

Synergies between metropolitan, agglomeration, infrastructure and network policies in urban Europe: The case of the Lower Rhine Region

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Extended summary

The importance of regions as crucial drivers of economic growth and as natural spatial and administrative units to formulate integrated development plans is increasingly acknowledged. The literature gradually moves away from countries as relevant spatial units of observation. This gives rise to a series of questions regarding the exact definition of regions, spillovers between regions, the spatial scope of agglomeration effects, the relevance of border effects, the available evidence on growth determinants at the regional level, and the importance of cross-border cooperation. This essay studies these issues taking the Lower Rhineland Region as an interesting case, as it is a region covering parts of the Netherlands, Belgium and Germany with clear physical, historical, economic and social connections, but also facing substantial challenges in enhancing cross-border cooperation. We aim to foster the debate on these issues by first surveying key theoretical and empirical insights and then to introduce a series of cases that illustrate the relevance and challenges of fostering productivity by means of optimally exploiting agglomeration benefits.

Chapter 2 summarises the state of affairs on urban development and agglomeration in our current age of transition. Economies simultaneously scale up into larger urban societies, while at the same time local (self-) organisation becomes more important. This challenges urban and regional development and policy. Caused by returns from specialisation associated with trade and urban agglomeration economies, a productivity premium for firms exists of approximately 5 percent associated with a doubling of the density of cities.

How to capture and facilitate this premium in a polycentric setting is a subject of debate. Facilitating agglomeration economies is not an easy task for policymakers. Current literature suggests that it depends on the level of interregional trade integration and specialization, on opportunities for learning, matching and sharing in the local economy, on lowering transaction and search costs for, respectively, knowledge, labour and inputs, on the industrial composition of and life cycle stages of industries in the region, on skills of knowledge workers, on relatedness in and cross-overs of innovative technologies combining economies of scale of specialization and economies of scope of diversification, on infrastructure as a possible substitute for agglomeration, on physical possibilities of densification in cities, and on border effects. Moreover, it requires the capacity from policy makers to accept sectoral or regional decline, and the strength to refrain from rowing against the tide in such situations (adopting a “go with the flow” approach). The latter may clearly benefit from coordination of policies internalizing the costs and benefits at the spatial level where they accrue. This level is typically higher than the level where most current decisions are being taken.

According to place-based development strategists, economic growth is not uniquely related to (monocentric) mega-cities. Instead, growth may be distributed across various urban systems in different ways in different countries. Many highly productive urban regions in the EU are indeed small- to medium-sized whose dominant competitive advantage is that they exhibit high degrees of connectivity compared to urban or home market scales. The Dutch, Belgian and German Lower Rhineland regions are prime examples of such urban scales. Involvement in polycentric urban regions can add to the competitiveness and economic growth of a city. In fact, this may indeed offset the lack of agglomeration advantages related to larger (monocentric) cities. Yet it only works out when the co-determining conditions of accessibility, knowledge relations, openness, social

networks, and diversification and specialization are met as well. Additionally, economic complementarities and institutional (governance) relatedness are found to be crucial for integration of medium-sized cities in a functional urban setting – and a lack of such complementarities and institutional unity presently even seems to hamper integration.

For accessibility and physical infrastructure as facilitators of agglomeration, the focus in research and policy has broadened from connectedness per se, to functional economic relations (“what does the infrastructure facilitate?”). Corridor development and intercity urban networks are the most recent playgrounds of this. Economic growth expectations due to physical infrastructure developments in corridors between cities (across countries) is not sustaining an agglomeration flywheel automatically: agglomeration advantages are bound to the urban centres more than to the transport axes. This suggests that “borrowing size and functions”, as suggested in the polycentricity argument, is not served by the larger corridors per se. Instead, it builds upon local and regional urban growth conditions, which facilitate localized initiatives and cooperation and which have much in common with the mechanisms identified in the agglomeration and international trade literature, here operating at a lower spatial scale. Although basically the main physical infrastructure in the LRR is of good or sufficient quality, infrastructural bottlenecks in corridors (now or in the future due to falling budgets for maintenance) specifically hamper interregional relations, and removing these are generally no-regret (cost-benefit) policies. More and more attention is given to accessibility within cities, like the first and last mile of firms and people, which matters maybe even more than between cities.

