] Throughout the paper "city" will be used synonymously with "Functional Urban Area", referring to the OECD definition of functional urban areas (OECD, 2012[43]).

2.2. What are the benefits of megaregions?

The benefits emerging from megaregions are not systematically analysed, but evidence from urban agglomerations suggest potential for economies of scale. The most common advantages of scale come from sharing transport infrastructure for people and goods, enabling robust housing markets and supporting the development of offices, science and technology parks (Sassen, 2010[19]). Moreover, finding from urban agglomerations can provide indicative for the potential of megaregions. Thus, a universal pattern across countries and regions indicate a positive correlation of city size and productivity levels. Urban agglomerations tend to outperform less densely populated areas due to economics of scale, networking benefits, and a larger and more skilled workforce (Puga, 2010[20]; Rosenthal and Strange, 2004[21]). For a series of OECD countries, this relationship has been confirmed by Ahrend et al. (2017[22]), who find that productivity increases with city size, even when controlling for possible sorting of higher-skilled individuals into cities. However, as cities grow, benefits in terms of higher productivity may be offset by higher house prices, congestion, pollution, or higher crime rates (OECD, 2014[23]). Within a megaregion that reflects a network of cities, a higher connectivity between the urban areas could mimic agglomeration economies reaping the benefits without accruing the costs – which are often argued to be highly localised. Especially for small and medium sized cities that face limitations in their agglomeration power, connectivity seems to be more relevant for productivity than size (Dijkstra, Garcilazo and McCann, 2012[24]; McCann and Acs, 2011[25]). Thus, two smaller or medium sized cities may be able to significantly increase their market size through better infrastructure, while providing the benefit to its population of living in a smaller sized environment.

Smaller megaregions may benefit from the potential to borrow agglomeration, whereas megaregions that are sufficiently large and diverse may support the existence of multiple agglomeration economies. As such, Sassen (2010[19]) argues that megaregions can provide benefits beyond the ones from urbanisation, when they enable complex interactions of divers economic components. Given their scale, megaregions have the potential to host a broad range of types of agglomeration economies that may complement each other. But even within smaller megaregions, a high connectivity may enable cities to borrow agglomeration from their neighbours and thus reducing the relevance of own population size. The concept of borrowed size is often attributed to Alonso (1973[26]), who highlighted that smaller cities can sustain urban functions that would typically require larger cities and markets if they are located close enough to larger cities. Alonso used this concept to explain why smaller cities that are part of the megalopolitan urban complex on the Atlantic seaboard had much higher incomes than independent cities of similar size. A similar pattern was found within the Randstad by OECD (2016[27]), where smaller functional urban areas located between larger metropolitan areas benefited from this proximity in terms of higher wages. The closer a region is located to a city the easier it is for its businesses to access these functions and the easier for residents and businesses in the region to borrow agglomeration economies from the city. For Europe, Camagni, Capello and Caragliu (2016[28]), for example, find that proximity to high-level urban functions in other cities is positively associated with productivity. For the United States, Meijers (2013[29]) finds a borrowed size effect for cities located nearby other relatively similar sized cities of 11% and therefore outperforming monocentric, single cities when controlling for the size of urban population, urban density, human capital and the structure of the metropolitan economy. Across the OECD, Ahrend and Schumann (2014[30]) find that *i)* regions benefit from proximity to urban centres and that *ii)* economic growth is negatively correlated with

travel time. Thus, as travel time increases, the effect of proximity on regional economic performance decreases.

Infrastructure is a necessary requirement for creating and strengthening social and economic ties between people across places. While the era of digitalisation increasingly allows for accessing services and knowledge without the need for actual mobility, physical transport infrastructure channelling goods and labour is still an important factor for supporting linkages and facilitate functional integration between regions. Policy discussions in a megaregional context therefore often focus on developing new or upgrading existing infrastructure to achieve sustainable goals that are environmentally and socially beneficial. For example, high-speed trains are often discussed as potential solution to overcome the greater distances within a megaregion while limiting the environmental impact that accompanies greater integration through shifting transport from air or road to rail (see e.g. (Ross, Woo and Wang, 2016[31]; Regional Plan Association, 2006[2])).

Apart from environmental benefits, especially smaller networks of cities aim to increase their joint competitiveness through higher accessibility between their economic centres. Not only does better infrastructure connection facilitate co-operation and pooling resources between neighbouring regions and cities, it can also increase international visibility and strengthen competitiveness at a global scale. The impacts of large scale infrastructure are however uncertain and benefits are not necessarily distributed equally across cities within the region. For example, in Japan, the city of Nagoya began to lose its role as "intermediary capital" between Tokyo and Osaka after the introduction of the Tokaido Shinkansen in 1965 and re-invented itself as high-value manufacturing location (Box 2.1 and (OECD, 2016[32])). The introduction of high-speed rail in France between Paris and the country's second city Lyon led to a shift of about one-third of passengers from air to rail and an increase of about 30% in the average annual number of journeys per passenger and the Lyon region was able to extend its markets. In Germany, the intermediate stops along the high-speed connection between Frankfurt and Cologne benefited substantially in terms of economic activity, and more importantly as potential places to live, offering new commuting possibilities towards the main centres (Ahlfeldt and Feddersen, 2015[33]). These experiences indicate that cities that have a greater accessibility to new high speed rail stations along the line are likely to benefit more. To ensure that the benefits of the investment are distributed into the greater area, a well-developed "feeder" network – the local rail network connecting to the high speed rail – is an important factor for the local development of regions surrounding the main cities.

Box 2.1. Spatial impact of high-speed trains

Japan

After the Tokaido Shinkansen came into service, traffic growth exceeded all forecasts, rising from 10.7 billion passenger-kilometres in 1965 to almost 46.1 billion in 2008; passenger traffic density27 rose fivefold. It did result in some reallocation of roles among the cities it connected. Prior to the introduction of the Tokaido, Nagoya played the role of an "intermediary capital" between Tokyo and Osaka (ECMT, 1991[34]). Advanced service activities were located there. After the Tokaido came into service, it seems that Nagoya began to lose this role. The number of jobs in such activities fell in Nagoya, while rising in Tokyo and even more so in Osaka. Nagoya did not decline, however; rather, it became more specialised in high-value manufacturing.

France

The introduction of high-speed rail (train à grande vitesse, TGV) in France between Paris and the country's second city Lyon (a distance of about 464 km) led to a steep increase in the number of passengers in both directions. This reflected two trends: i) a shift of about one-third of passengers from air to rail; and ii) an increase of about 30% in the average annual number of journeys per passenger. The Lyon region, far from being absorbed by the Paris region as some had feared, actually extended its markets. Some firms from the Lyon area had advantages over their Parisian competitors that they had previously been unable to exploit (because at that time, it took too long to get there; transport costs were too high, etc.). Chen and Hall (2012[37]) examine the effect of increased connectivity in the form of reduced travel time, and the degree to which it facilitates economic restructuring in de-industrialising regions in a comparison of Nord-Pas-de-Calais (France) and Lancashire (United Kingdom). They find that the roll-out of high-speed rail in France has a more pronounced and broader regional impact than the mere upgrading of existing infrastructure, such as the one that occurred in the United Kingdom, but that the benefits still tend to accrue to the larger and economically more dominant region (in this case, Paris).

Germany

Ahlfeldt and Feddersen (2015[33]) examine the impact of the construction of a high speed rail link between Frankfurt and Cologne that was inaugurated in 2002. They argue that the location of intermediate stations was effectively exogenous to local economies. This assumption allows them to identify the impact of rail connection on different places, as well as the agglomeration effect in surrounding areas and the spread of those effects in space. They find that the intermediate stops benefited substantially from high-speed rail in terms of economic activity, but that they benefited far more as potential places to live, offering new commuting possibilities towards the main centres. These benefits were highly localised and were found to decrease rapidly with distance from the stations. This suggests that a high-speed rail link between Oslo and Malmö or Copenhagen might have a similar effect, leading to greater concentration of economic activity along the line, and especially in the three metropolitan areas, while intermediate places and those located near the line but lacking stops might miss out on potential benefits.

Spain

The high-speed rail between Barcelona and Madrid was opened in 2008, covering a distance of about 620km. It reduced the travel time between the two cities from 5.5 to 2.5 hours. Since the introduction of the high-speed rail, passenger numbers increased due to a shift from air to train. In 2008, about 12% travelled by train, whereas the number increased to 63% in 2016. The high-speed rail link has been successful with respect to connecting both cities. In the case of Catalonia, it has also been a valuable networking tool for the large cities and supported the development of some medium-sized cities and the creation of new economic opportunities.

United Kingdom - France (Eurostar)

The Eurostar connecting London to Paris provides a salient case study of potential impacts at various geographic scales. Although the service began in 1994, the project did not reach its full potential until 2007, when the high speed rail was fully extended to London. The benefits of high-speed rail to the English County of Kent – a region along this corridor that feared the potential loss of employment in competing port and ferry services - are, to date, ambiguous. The construction of intermediate stations (especially Ebbsfleet) connected to the local rail network led to important investment in housing and commercial property, but these investments remain limited in scope and scale. Looking at the period when the Eurostar's high speed rail stopped at the tunnel and continued on conventional lines to London Waterloo, Hay, Meredith and Vickerman (2004[36]) found only limited impact on Kent and little potential for further development. This is consistent with other research suggesting that a region's economic potential prior to large infrastructure investment is a critical determinant of the investment's impact. For example, Kveiborg's (2013[34]) comparative case study of Eurostar and the proposed Fehmarn Belt fixed link emphasises that the impact on the intermediate regions is likely to be limited and will accrue only over the long-term, except where those intermediate regions have latent potential that could be exploited through increased connectivity. The main exceptions are places where intermediate stops are located. In the case of the Eurostar, Lille and Ashford (before the re-routing of Eurostar via Ebbsfleet) enjoyed better economic performance than their respective regions in the first decade of Eurostar's operation.

Source: ECMT (1991[35]), Transport and Spatial Distribution of Activities: Report of the Eighty-Fifth Round Table on Transport Economics Held in Paris on 5-6 April 1990, ECMT Round Tables, No. 85, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789282105320-en; Hay, A.,K. Meredith and R. Vickerman (2004[36]), "The Impact of the Channel Tunnel on Kent and Relationships with Nord-Pas de Calais", Centre for European Regional and Transport Economics, University of Kent, Canterbury; Chen, C. L. and P. Hall (2012[37]), "The Wider Spatial-Economic Impacts of High-Speed Trains: A Comparative Case study of Manchester and Lille Sub-regions, Journal of Transport Geography, Vol. 24, pp. 89 110; Kveiborg, O. (2013[34]), Economic Effects of Large-Scale Infrastructure Projects, BeltTrade, Copenhagen; Ahlfeldt, G. M. and A. Feddersen (2015[33]), "From periphery to core: Measuring Agglomeration Effects Using High-Speed Rail", SERC Discussion Paper, No. 172.

3. Approaches to delineate megaregions

The concept of megaregions is of growing interest in academic and political discussions; however there is only little research conducted on identifying and modelling potential or existing megaregions. In practice, bottom-up approaches of cities and regions seem to be an important driver for collaboration on a megaregional scale (see e.g. OECD (OECD, 2018[38])). Thus, common challenges that need to be addressed at a wider regional scale are recognised and efforts are made to find partners in the surrounding regions. However, not knowing the "true" extent of the megaregion may result in crucial areas being left out. Similarly, top-down approaches face the difficulty of identifying potential megaregions based on quantitative criteria. For example, national governments that want to support collaboration on a megaregional scale have to know which areas have the potential for integration and to foster economic growth. Modelling potential megaregions is therefore not only of interest from a research perspective, but can also provide vital input for the discussion among potential stakeholders.

In theory, megaregions can be delineated through a morphological, functional or network approach (Marull, Font and Boix, 2015[39]; Ross, 2009[3]): The *morphological* approach identifies megaregions based on continuous urban settlement areas that reach certain thresholds of density, dimension or degree of urbanisation. The underlying idea of this approach is that contiguous development results from a functioning as a megaregion. Thus, if multiple urban centres become integrated to the point where their labour markets and local supply chains overlap, the space between them tends to fill up with lower density development. The *functional* or *network* approach defines a megaregion as an area of interactions between actors that can go in multiple directions and on several interconnected multiple layers. Identifying complex structures requires information on flows between the different parts of the megaregion. Such information can help capture material or immaterial flows. Material flows are directly observable and can be measured such as commuting flows or commodity flows. Immaterial flows include observable ones, such as email and telephone exchange, as well as non-observable ones such as knowledge flows (Trullén, Boix and Galletto, 2013, p. 256[40]). In practice, variants of the morphological approach dominate as the functional or network approach is much harder to conduct, due to constraints in data availability at the local level and limited comparability across regions (see Box 3.1 for some examples).

Box 3.1. Examples for morphological and flow analysis in the megaregional context

Morphological approach

Delineating megaregions based on contiguous urban development is the most common approach undertaken so far as data tends to be more readily available. Population density, land use or satellite night light data allows identifying contiguous urban build up that can then be used to delineate megaregions. Back in the 1960s, Jean Gottman (1961[4]) noticed the growing interconnection of built up area between Boston and Washington. Gottman defined this corridor as a megalopolis, i.e. an agglomeration of different activities, settlements and landscapes, reaching a much larger size than that which typically characterises urban agglomerations (Gottmann, 1961[4]).

Functional integration or network approach using commuting data

Flow data that is collected by national statistical institutes extends in most cases to commuting data. Analysing this type of data allows identifying people's daily activity patterns and economic connectivity based on travel to work information. Nelson and Rae (2016[41]) use commuting data from the American Community Survey to delineate megaregions in the United States. Data on journeys to work are available for about 4 million observations covering the flows between census tracts. In their study, the authors apply an algorithm that only considered the strength of connections between census tracts and ignores the physical locations. After eliminating extreme outliers, 50 megaregions were identified, a significantly higher number than identified by the Regional Plan Association. Delineating megaregions based on commuting flows may underestimate the true extent of a megaregion and are likely to be estimated as too narrow and rather reflecting the extent of metropolitan areas. Nelson and Rae (2016[41]) note, that discovering a perfect natural break within the pattern of commuter geography is especially difficult in contiguous areas and the allocation to one or the other megaregion may solely depend on the decision whether to use the area of commuting origin or destination.