We also elaborate on the signalled new, smart (to overcome fragmentation) and broader network dimensions related to economic and societal transitions in (European) cities. Besides agglomeration in larger cities, social network relations of people and firms become commonplace in urban environments, involving governmental and network providing stakeholders on various levels ranging from the EU to regions and locations. This adds the important and essential dimension of governance and network policy to the urban agenda.

In the third chapter we assess the impact of different urban interaction strategies on the economic production of the Lower Rhineland Region (LRR), one of the largest polycentric regions in the European Union. Although we lack full information on all the aspects that determine integration and agglomeration advantages, we present nine spatial-economic interaction scenarios that (explicitly or implicitly) distinguish on these determinants in the LRR.

The relative impact of the scenarios vis-à-vis each other is quite clear. Scenarios focused on business as usual, closing (national and regional) borders, and uniform distributions across all locations in the LRR, do not result in gains for total production (and may even result in net losses). The gains from removing the national borders are positive but relatively small. The total gain in production is largest when we allow for more interaction within countries as well: in scenarios including borrowed size most welfare is gained, either for the total population or especially for the higher educated. Gains are largest in the cities, yet the answer at this scale level does not lie, as some wishfully argue, with the largest (capital) cities. A focus on solely the largest cities does not lead to the highest gains in the LRR. Although the return on knowledge workers is high in the largest cities, these cities are not that much larger than many other cities in the LRR.

Scenarios that exclude gains on knowledge workers and through borrowed size in these other medium-sized cities in the region are less favourable.

This stylized exercise can be illustrated by real-life examples of policy orientations on cross-border connections (Maastricht-Aachen-Liège-Hasselt), toward urban density (Amsterdam, Cologne, Dusseldorf, inter-urban accessibility) or focusing on borrowed size (North wing of the Randstad, Ruhr region, Betuweroute connection, highway improvements). Most importantly, it confirms the hypothesis that a combination of borrowed size and local urban focus is most favourable for production gains in a polycentric mega-region like the LRR.

We argue in this essay that the Lower Rhineland Region (LRR) as one of Europe's prototype mega-regions has a substantial untapped economic potential in further exploiting existing and emerging synergies and complementarities in economic performance. The polycentric nature of the region though implies that economic growth, resilience, competitiveness and societal transitions that benefit from urban mass, density and diversity, is not to be taken for granted. Using the existing literature on agglomeration and scaling as well as a stylized scenario analysis of the LRR applying the outcomes of this literature, we suggest where (in the urban network of the region) and how (using which instruments, applied by who) untapped potentials can best be exploited. Borrowed functions and borrowed performance (together borrowed size) may offset the lack of agglomeration advantages related to larger (monocentric) cities. Yet this only works out when the co-determining conditions of accessibility, knowledge relations, openness, social networks, and diversification and specialization, economic complementarities and institutional unity (governance involving the European Union, nation states, regions, border regions, cities and network providers in tandem) are simultaneously met as well. A lack of any of these elements hampers (full) integration and the tapping of potentials. This essay is explorative in character, and we stress that many effects, relations and causalities are only starting to be revealed by empirical research. Particularly important are the trade-offs that potentially exist between the in tandem multilevel approach of borrowed size with more centralised economic, regional and institutional approaches. More research on this is needed, and we therefore end with an integrated research agenda and policy agenda.