While commuting data can provide interesting insights on the connectivity within and between cities and regions, results for delineating megaregion solely based on this type of data should be carefully interpreted: First, within a megaregion, distances may extend over several hundreds of kilometres, and therefore people might not commute this distance on a daily basis (and are therefore less likely to be captured in a survey). Similarly, administrative data recording place of residence and place of work might not be suitable to observe regular, but less frequent travels to work in other places (e.g. project based). Second, in order to observe commuting individuals, transport infrastructure has to be available in order to observe commute. Areas, where transport connections are not that well developed might therefore not be considered as a (potential) megaregion, even though cities and regions might be connected to each other with respect to common culture, environment, and economic linkages.

Economic connections and flows of capital

In order to assess the functional integration of the Randstad region in the Netherlands in 2005, Van Oort et al. (2010[16]) surveyed more than 20 000 selected firms with more than one employer based in the Randstad. Their empirical analysis of business relations focuses on the sources and destination of an individual firm's ten most important selling and purchasing relations. To avoid biased results, the authors only include firms in

manufacturing, wholesale and business services, as they are not bound to consumers for their location. The analysis of interrelationship between firms shows that the four main cities in the Randstad function as the centres of the urban network. Thus, companies located in these cities tend to have more relationships with other firms within the same municipality, but they are also involved in a larger number of connections with firms within the wider urban network. Despite a high degree of interconnectedness, the test for spatial integration based on a gravity model indicates that the Randstad region is not spatially and functionally integrated yet.

Combined approaches

Combining contiguity criteria jointly with measures of functional integration, Ross et al (2009[41]) identify 10 existing and emerging megaregions within the United States using a three step procedure taking into account: i) the core of metro-regions and their area of influence; ii) identification of functional regions and measurements of integration among regions based on commodity flows; and iii) delineating the boundaries based on proximity and contiguity criteria. Combining the morphological and functional approach can be expected to provide a more realistic snapshot of the megaregions, but still faces limitations to data availability and comparability when applying it in an international context.

Sources: Gottman (1961[4]), *Megalopolis: The Urbanized Northeastern Seaboard of the United States*, Twentieth Century Fund, http://dx.doi.org/10.2307/1952505; Nelson and Rae (2016[41]), "An Economic Geography of the United States: From Commutes to Megaregions", http://dx.doi.org/10.1371/journal.pone.0166083; Van Oort et al. (2010[16]), "On the Economic Foundation of the Urban Network Paradigm: Spatial Integration, Functional Integration and Economic Complementarities within the Dutch Randstad", *Urban Studies*, Vol. 47/4, pp. 725-748, http://dx.doi.org/10.1177/0042098009352362; Ross et al (2009[41]), *Megaregions: Delineating Existing and Emerging Megaregions*.

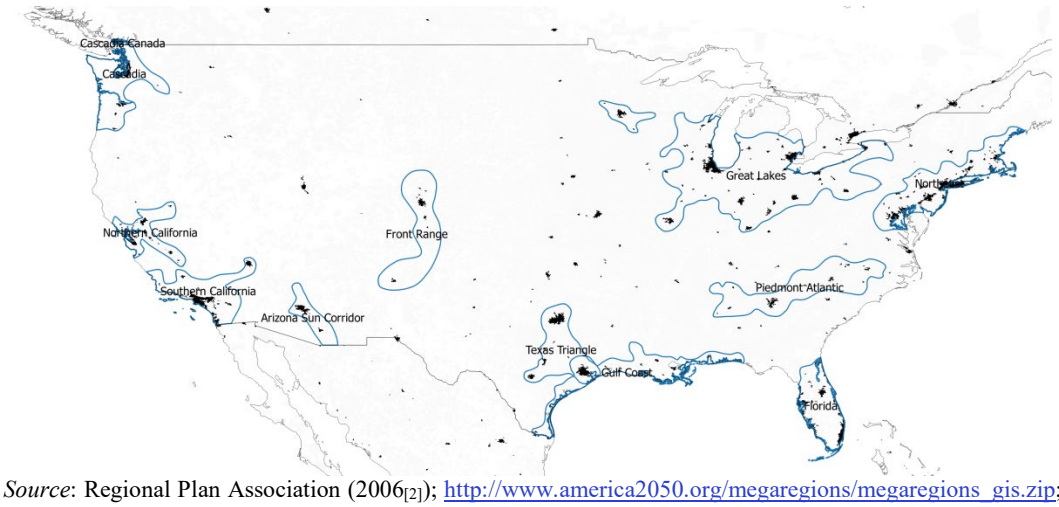
Empirical research on megaregions is grounded on the megaregions identified by the Regional Planning Association (Regional Plan Association, 2006[2]). Within the America 2050 project, researchers of the Regional Planning Administration applied quantitative criteria to delineate megaregions within the United States based on population and employment information, as well as connectivity measures. More precisely, a county scored a point for each of the following conditions met:

- It was part of a core based statistical area;
- Its population density exceeded 200 people per square mile in the 2000 census;
- The projected population growth rate was expected to be greater than 15 percent and total increased population was expected to exceed 1,000 people by 2025;
- The population density was expected to increase by 50 or more people per square mile between 2000 -2025; and
- The projected employment growth rate was expected to be greater than 15 percent and total growth in jobs was expected to exceed 20 000 by 2025.

After each county was assigned a score between 0 and 5, a qualitative 2-step procedure followed: First, based on their personal and professional knowledge the RPA staff

interpreted the agglomerations based on the county-scores as displayed on a map. In a second step, aerial photography and satellite imagery was used to refine the identified boundaries during the first step. Using the quantitative criteria, refined with the qualitative assessment based on local expertise, 11 emerging megaregions were identified (see Figure 3.1).

Figure 3.1. Emerging megaregions in the United States



Source: Regional Plan Association (2006[2]); http://www.america2050.org/megaregions/megaregions_gis.zip; Hagler (2009), Defining U.S. megaregions", America 2050: New York, NY..

Combining morphological and functional approaches to delineate megaregions are the exception. The availability of flow data tends to be limited, and of low comparability across countries. As such, identifying megaregions on an international scale relies on morphological approaches. Using satellite nightlight data, Florida et al. (2008[12]) are able to identify 40 megaregions across the world. The main strength of their approach is that this global data does not rely on administrative boundaries and megaregions are defined as contiguously lighted areas as seen from space. To derive the delineation of megaregions, the authors estimate economic activity based on night light activity, calibrated with economic activity in US megaregions as defined by the Regional Plan Association (2006[2]). Assuming that the intensity of light reflects similar GDP across the world, the authors use the derived thresholds and apply them to the rest of the world. In heavily industrialised areas of Northeastern America, Europe and Japan megaregions that tenuously connect to one another, conjoined regions are split at their narrowest connection. It should however be noted that relying on contiguous build up areas as only indicator for megaregions neglects integration of regions through well-established transport connections. This might be more important in regions that are characterised by polycentric settlement patterns, where cities can be functionally integrated through well-established transport connections, but separated by greenspace or low density development. Still, as measuring functional integration is a difficult and data intensive task, delineating megaregions based on contiguity criteria may serve as first step to identify potential areas of interest.

3.1. Towards modelling megaregions within the OECD

Existing methods to delineate megaregions have the limitation of not being applicable on an international scale or are very data intensive. For policy makers to identify relevant partners for the formation of a potential megaregion, information based on spatial proximity could be utilised to identify potential market access proxied through population size within a given area. This section proposes a methodology drawing from Network Theory to identify potential megaregions that is easily applicable relying on information on location in space and population size. Not only may this inform policy makers about potential partners to engage with to increase market access, but also provides a simple analytical framework for future research on megaregions.

Measures that are common in Network Theory, extended by the geographic dimension are increasingly finding their way into the academic literature (see e.g. (Barthélemy, 2011[42]). Generally speaking, Network Theory provides a framework to analyse systems in which nodes are connected to one another in some way via edges. In the context of this paper, nodes refer to cities and edges to physical infrastructure connecting these cities (e.g. roads). Using this approach to analysing potential and existing relations has the main advantage that only a limited set of information is needed. Megaregions are therefore characterised by the location of cities in space and are related to each other based on infrastructure links and distances.

The identification of megaregions is conducted in a two-step procedure using a sample of 1 251 OECD functional urban areas across for 31 countries (OECD, 2012[43]). First, functional urban areas – that based on their definition are already reflecting some integration of the urban cores and their commuting zone – are grouped into potential megaregions based on the shortest distances (as the crow flies) between them. Functional urban areas that are within a search radius of 300km were selected to be part of a joint potential megaregion. This threshold was selected as reasonable to reflect that travelling back and forth between those two places is hypothetically possible within a day. As the resulting megaregions disregard topology or existing transport connections between them, they reflect the "best case" – where potential connection based on direct distance is possible. To translate this "best-case" or "potential" megaregion to the real world, travel times and distances along the road network are introduced. Differences between potential megaregions and existing megaregions may exist. For example, the direct distance between two places might be short, but a river without a bridge might present an obstacle to functional integration that is indirectly captured when taking into account actual travel times or distances along the road network. The result of step 1 therefore identifies potential megaregions, and step 2 identifies megaregions where cities are connected and functional integration might already be present.

3.1.1. Identifying potential megaregion based on direct distances (as the crow flies):

To derive potential megaregions, a mean-shift clustering algorithm is applied to the sample of cities.[2] This approach has the advantage that no assumptions regarding the shape nor the

[2] While in network theory, "community detection algorithm" are applied to networks to identify areas that are highly connected with each other, these algorithms are not best suited for delineating megaregions for two reasons. First, there is no definitive method for identification yet and the standard algorithms that are in place tend to perform poorly when trying to detect smaller communities (Barthélemy, 2011[42]). Moreover,

number of clusters have to be made in advance. In general, a mean-shift clustering algorithm assigns data points to clusters iteratively by shifting the points towards the highest density of data points. The shift $m(x)$ is defined as:

$$m(x) = \frac{\sum_{x_i \in N} w_i \, x_i}{\sum_{x_i \in N} w_i},$$

where w usually describes the assigned weight based on a distance function (Cheng, 1995[45]; Fukunaga and Hostetler, 1975[46]).

Within the context of megaregions, the size of nearby cities matters as they indicate larger market access. Thus, population weights are used to calculate the mean-shift, such that within a certain search distance larger cities are more important than smaller cities and pull the centre of the megaregion towards them. The mean-shift algorithm is applied in a sequential procedure to speed up the processing time:[3][4]

The initial step of the algorithm (step 1) regards every city as single "megaregion" and then merges them step by step. To give larger weight to large economic centres, the algorithm starts by taking cities that are larger than 1.5 million inhabitants. Each city is iteratively assigned towards the closest cluster centroid if the respective distance is less than the search distance of 300km. If a city is within the search distance of more than one megaregion, it is 1) identified as "connecting city" that links the megaregions together and 2) assigned to the megaregion with the closest centre. If the centres of two megaregions are in close proximity, and thus there is a large spatial overlap of the respective megaregions, they are considered to be one joint megaregion. A new centre for the megaregion is then calculated weighted by the population sizes of the joining cities. The iteration through this step stops once the cluster centroids are not moving anymore.

In the following step (step 2), cities with more than 500 000 inhabitants are included. If such a city is within the search distance of 300km to the centre of a megaregion identified in the previous step, it is assigned to that megaregion. As before, a city that overlaps with more than one megaregion is identified as connecting city that links megaregions together; two megaregions with the population weighted centres in close proximity are considered to be a joint megaregion; and a new population weighted centre for the megaregion is calculated. Cities that were not assigned to a megaregion identified in step 1 (which includes at least one large city with more than 1.5 million inhabitants) are analysed separately to identify whether they form a megaregion consisting only of cities introduced in the second step with a population size of 500 000-1.5 million inhabitants. Megaregions that are formed by cities in that step (i.e. only consisting of 500 000-1.5 million population), are added to the set of potential megaregions.

The last step assigns smaller functional urban areas that have a population less than 500 000 to the nearest megaregion identified in the previous step if they are within the search distance.

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perfect direct links between cities are assumed in this initial setting. Therefore, the evaluation against a randomised network is likely to produce poor results.

[3] The drawback of the mean shift clustering lies in the complexity of the algorithm's runtime, which exponentially increases with data points (more formally, the runtime can be described as $O(KN^2)$, where N is the number of datapoints and K is the number of iterations of the mean-shift).

[4] The algorithm can be provide as python code upon request from the author.

3.1.2. Connectivity within identified potential megaregions

Identifying the potential megaregions allows reducing the computational burden in the calculation of existing connections. In the following, the potential megaregions identified in the previous step are analysed with respect to their actual reach to markets within the megaregion. More formally, this can be described by the Reach Centrality measure[5]: Within a given Megaregion G, the reach centrality $R^r[i]$ of city i describes the number of other cities that can be reached from i using the shortest path distance within a search distance r. For this exercise, two specifications of search distance are applied: i) 300km along the road network, and ii) three hours travel time by road. As within a megaregion the potential to reach larger cities is more important than reaching only smaller cities in terms of accessing market size, the measure is weighted by population size of city j ($P[j]$). The reach centrality can therefore be described as

$R^r[i] = \sum_{j \in G-\{i\}:d[i,j]\leq r} P[j]$,

where $d[i,j]$ is the shortest path distances between city i and city j in Megaregion G (see e.g. (Sevtsuk, 2010[44])). Normalising the reach measure with the total population within a given potential megaregion (excluding own city size) allows to identify cities that are less well connected to the centres:

$$R^{r,p}[i] = \frac{\sum_{j \in G-\{i\}:d[i,j]\leq r} P[j]}{\sum_{j \in G-\{i\}} P[j]}$$

3.1.3. Results

Potential Megaregions across the OECD

Across the OECD, 25 megaregions with at least 10 million inhabitants living in the functional urban areas are identified by applying the mean-shift clustering algorithm. The potential megaregions differ significantly in terms of the number of functional urban areas they contain. In contrast to megaregions formed in North America, megaregions in Europe tend to incorporate several small sized functional urban areas (Table 3.2). For example, more than 70 cities with less than 500 000 inhabitants are part of the megaregion covering London and large parts of England. Similar patterns are found for megaregions covering Germany and the Netherlands. By contrast, in the US, the number of smaller cities with a population of less than 500 000 is with about 15 significantly smaller. The composition of megaregions reflects the different settlement patterns between North America (with on average larger cities) and Europe with its comparatively smaller cities and more polycentric settlement structure. This pattern become visible when comparing the proximity of

[5] Depending on the research question, other centrality measures could be of greater interest. I.e with respect to where in the megaregion to place infrastructure investments, the gravity, closeness or between-ness measure might be more informing. The *Gravity Index* assumes that accessibility at city *i* is proportional to the attractiveness (*P[j]*) of cities *j* surrounding city i, and inversely proportional to the distances between city *i* and *j* (Hansen, 1959[60]). *Between-ness centrality* captures the fraction of the shortest paths between pairs of cities (*j*,*k*) that pass by city *i* (Freeman, 1977[58]). Within a megaregion, cities may have locational advantages when having a high between-ness index as they are located at major crossroads. The *Closeness Centrality* measure the closeness of city *i* defined as the inverse of the cumulative distance required to reach all other cities within the megaregion while remaining within the limits of the set search radius along the shortest path (Sabidussi, 1966[59]).

megaregions (including also smaller ones with populations less than 10 million) across both continents.[6]

[6] The figures for the megaregions in Korea and Japan can be found in the appendix.

Table 3.1. Potential megaregions across OECD

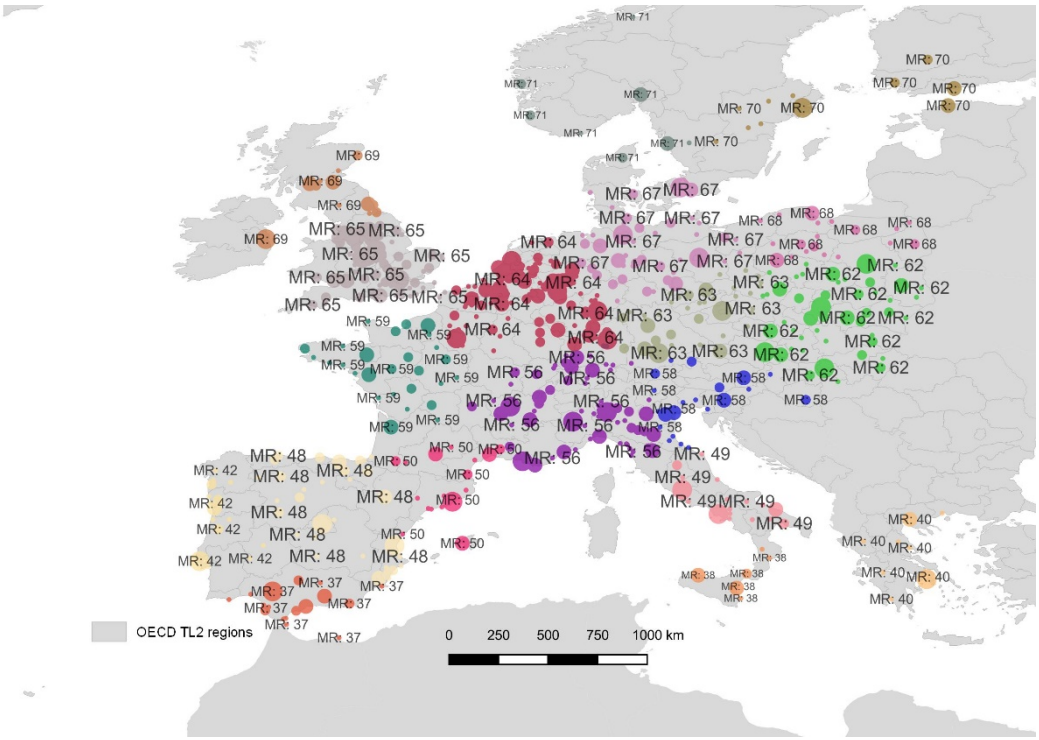
With more than 10 million inhabitants living in FUAs, 2014

Code	Region	Population living in FUAs in the Megaregion	Number of FUAs with a population				Number of FUAs in the Megaregion	Code of Metropolitan regions in the Megaregion that have a population >1.5mio
			less than 250,000	between 250,000 and 500,000	between 500,000 and 1,500,000	more than 1,500,000		
32	Asia	78 394 168	1	13	19	3	36	JP015 JP030 JP034 JP038
64	Europe	60 944 012	60	28	19	7	114	BE001 BE002 DE004 DE005 DE007 DE011 DE502 FR001 FR009 NL002 NL003
35	Asia	45 242 076	25	8	7	5	45	KR004 KR018 KR025 KR029 KR032 KR035
65	Europe	42 939 420	43	35	9	3	90	UK001 UK002 UK003 UK006
47	North America	35 047 780	16	9	5	4	34	US048 US084 US106 US122
11	North America	34 327 248	4	9	7	3	23	MEX51 MEX55 MEX60
56	Europe	29 412 568	40	14	12	4	70	CH001 FR003 FR203 IT002 IT004
28	North America	26 835 436	8	2	3	3	16	MEX01 MEX02 US190 US210
62	Europe	25 458 584	28	13	7	4	52	AT001 HU001 PL001 PL003 PL010
67	Europe	22 012 920	21	16	4	3	44	DE001 DE002 DE012 DE013 DK001
7	South America	20 925 802	16	7	2	3	28	COL01 COL02 COL03
23	North America	20 567 644	4	8	0	5	17	US209 US212 US234 US242 US245
48	Europe	17 302 840	16	11	3	2	32	ES001 ES003 ES019
51	North America	16 783 896	10	9	2	2	23	US033 US055
45	North America	15 503 328	6	6	3	4	19	US045 US107 US115 US124 US141
52	North America	15 171 718	9	3	6	1	19	CAN26 US038 US069 US097
12	North America	14 729 043	3	5	6	2	16	MEX29 MEX31 MEX34 MEX37 MEX40
39	North America	14 366 703	12	2	4	2	20	US135 US146 US155
63	Europe	14 136 164	24	7	4	2	37	CZ001 DE003 DE014
25	Asia	13 677 334	9	6	9	1	25	JP053 JP064 JP066
36	North America	11 327 568	2	4	4	1	11	US125 US154 US170
49	Europe	10 951 789	13	2	1	2	18	IT001 IT003
16	North America	10 847 142	3	7	4	1	15	MEX19
29	North America	10 140 775	4	4	3	1	12	US160 US196
60	North America	10 132 604	7	3	0	3	13	CAN09 US003 US012

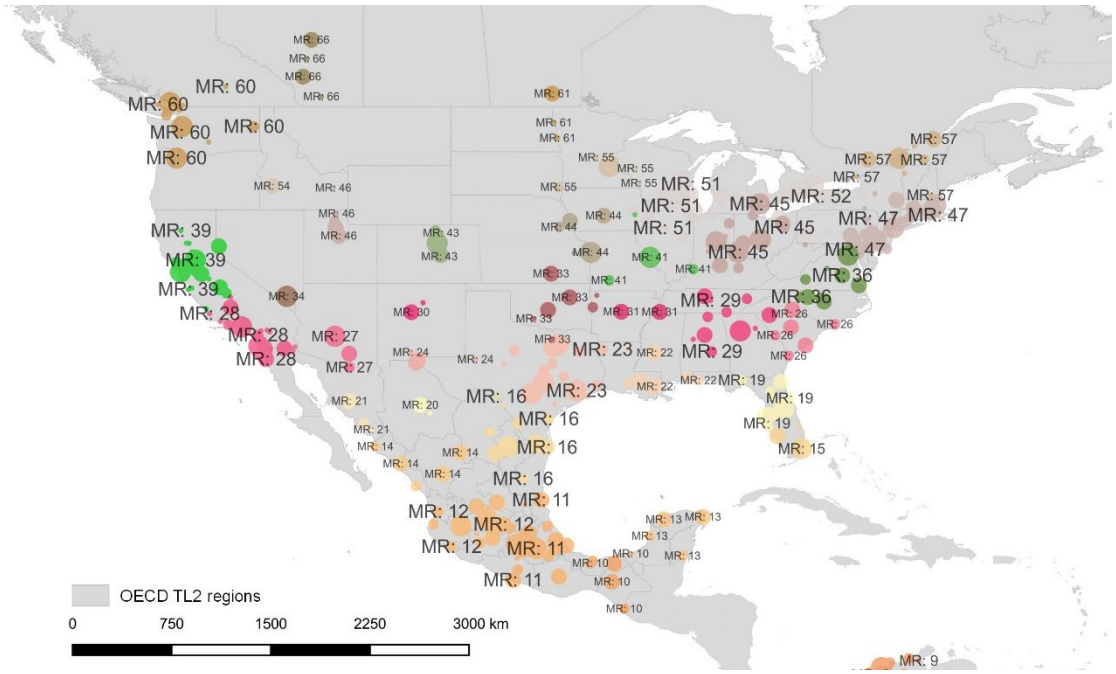
Note: Sorted by total population.

Figure 3.2. Potential megaregions across Europe and North America

A. Europe



B. North America



Note: Larger label sizes indicate larger population size in the megaregion

The mean-shift algorithm to identify potential megaregions performs equally well as traditional methods, requiring less information. Comparing the results derived through the algorithm with the emerging megaregions identified by the Regional Plan Association, a substantial overlap can be found (see Figure 4.1 in the Annex). As described above, the Regional Plan Association uses population and employment growth criteria to identify the emerging megaregions for the United States. Conditioning the potential megaregions identified by the algorithm on similar quantitative criteria, would result in an even greater overlap. It should however be noted, that in larger megaregions, the algorithm tends to identify several smaller megaregions (see e.g. the Chicago area). This could reflect that the applied search radius of 300km might be too narrow for the United States, where distances between places tend to be larger than in Europe. In that instance the search radius can be adjusted without risking too many overlaps in the detected potential megaregions.

Connectivity in the identified potential megaregions across the OECD

The size of accessible markets reflected by the share of population that can be reached may differ for cities based on their individual location and existing (connecting) infrastructure within a given megaregion. Thus, a city that is poorly connected to the surrounding cities in the megaregion will not reap the potential benefits of proximity to market size. As described above, the share of population that lives within the entire megaregion - but outside the own city – and that can be reached in a certain time or is located within a certain distance can be calculated using the normalised reach centrality and is shown in Table 3.2 for large potential megaregions across the OECD. According to this measure, the megaregion spanning across the United Kingdom (Code 65) and across South Korea (Code 35) have the highest potential access to population, both in terms of distance and travel time.

Natural obstacles as well as missing or bad infrastructure can be inferred form the potential reach measure. In some megaregions, cities with no potential access to population outside their own indicate missing infrastructure connectivity and/or natural barriers. For example, in the megaregions spanning across South Korea, the city located on the island of Jeju is disconnected from the potential megaregion and has thus no market access along the road network (see appendix B). Large differences between potential reachability with respect to distance and travel time along the road network may indicate a difficult topology or the lack of good roads that allow for faster travel time. The megaregions spanning across the mountainous Centre of Mexico, including the city of Guadalajara and San Luis Potosi (Code 12) show significant differences between the potential access to population in terms of distance and travel time.

Table 3.2. Reach centrality within megaregions across OECD

Along the road network, Megaregions with a population of more than 10 million living in FUAs.

Code	Region	Population	Number of FUAs	Share of reachable population Distance < 300km			Share of reachable population Time < 3 hours		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	Asia	78 394 168	36	6.4	53.5	91.7	2.9	48.2	90.5
64	Europe	60 944 012	114	20.1	52.9	80.7	14.7	50.5	78.5
35	Asia	45 242 076	45	0.0	66.8	99.1	0.0	59.1	97.9
65	Europe	42 939 420	90	15.0	80.8	100.0	2.1	66.0	97.9
47	North America	35 047 780	34	7.1	66.1	90.2	5.3	53.0	86.1

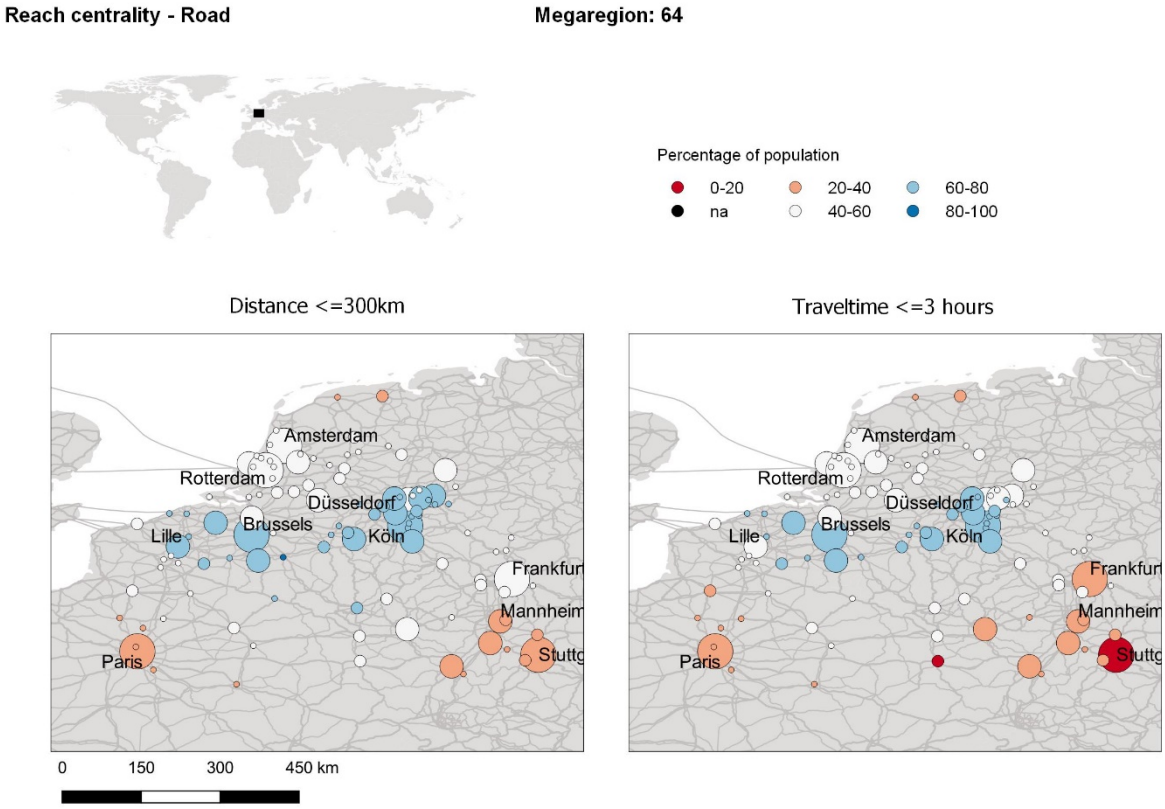
11	North America	34 327 248	23	1.1	68.1	91.5	0.5	43.2	86.8
56	Europe	29 412 568	70	10.5	37.5	57.9	9.2	31.0	49.6
28	North America	26 835 436	16	24.8	78.7	96.7	19.0	75.9	93.9
62	Europe	25 458 584	52	19.3	45.5	68.3	6.1	27.3	49.5
67	Europe	22 012 920	44	15.7	54.8	81.7	6.9	47.5	79.5
7	South America	20 925 802	28	3.0	44.0	92.3	0.0	18.2	47.9
23	North America	20 567 644	17	2.8	44.8	95.9	1.4	40.9	95.9
48	Europe	17 302 840	32	11.9	32.4	75.8	11.9	32.9	75.8
51	North America	16 783 896	23	8.5	70.4	93.9	8.5	57.9	86.1
45	North America	15 503 328	19	5.4	54.1	88.5	5.4	43.5	67.8
52	North America	15 171 718	19	5.3	54.2	87.1	4.4	46.4	78.2
12	North America	14 729 043	16	35.5	68.7	92.2	0.0	32.6	49.3
39	North America	14 366 703	20	13.3	76.0	97.6	12.5	69.5	97.6
63	Europe	14 136 164	37	34.1	60.3	93.0	12.4	49.8	83.4
25	Asia	13 677 334	25	26.2	63.0	83.6	13.5	57.3	82.3
36	North America	11 327 568	11	24.9	53.9	94.7	10.0	36.7	89.7
49	Europe	10 951 789	18	16.8	71.4	97.6	10.0	63.6	90.4
16	North America	10 847 142	15	3.6	55.3	93.1	0.0	29.7	63.3
29	North America	10 140 775	12	17.7	59.6	86.3	17.7	51.1	86.3
60	North America	10 132 604	13	0.0	55.9	92.0	0.0	43.6	84.4