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1. INTRODUCTION

1.1. *Europe in transition*

Europe is in transition – economically, as well as socially and institutionally. Europe has not fully recovered from the latest economic crisis yet, with several regions still facing negative growth rates and high unemployment rates.² The resilience and recovery patterns suggest that urban regions in Western-Germany, the Benelux, Scandinavia, England, France and Poland are structurally better off, while other Eastern European regions, and Spanish, Portuguese and Greek regions lag behind, resulting in a highly diversified mosaic of economic performance across EU regions.³ Partly, this is due to historically grown regional economic structures⁴ that strongly determine worldwide market opportunities by demand-led growth. But equally important is the fact that innovative capabilities of regions that help firms to become more resilient and competitive in the long run by creating adaptability and structural growth,⁵ are not equally distributed and exploited across EU-regions either.⁶ Especially German and English urban regions stand out in product innovation, while process innovation is somewhat more widespread across the EU. Compared to economic performance, resilience and innovation patterns elsewhere in the world,⁷ the European (regional) economy appears vulnerable, with diverging institutional qualities across the continent,⁸ varying capacities for diversifying and renewing the economy,⁹ and fragmentation of economic mass and investments both across and within countries.¹⁰

It is not only economic and institutional heterogeneity that characterizes European regions; this is complemented by cultural, political and social inequalities.¹¹ European societies are in transition, economically shifting from manufacturing to services (and perhaps back to small-scale manufacturing facilitated by 3-D printing), from fossil energy to bio-based energy, from known value chains to extended ones in circular economies, from organisation in industries and sectors to self-organisation by firms and citizens.¹² More than ever, the EU faces the challenge to profit from economies of scale and scope in its organisation, economy and society. However, smart solutions are needed to overcome the fragmented structure of EU economies and societies.

There are currently many initiatives and policies to overcome organisational and economic fragmentation in the EU. To name but a few:

- the Juncker (EFSI) investment plan, launched in 2015, aims for public-private partnerships in large societal issues, where public seed money is expected to result in a large private multiplier in increased trade and participation in innovative activities.
- Smart specialization strategies aim to stimulate innovative economic development in every EU-region using smartly designed diversification and specialization strategies that should be place-specific in order to adjust to the observed heterogeneity.¹³
- TEN-T infrastructure programmes plan international and interregional train and truck logistics corridors across Europe to assure accessibility and international competitiveness.¹⁴
- Multilevel governance is promoted as a successful means to cooperate and integrate the various fragmented geographical policy layers in EU member states.¹⁵ Political cooperation is urged for pressing issues, like migration and sustainability.
- Finally, social cohesion policy on various geographical levels is actively pursued by the EU to overcome inequalities.¹⁶

These initiatives cover a wide range of aspects of regional development, yet their common factor is that they all attempt to create larger masses by enhancing connections.

1.2. *Urban agenda*

Increasingly, the focus of “smart” EU policy is turned towards cities.¹⁷ In larger metropolitan areas, smart solutions for the complex and transitional issues at hand may be found easier than elsewhere. Many stakeholders in Europe agree that the economic and societal transitions should be taken up in a common urban agenda. Comparative economic advantages increasingly manifest themselves in agglomerations – characterized by so-called agglomeration advantages,¹⁸ co-evolving with increasing economic mass, a combination of local advantages for firms and people (“local buzz”), and international connectedness (“global pipelines”).¹⁹ Larger cities are thus generally found to be more productive (controlled for sorting effects of education, occupation and demography) because of opportunities of scaling, leading to better opportunities for growth and resilience. But besides London and Paris, Europe does not have very large cities. Europe does have large urban regions, like Randstad Holland, the Ruhr region in Germany and the Flemish city network – but these are characterized by their polycentric nature of smaller and medium sized cities. This polycentric character of Europe’s urban regions is envisioned by the EU as an untapped potential for economic, institutional and social synergies and complementarities.²⁰ In an urban network setting, European city-regions may function as a mega-region in which economic and social economies of scale may be gained as if these regions were one large city, functioning as an urban network.