Disaggregating the reach potential for each city gives insights into the spatial layout, the population distribution and the connectivity in the megaregion. Figure 3.3 demonstrates the case for the largest megaregion in Europe, which stretches from the Netherlands into Germany and France.[7] This particular megaregion can be roughly divided into three areas: i) the centre around the city of Brussels and Cologne, from which the majority of population can be reached, both in terms of travel time (less than 3 hrs) and road distance (less than 300km); ii) a cluster in the north-west around the city of Amsterdam that allow to access more than half of the megaregional population, reflecting that while the centre can be reached within the given search radius, distances and travel times to the far outer edges in the South and South East are above the threshold; and iii) less well connected areas that have only a low accessibility to the potential megaregional population located in the southern outskirts of the potential megaregion. Indirectly, this figure also reflects that most of the population of this megaregion is located in its northern and central area. Around Frankfurt and Stuttgart (south east corner), as well as Paris (south corner), the number of cities is for one smaller, and those also tend to be smaller in terms of population size. It should however be noted, that the railway network between the larger cities in this particular megaregion is well developed improving overall potential accessibility. As such, the high-speed connection between Cologne and Frankfurt am Main, as well as Paris to Brussels and Rotterdam/Amsterdam allows for greater reach to the population within in the megaregion.

[7] The normalised reach centrality for other large megaregions in Europe can be found in the appendix.

Figure 3.3. Reach centrality

A. Along the road network



Note: only FUAs with more than 1 000 000 inhabitants are labelled.

The identification of megaregions provides the foundation for further research on the functional integration of megaregion and their development over time. As new data sources become available, flows between cities within a potential megaregions can be analysed. For example, large scale traffic data can provide insights on mobility patterns between cities within a megaregion and identify the need for joint policy action between cities.[8]

Potential future research can built on the methodology and the identified megaregions to conduct comparative analysis. For example, potential megaregions can be linked to the OECD TL-3 regional database that provides information on economic and demographic characteristics; agglomeration benefits could be assessed on a megaregional scale; functional integration within megaregions could be analysed using alternative centrality measures and flow data (such as research collaborations or co-patenting), that might be not available for all OECD countries, but for the respective megaregion. To monitor the development and success of a megaregion, comparable data that is available for all parts of the megaregion needs to be collected and evaluated to provide evidence based expertise, data collection should follow in comparable ways across the megaregion. This is especially

[8] Traffic data is increasingly collect by several providers using information from passenger transport providers (see e.g. World Bank's open traffic project).

important in cross-border regions, where national statistical offices apply different techniques or collect data at different times. The identification of (potential) megaregional should therefore be seen as a first step for *i)* further research on megaregions, and *ii)* allow policy makers to identify potential partners in surrounding regions to address joint strategies to advance competitiveness.

4. Conclusion and ways forward

Megaregions describe a new geographic scale of social and economic interaction that span over several administrative boundaries. Advances in technology and transport allow people to connect over greater distances than it was possible just a few decades ago. However, agglomeration economies do not necessarily occur automatically in megaregion; fully exploiting them requires collaborative efforts. To engage with relevant partners at the right regional scale, it is important to know who the potential partners could be. In this paper, a methodology is provided to identify potential megaregions that can provide the basis for policy makers to initiate discussions. It is important to note, that this does not mean that all decisions should be made at a higher "megaregional" scale. Rather it allows the identification of potential partners that are located in a certain proximity and who might face similarities such that economies of scales could be utilised when addressing challenges at this scale.

Megaregions that connect metropolitan centres spatially and functionally provide an opportunity to achieve much greater efficiency and economies of scale through greater coordination and joint infrastructure planning across cities, regions, and states. While governance alone can do little to empower a territory where there is no compelling economic, social, and institutional rationale for collaboration – a mere political construct is bound to hit its own limits soon enough. Reversely, with no effective governance in place to help local partners identify a common goal, leverage their combined spending power and implement their action plan together will only have a limited impact. In order to become a competitive megaregion, there needs to be a clear agreement about its vision and concrete steps to take need to be collectively defined. To initiate cooperation amongst partners within a megaregion, a concrete project that creates positive spill-overs can serve as motivation for greater collaboration. Within a megaregion context, regions have identified joint transport challenges as one enabler to promote greater coordination in the planning process. But also cultural events provide a means to foster collaboration. Thus, applications for large scale sport events now tend to include several cities (i.e. the joint Olympic application of Hamburg, Kiel and Berlin which reflect the potential megaregion in the northern part of Germany). If such a first collaboration has been fruitful, follow up projects may lead to greater integration with respect to planning and development strategies.

New economic geographies call for adjustments in the policy framework adapted to the new scale in order to maximise the benefits. At this stage, however, empirical evidence on the economic and social benefits of megaregions as well as successful governance arrangements at this scale are lacking. The methodology proposed in this paper to identify

potential megaregions can serve as a basis for future research looking into drivers of megaregional success.

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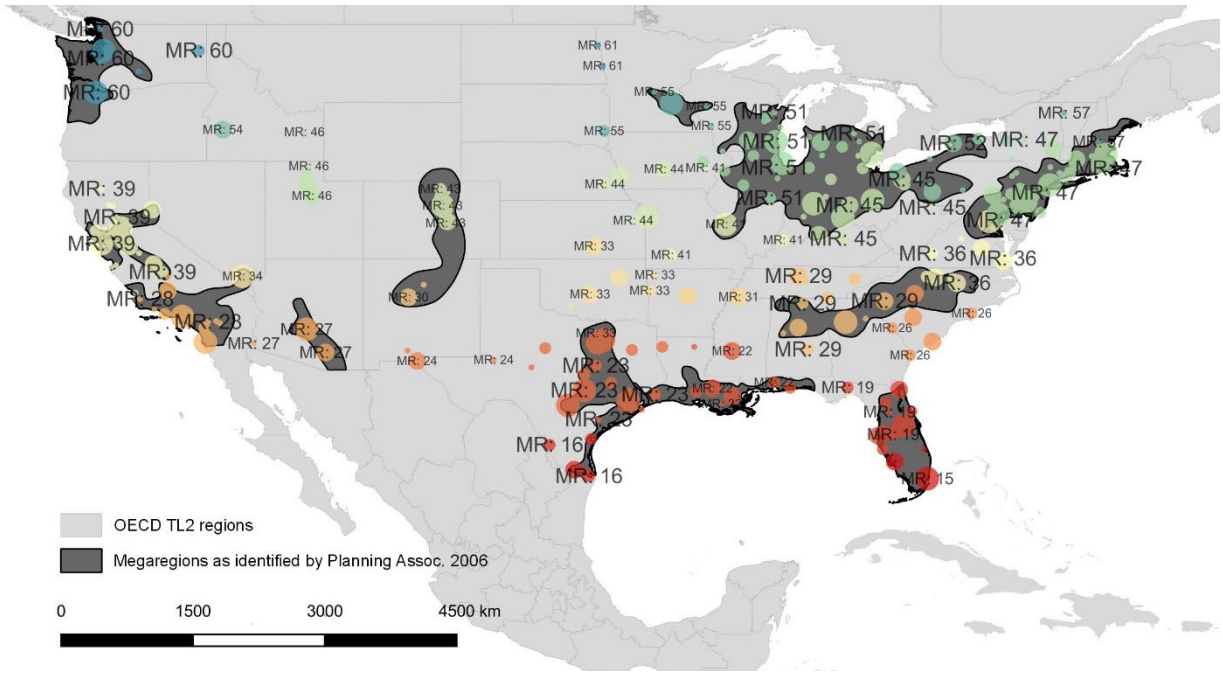
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Annex A. Potential megaregions

Figure A.1. Comparison of potential megaregions in the United States identified by the Algorithm and by the Regional Planning Association



Note: Larger label sizes indicate larger population size in the megaregion.
Source: Own elaboration and Regional Plan Association (2006); http://www.america2050.org/megaregions/megaregions_gis.zip.

Figure A.1. Potential megaregions in Japan and Korea

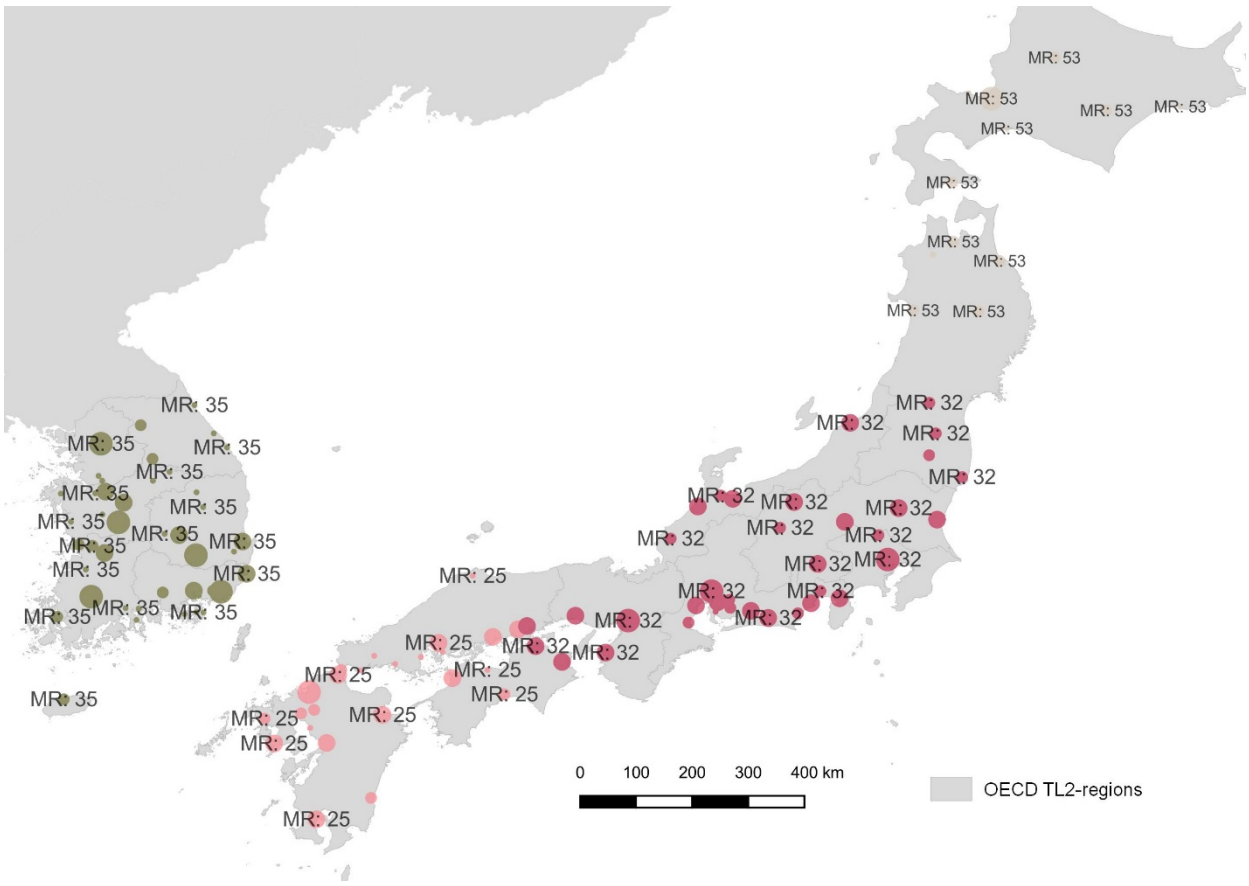


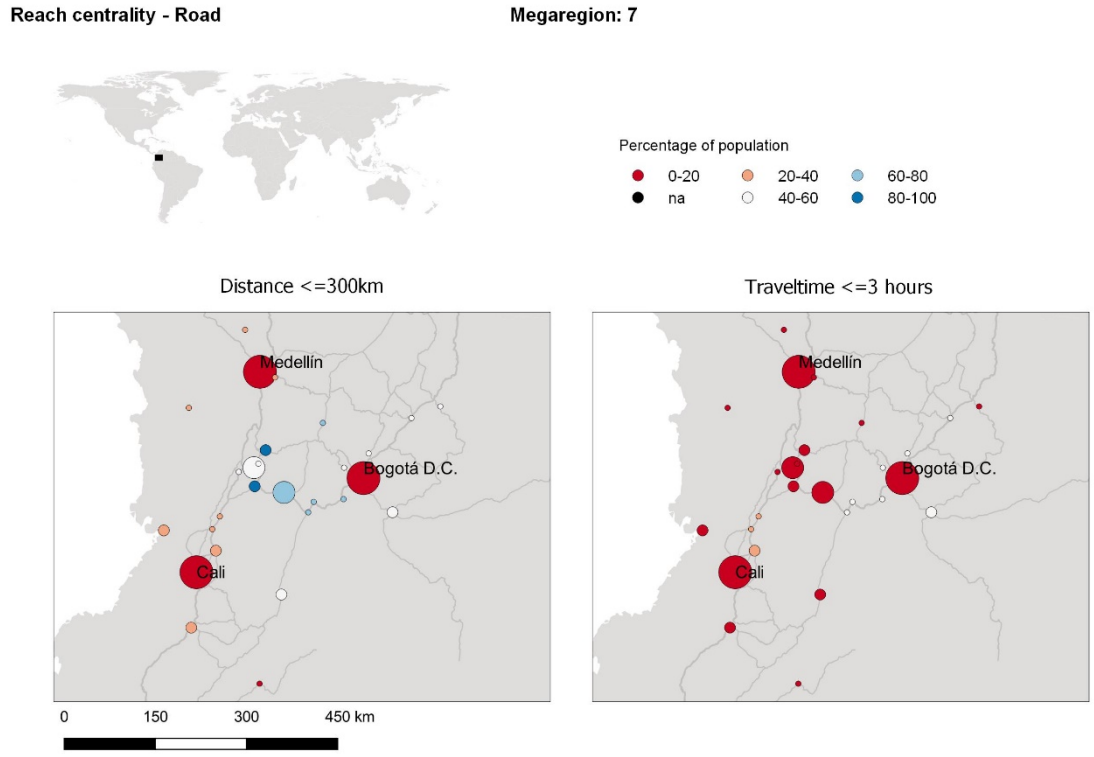
Table A.3. Potential megaregions across the OECD

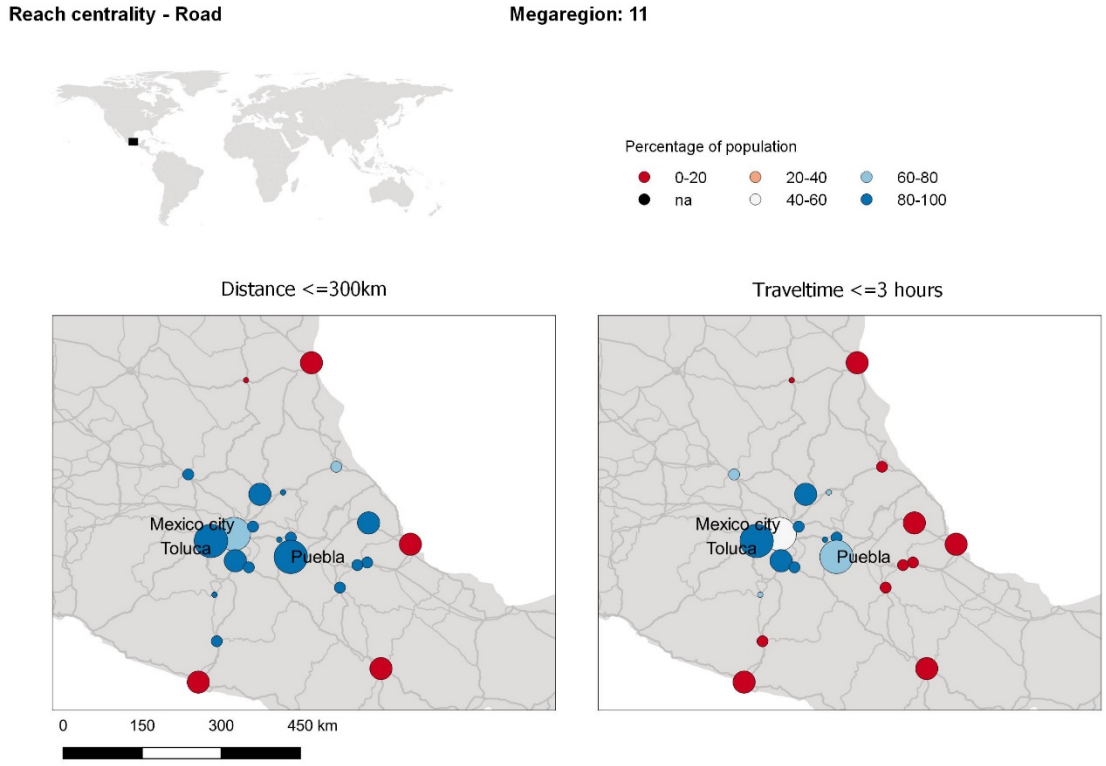
Larger than 5 million, population living in FUAs 2014

Code	Region	Population living in FUAs in the Megaregion	Number of FUAs with a population				Number of FUAs in the Megaregion	Metropolitan areas in the Megaregion with more than 1.5million inhabitants
			less than 250,000	between 250,000 and 500,000	between 500,000 and 1,500,000	more than 1,500,000		
32	Asia	78 394 168	1	13	19	3	36	JP015 JP030 JP034 JP038
64	Europe	60 944 012	60	28	19	7	114	BE001 BE002 DE004 DE005 DE007 DE011 DE502 FR001 FR009 NL002 NL003
35	Asia	45 242 076	25	8	7	5	45	KR004 KR018 KR025 KR029 KR032 KR035
65	Europe	42 939 420	43	35	9	3	90	UK001 UK002 UK003 UK006
47	North America	35 047 780	16	9	5	4	34	US048 US084 US106 US122
11	North America	34 327 248	4	9	7	3	23	MEX51 MEX55 MEX60
56	Europe	29 412 568	40	14	12	4	70	CH001 FR003 FR203 IT002 IT004
28	North America	26 835 436	8	2	3	3	16	MEX01 MEX02 US190 US210
62	Europe	25 458 584	28	13	7	4	52	AT001 HU001 PL001 PL003 PL010
67	Europe	22 012 920	21	16	4	3	44	DE001 DE002 DE012 DE013 DK001
7	South America	20 925 802	16	7	2	3	28	COL01 COL02 COL03
23	North America	20 567 644	4	8	0	5	17	US209 US212 US234 US242 US245
48	Europe	17 302 840	16	11	3	2	32	ES001 ES003 ES019
51	North America	16 783 896	10	9	2	2	23	US033 US055
45	North America	15 503 328	6	6	3	4	19	US045 US107 US115 US124 US141
52	North America	15 171 718	9	3	6	1	19	CAN26 US038 US069 US097
12	North America	14 729 043	3	5	6	2	16	MEX29 MEX31 MEX34 MEX37 MEX40
39	North America	14 366 703	12	2	4	2	20	US135 US146 US155
63	Europe	14 136 164	24	7	4	2	37	CZ001 DE003 DE014
25	Asia	13 677 334	9	6	9	1	25	JP053 JP064 JP066
36	North America	11 327 568	2	4	4	1	11	US125 US154 US170
49	Europe	10 951 789	13	2	1	2	18	IT001 IT003
16	North America	10 847 142	3	7	4	1	15	MEX19
29	North America	10 140 775	4	4	3	1	12	US160 US196
60	North America	10 132 604	7	3	0	3	13	CAN09 US003 US012
50	Europe	9 985 154	13	4	3	1	21	ES002 FR004
59	Europe	9 411 388	14	9	4	0	27	FR007
4	South America	9 211 916	7	2	1	1	11	CL010 CL011

19	North America	8 768 324	3	5	3	1	12	US237 US250 US251 US252
57	North America	7 610 358	4	1	2	1	8	CAN20 CAN21
69	Europe	7 060 561	6	4	3	1	14	IE001 UK010
42	Europe	6 760 157	11	3	1	1	16	PT001 PT002
15	North America	6 603 327	1	0	1	1	3	US259
58	Europe	6 093 507	14	4	4	0	22	
9	South America	5 960 115	6	5	1	1	13	COL04 COL05
3	Australia	5 959 822	0	3	0	1	4	AUS01
37	Europe	5 930 406	12	4	2	1	19	ES004
27	North America	5 861 897	2	1	1	1	5	US202 US223
70	Europe	5 830 669	6	2	2	1	11	FI001 SE001
40	Europe	5 552 743	7	0	1	1	9	GR001
53	Asia	5 359 736	4	7	0	1	12	JP003
68	Europe	5 164 819	13	4	2	0	19	PL006

Annex B. Reach Centrality in large megaregions across the OECD

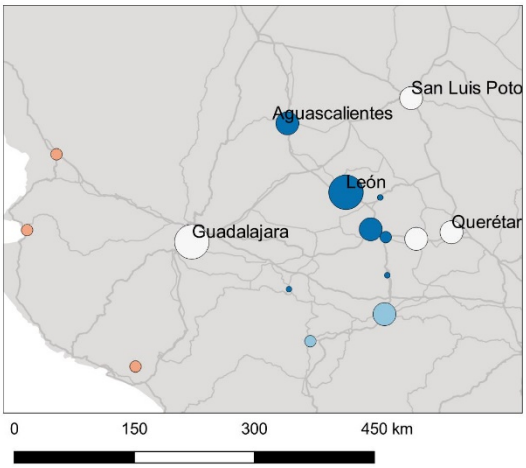



Reach centrality - Road
Megaregion: 11
Percentage of population
0-20
20-40
60-80
na
40-60
80-100
Distance <=300km
Traveltime <=3 hours
Mexico city
Toluca
Puebla
Mexico city
Toluca
Puebla
0
150
300
450 km

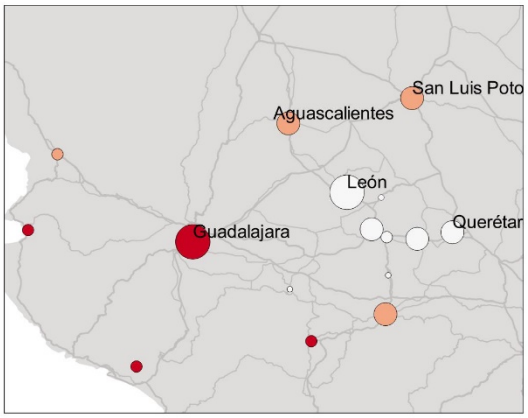
Reach centrality - Road **Megaregion: 12**



Distance <=300km



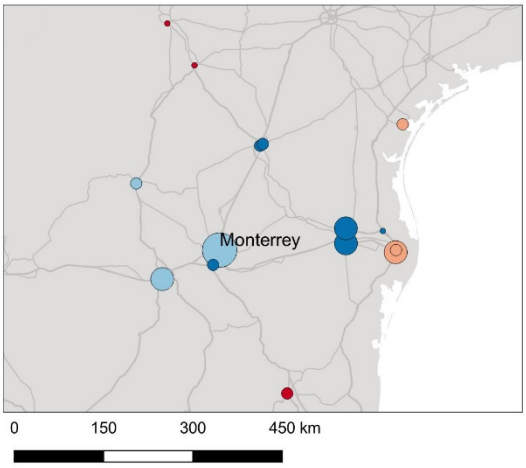
Traveltime <=3 hours



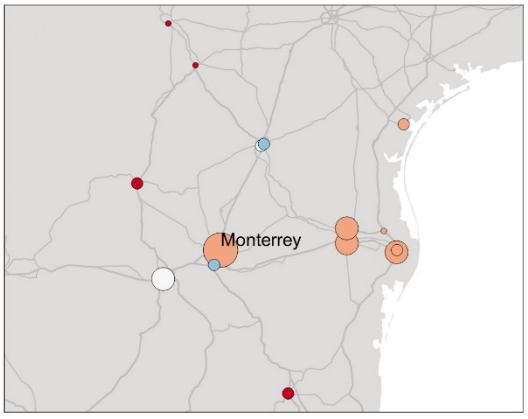
Reach centrality - Road **Megaregion: 16**



Distance <=300km



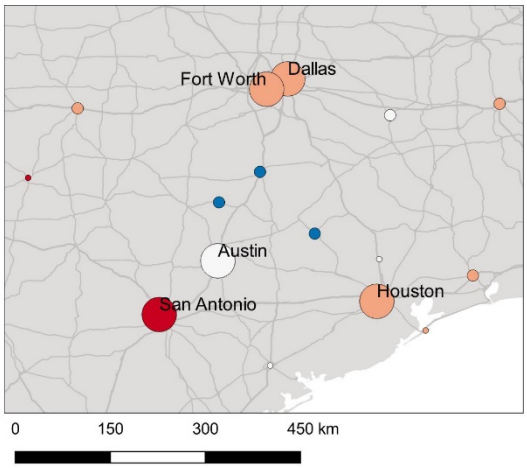
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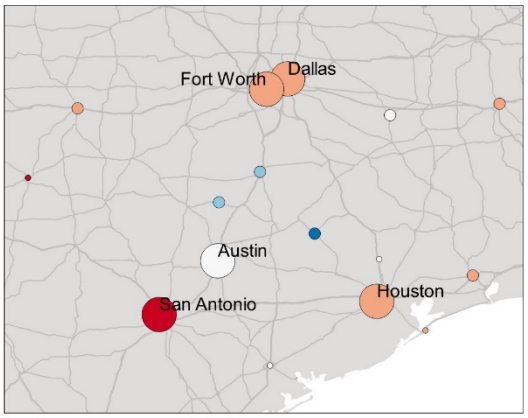
Reach centrality - Road **Megaregion: 23**



Distance <=300km



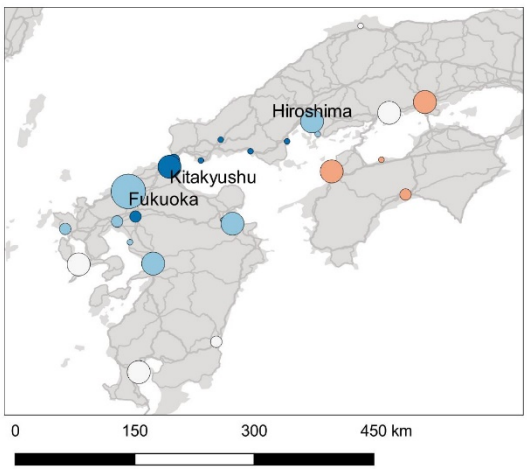
Traveltime <=3 hours



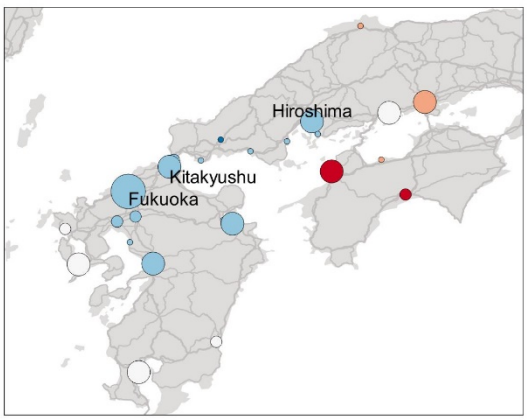
Reach centrality - Road **Megaregion: 25**



Distance <=300km



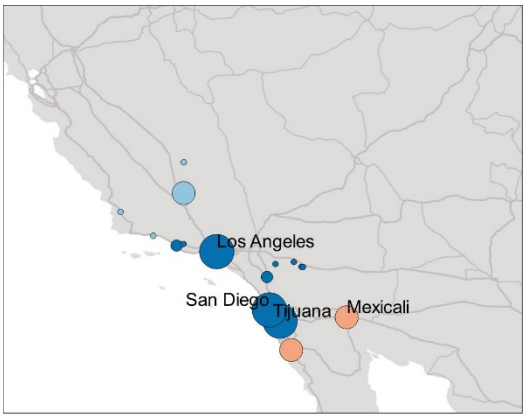
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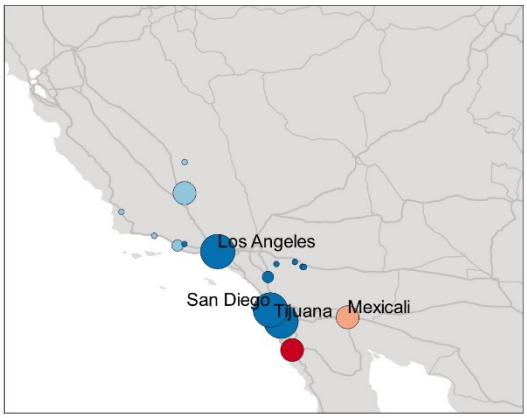
Reach centrality - Road **Megaregion: 28**



Distance <=300km



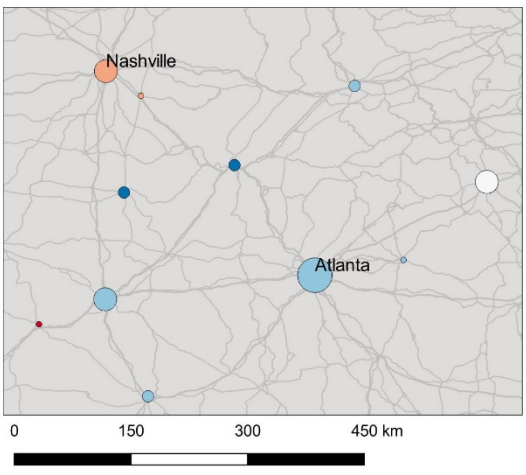
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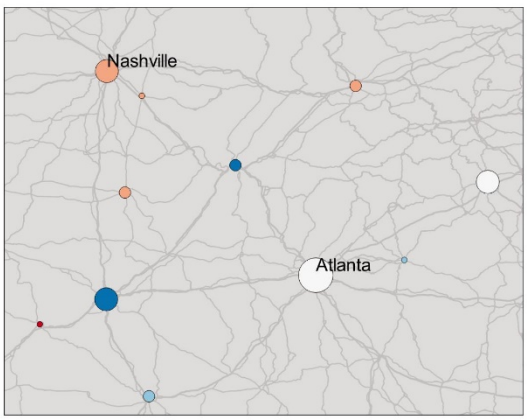
Reach centrality - Road **Megaregion: 29**



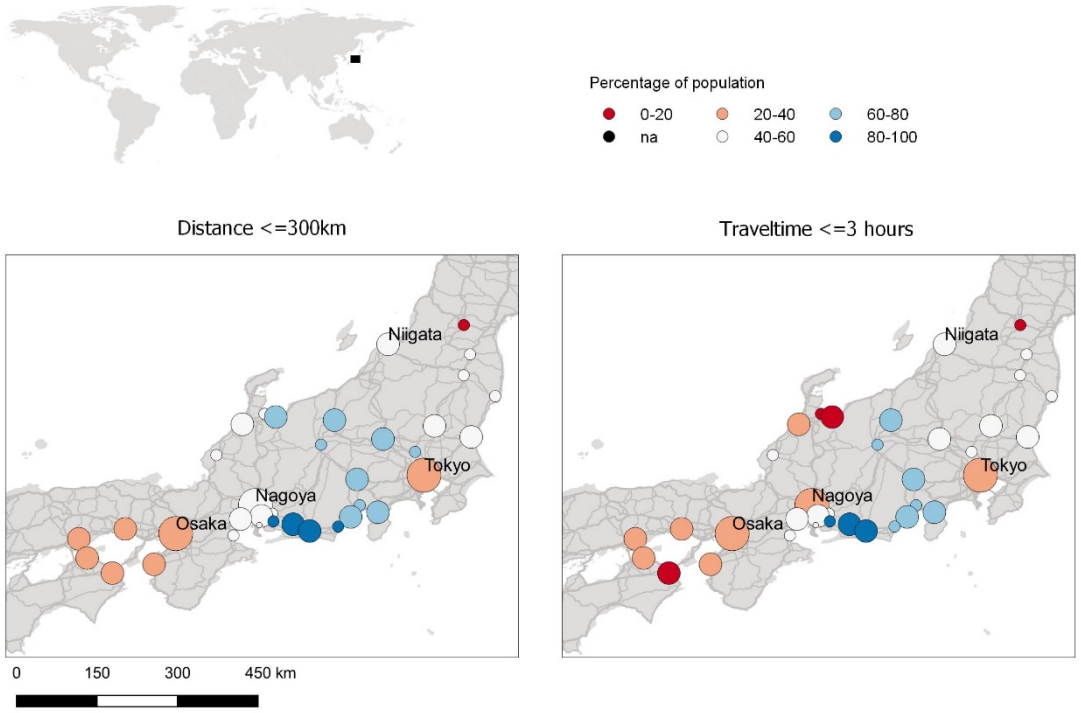
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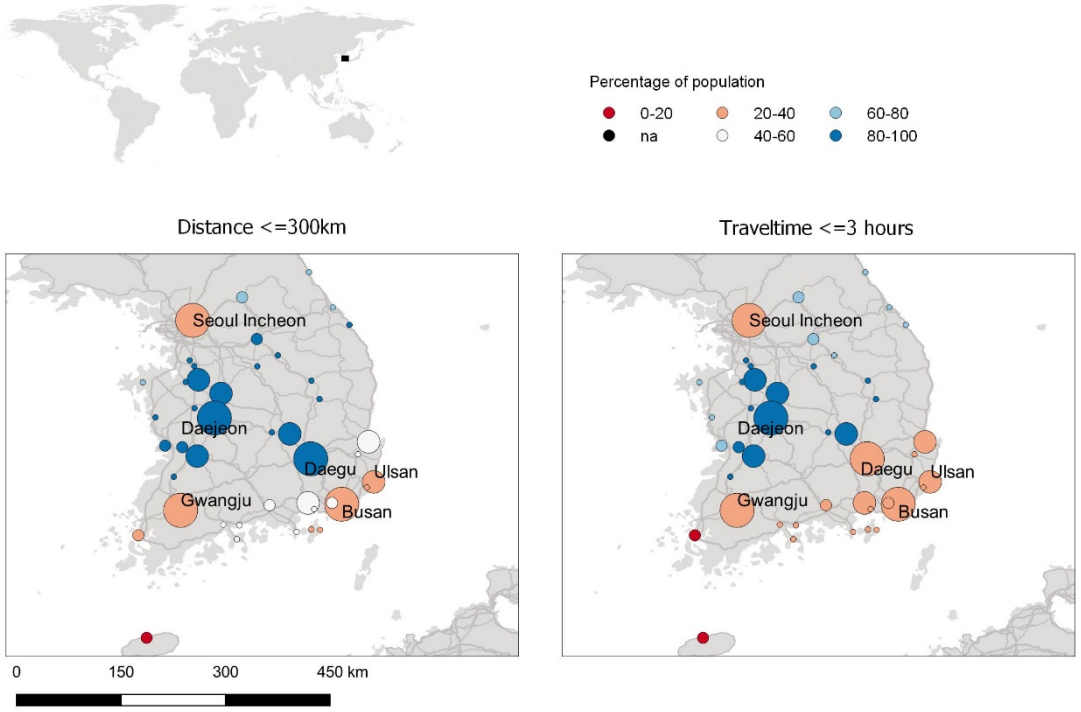
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Reach centrality - Road **Megaregion: 32**



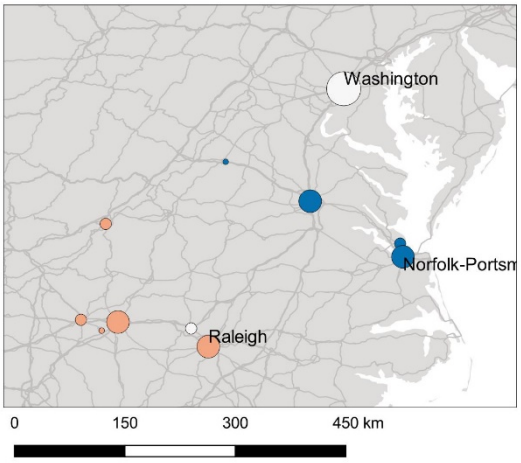
Reach centrality - Road **Megaregion: 35**



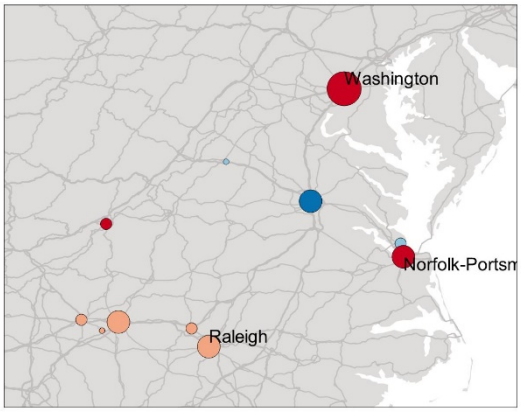
Reach centrality - Road **Megaregion: 36**



Distance <=300km



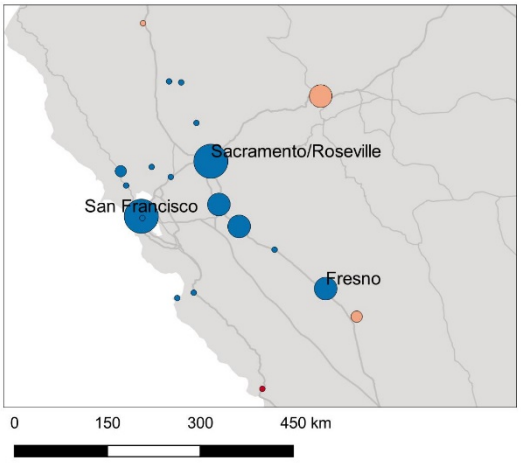
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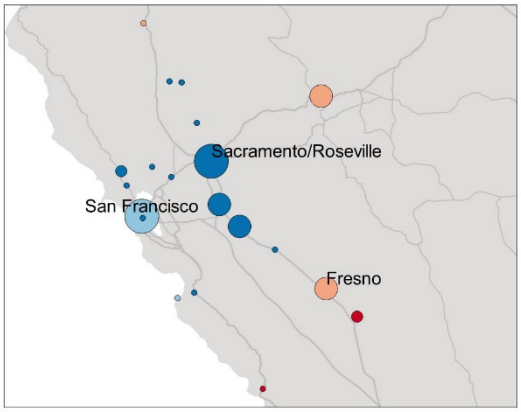
Reach centrality - Road **Megaregion: 39**



Distance <=300km



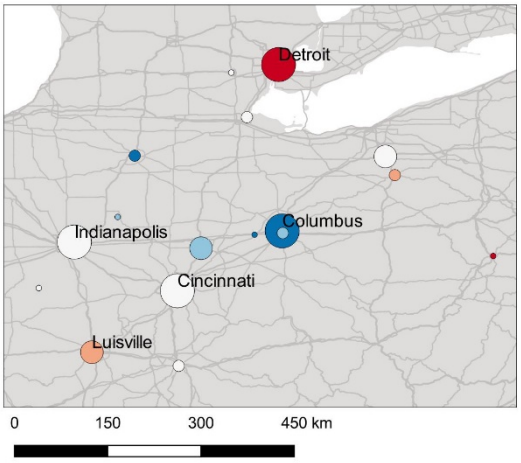
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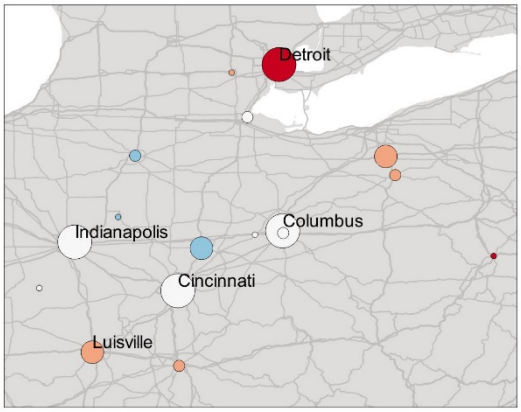
Reach centrality - Road **Megaregion: 45**



Distance <=300km



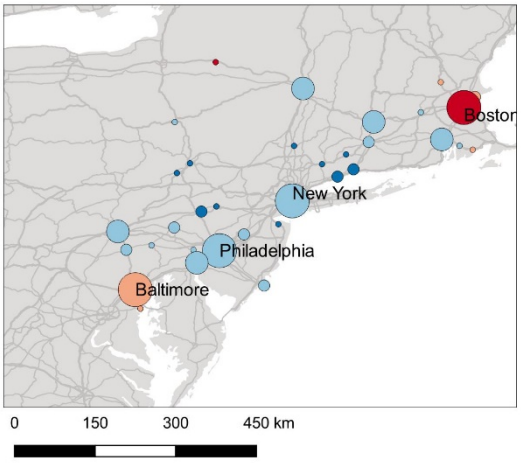
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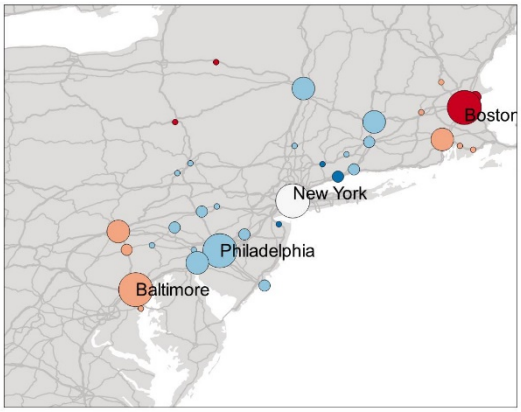
Reach centrality - Road **Megaregion: 47**



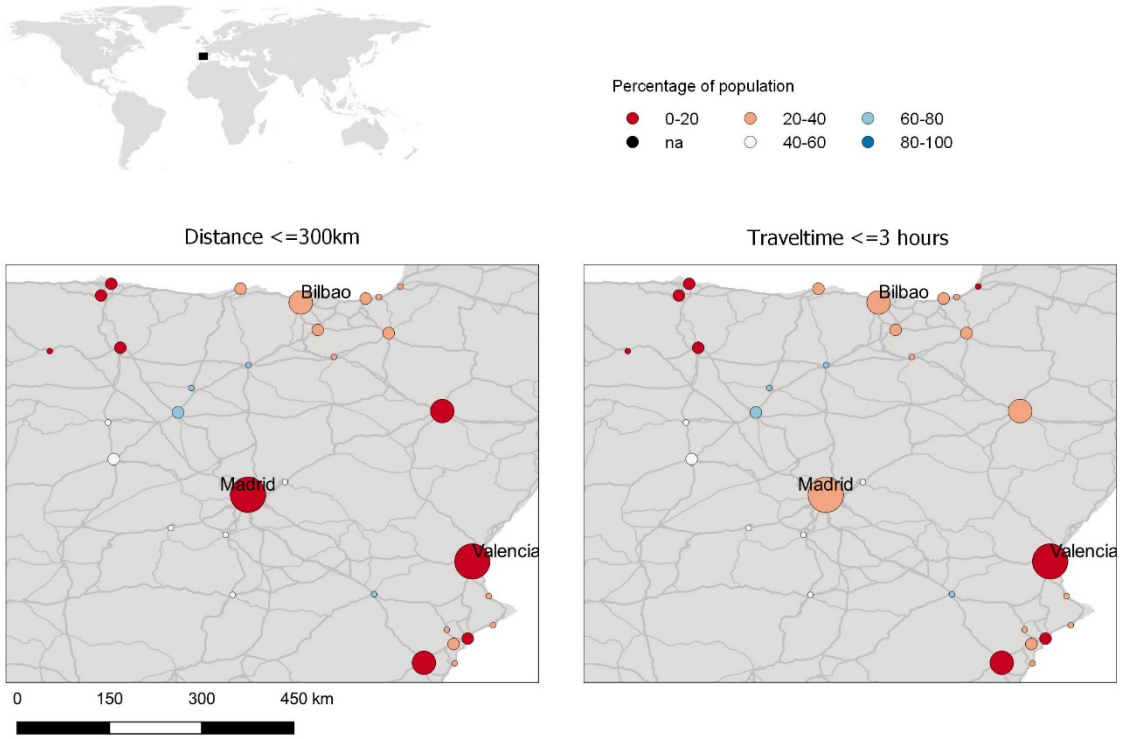
Distance <=300km



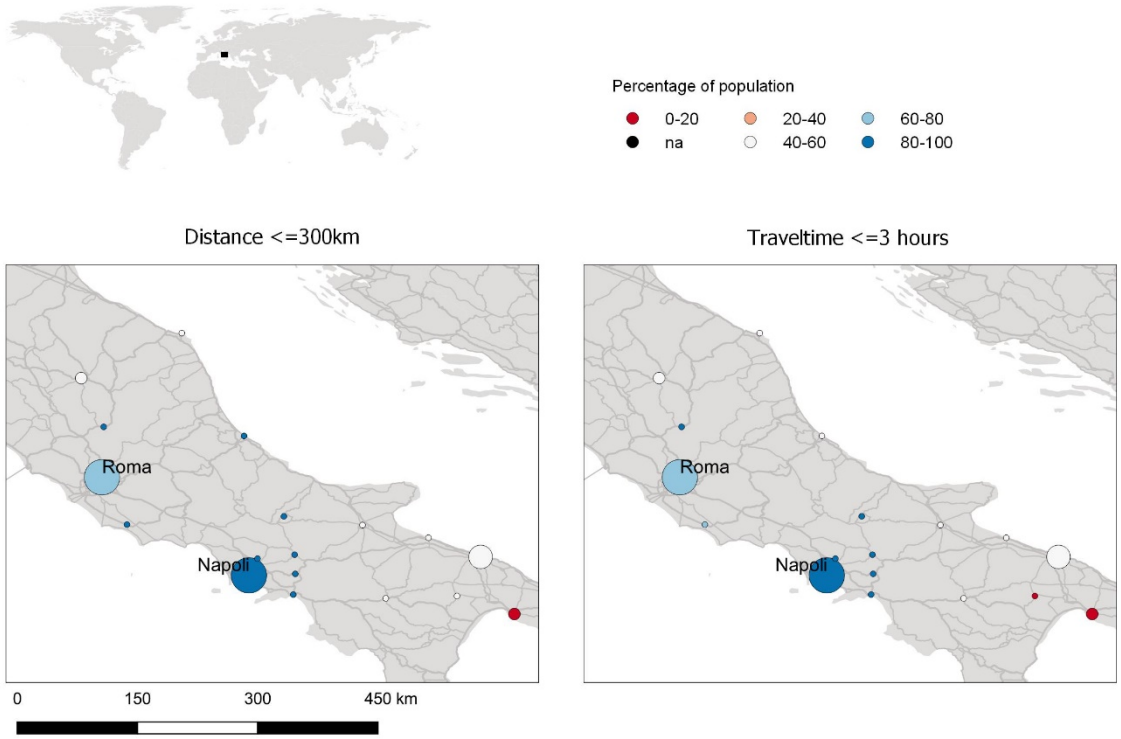
Traveltime <=3 hours



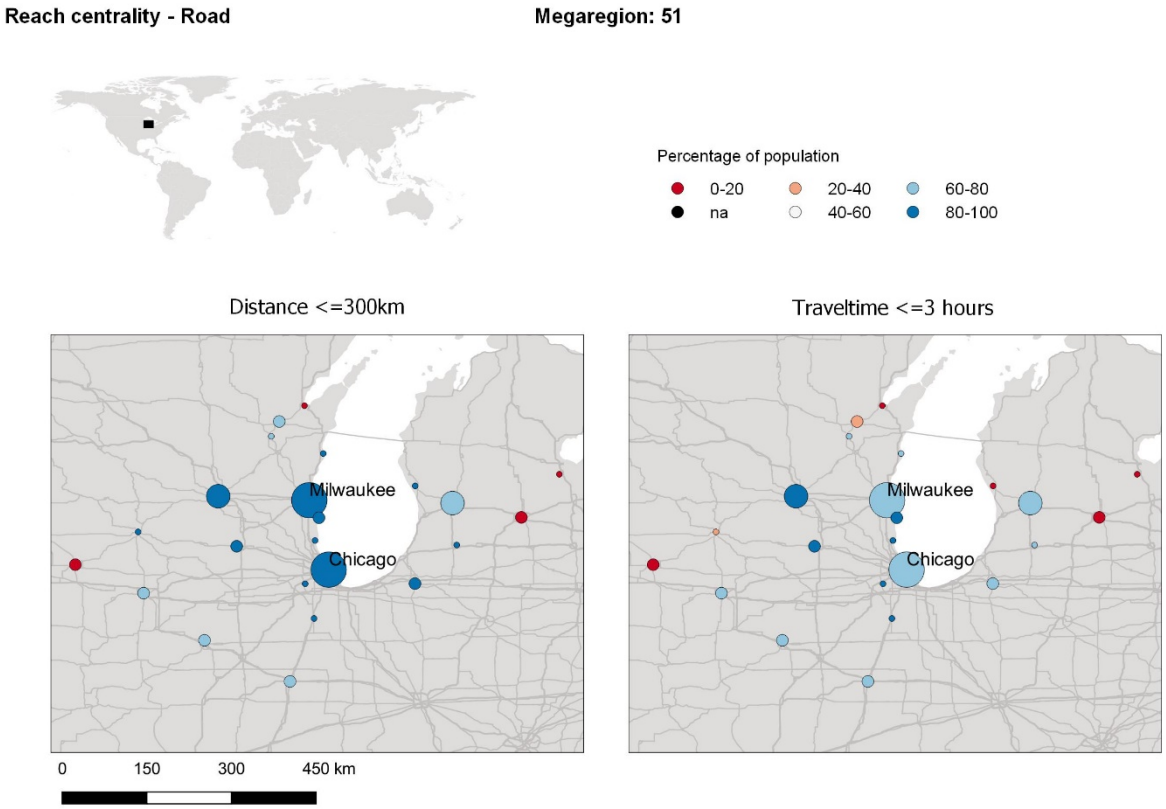
Reach centrality - Road **Megaregion: 48**



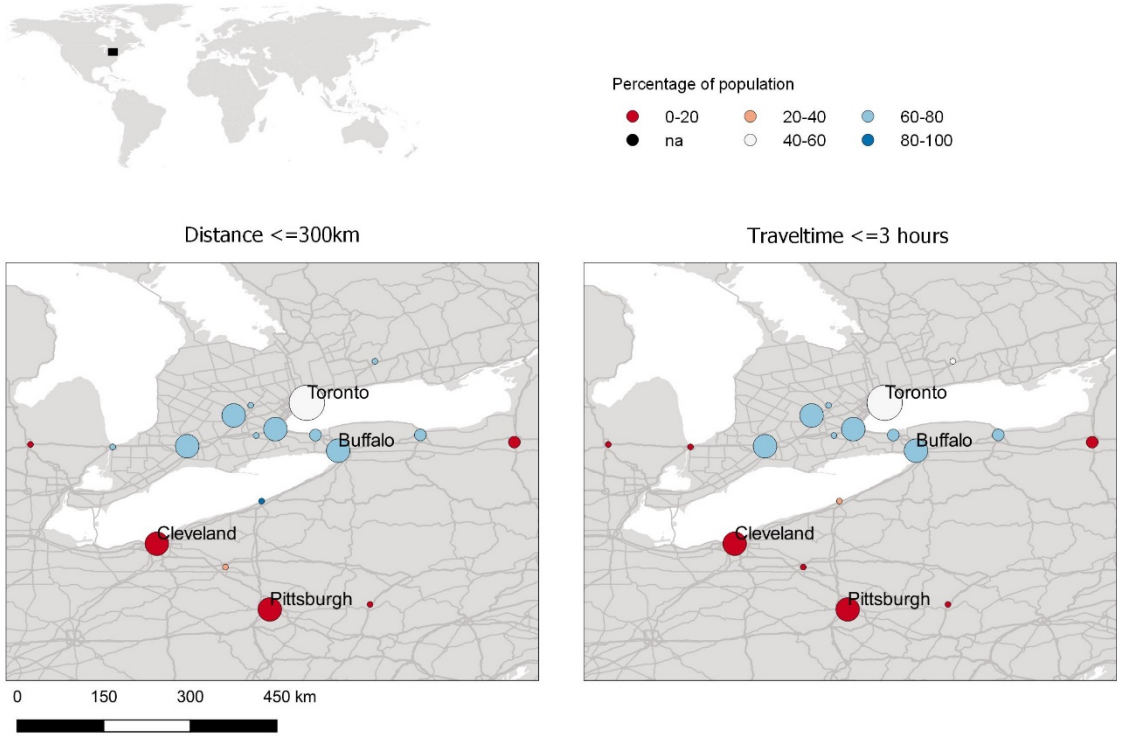
Reach centrality - Road **Megaregion: 49**



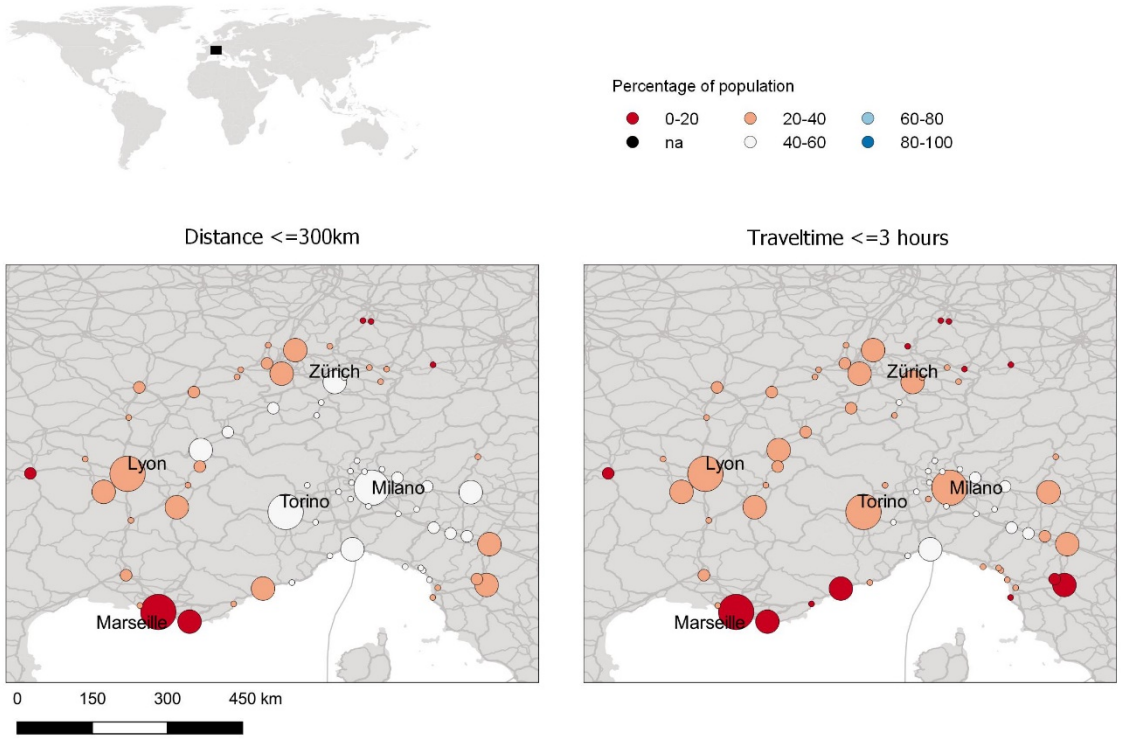
The Rise of Megaregions: © OECD 2018

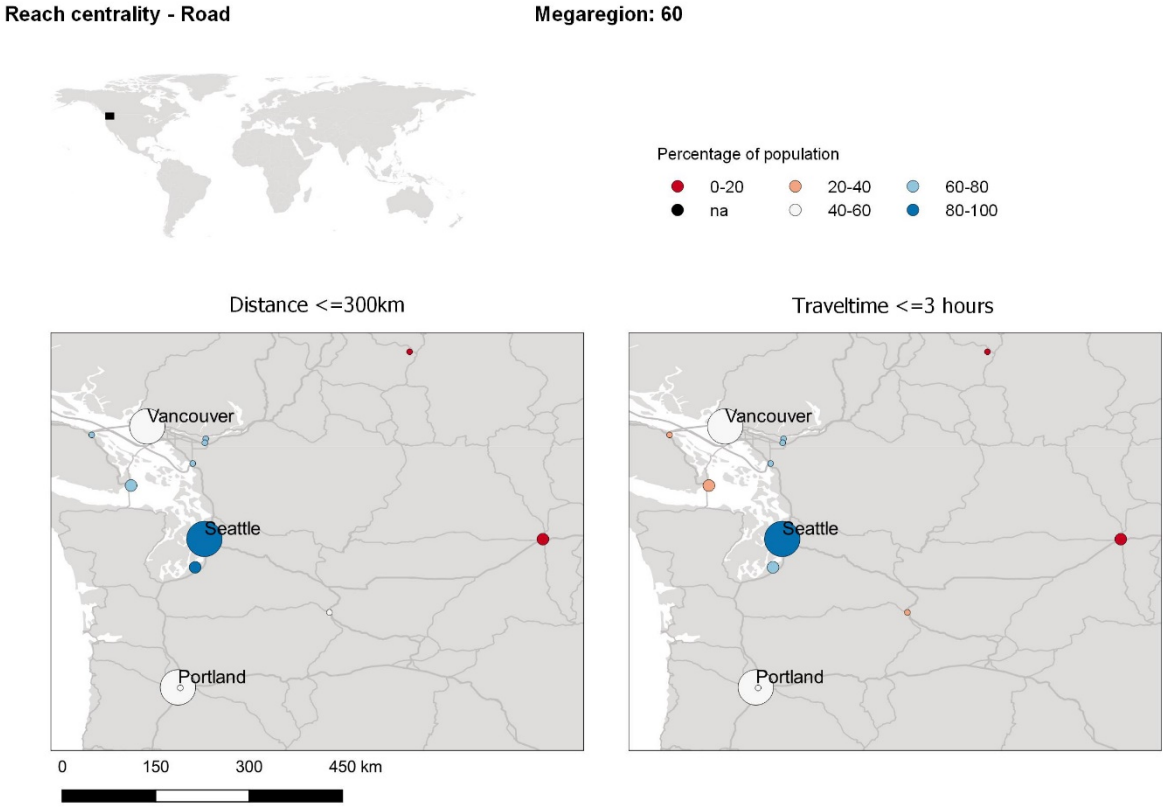

Reach centrality - Road
Megaregion: 51
Percentage of population
0-20
20-40
60-80
na
40-60
80-100
Distance <=300km
Traveltime <=3 hours
Milwaukee
Chicago
Milwaukee
Chicago
0
150
300
450 km

Reach centrality - Road **Megaregion: 52**



Reach centrality - Road **Megaregion: 56**

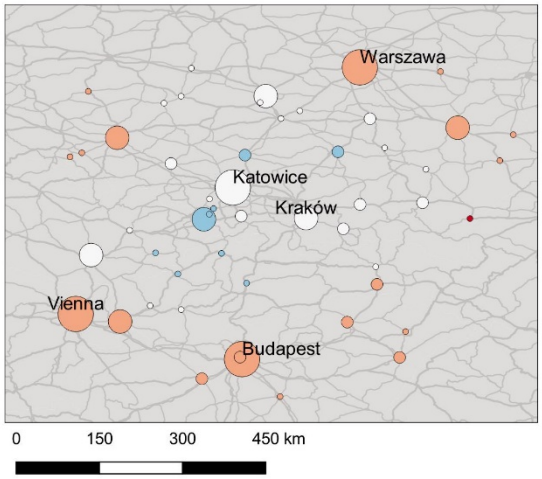



Reach centrality - Road
Megaregion: 60
Percentage of population
0-20
20-40
60-80
na
40-60
80-100
Distance <=300km
Traveltime <=3 hours
Vancouver
Seattle
Portland
Vancouver
Seattle
Portland
0
150
300
450 km

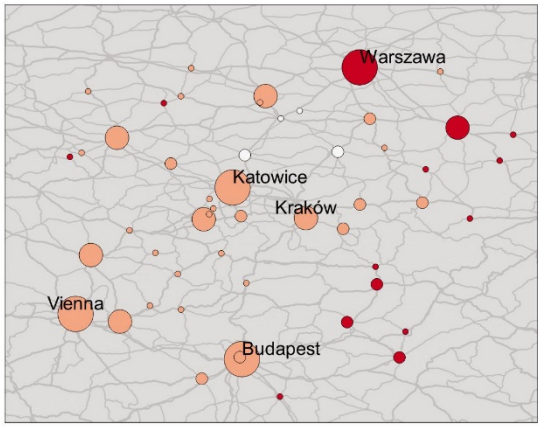
Reach centrality - Road **Megaregion: 62**



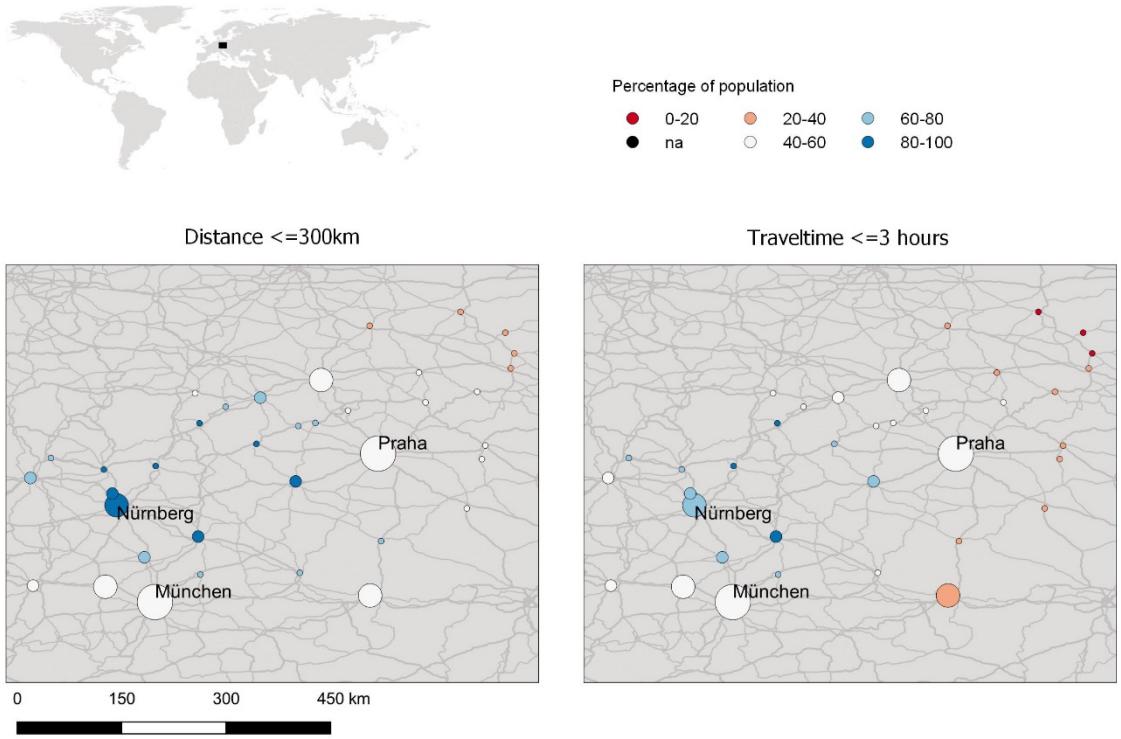
Distance <=300km



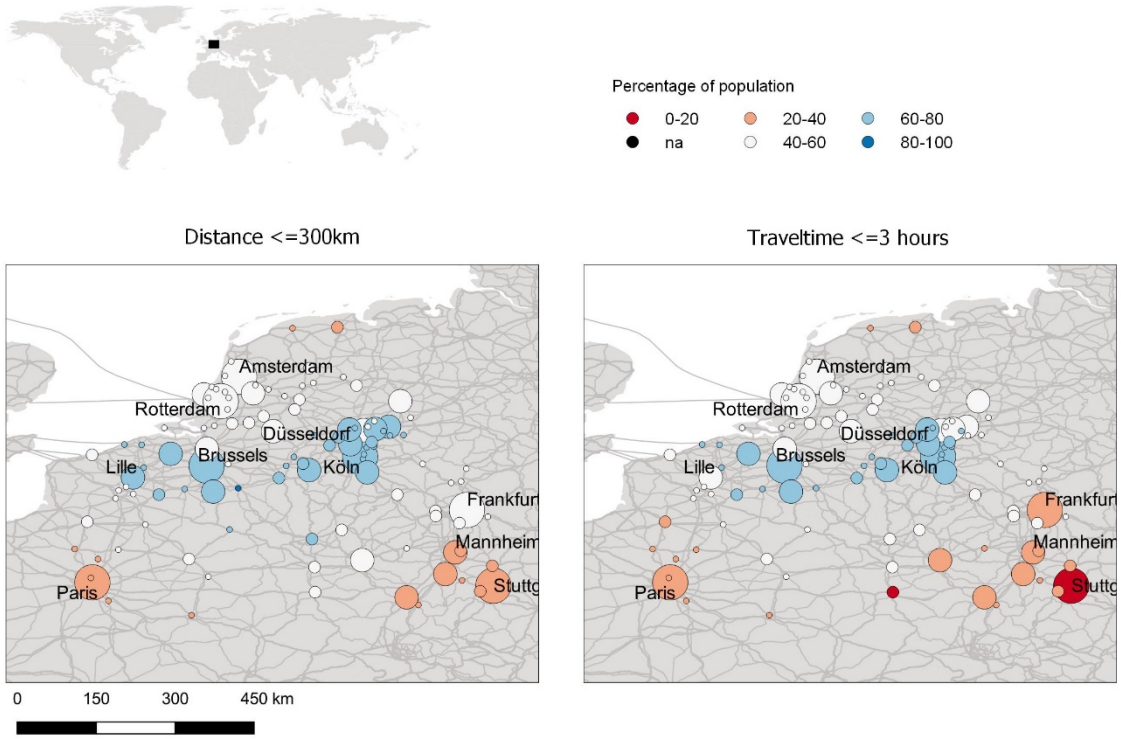
Traveltime <=3 hours



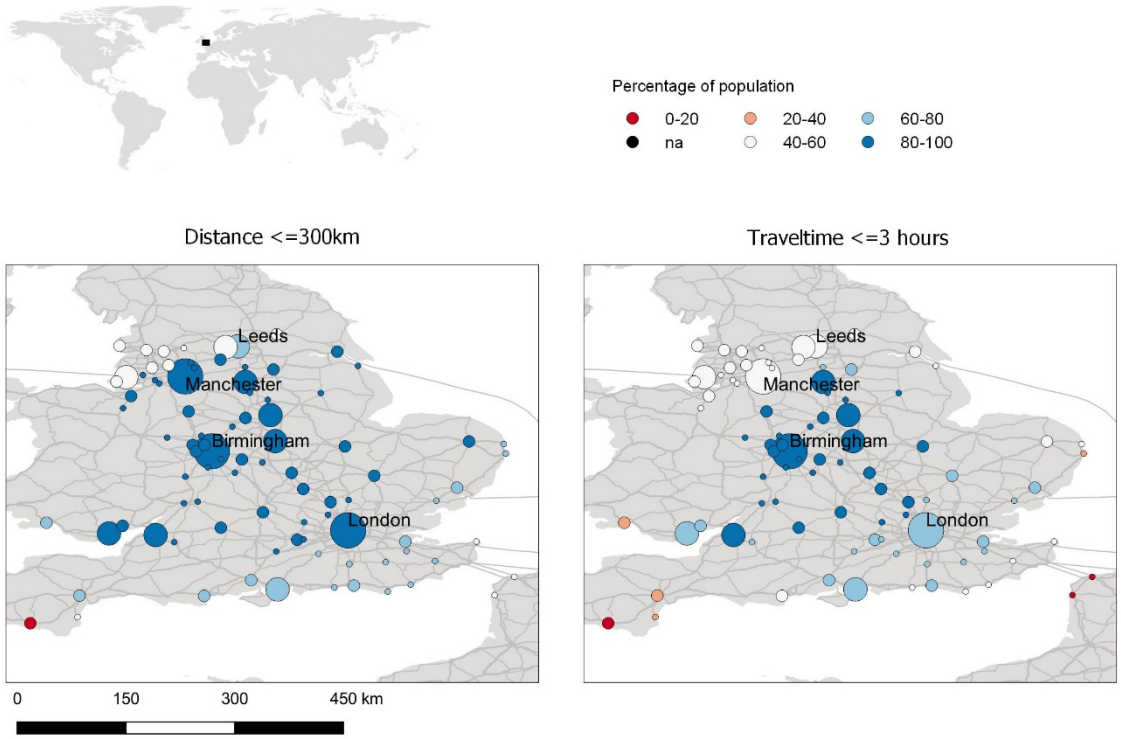
Reach centrality - Road **Megaregion: 63**



Reach centrality - Road **Megaregion: 64**



Reach centrality - Road **Megaregion: 65**



Reach centrality - Road **Megaregion: 67**