1.3. *Where and how?*

We determine in this essay what it actually takes for the Lower Rhineland Region as an exemplary polycentric (mega-)region²¹ in Europe to capitalize on such untapped economic potentials by further exploiting existing and emerging synergies and complementarities. The polycentric nature of this region implies that economic growth, resilience, competitiveness and societal transitions that benefit from urban mass, density and diversity, are not to be taken for granted. We will explore the existing literature on agglomeration and scaling to reveal the arguments of where (in the urban network of the region) and how (using which instruments) untapped potentials can best be exploited. The previously described economic and scaling logic makes the Lower Rhine region a relevant regional scale for this.

We want to show *where* and *how* the Lower Rhineland economy should organize its future welfare and well-being according to the untapped potential logic. As a very open economy, and as one of the oldest industrialised and urbanised areas in Europe with historically successful cities like Amsterdam, Bruges, Brussel, Ghent, Rotterdam and Cologne, the need for an evidence-based vision addressing this question is not only important for the mega-region itself and its cities, but also for similarly open regions elsewhere in Europe that learn comparative lessons from this region. It is an ideal case study due to its barriers to integration, its polycentricity, and its multiplicity of stakeholders, each with their own vested interests, including cities, provinces, border regions, nations, and network facilitators.

In our globalizing world in which competitive regions and cities become ever more important, the *where* question is more important than ever. Seen from an international perspective, the Lower

Rhine region has a fragmented morphological and economic setup. Additionally, the region covers three nation states with significant differences in institutions and culture. Arguably, these differences still hamper economic interaction and integration, despite the European unification process.²² *Where* the region should capitalize on its mega-region potential is therefore far from clear. Closely related to the *where* question is the *how* question. Should cities individually be enlarged, by allowing higher densities and/or larger urban land-use – a strategy that is argued to lead to an economically more efficient allocation given the importance of positive agglomeration externalities?²³ Or can medium-sized cities in European polycentric regions borrow economic size from each other – as long as they are (physically) well connected?²⁴ Especially for the Lower Rhine Region such a strategy of borrowing size in an urban network may be beneficial in releasing its full economic potential. Borrowed size may benefit from investments in connectivity between (medium-sized) cities, but other forms of economic and institutional relatedness may be equally needed. *How* the region should capitalize on its mega-region potential is therefore also far from clear, but we will attempt to point in a few directions.

1.4. Trade-offs

The complexity of where and how to capitalize on relatedness between cities in the network is part of a larger set of trade-offs. Cities and agglomeration advantages, local-global interaction, and borrowed size are relatively new kids on the block in policy-oriented regional economic thinking. Density and infrastructure investments are already longer part of the regional development discussion. The *why*, *where* and *how* questions boil down to a range of policy trade-offs: between mass and density versus proximity and connectedness, but related also to equity versus efficiency development strategies, economic (smart) specialisation versus diversity, and commuting versus housing. These debates are politically complicated by the fact that there is substantial heterogeneity in who exactly benefits from agglomeration. It is crucial to understand this heterogeneity, because it implies that urban investments and growth patterns are not distributed according to a one-size-fits all rule.

1.5. Structure of the essay

In section 2 of this essay we present a concise overview of the theoretical and empirical literature on urban scaling and density, agglomeration advantages, polycentricity and borrowed size. From this we distil the main arguments that are related to the potential of economic prosperity facilitated by spatial and economic structure. We then present in section 3 a scenario simulation, using these arguments, to show how large the economic potential of urban networking can be in the Lower Rhine region. We assess the impact of various forms of intercity interaction within the region, ranging from local to cross-border and large-scale integration (based on real-time examples in the region). The essay will then particularly focus on the “in tandem” approaches in terms of economic, regional and institutional efforts needed in section 4, resulting in a multilevel policy and research agenda.

2. URBAN DEVELOPMENT AND AGGLOMERATION

2.1. *Scaling up and down*

Since 2008, more than half of the world population lives in cities, and in 2050 this proportion rises to 70%; within the European Union, the share was 42% in 2011, with another 35% in intermediately urbanized regions,²⁵ while according to the UN definition Western Europe already has a share of 79% in 2015, projected to rise to 81% by 2025.²⁶ While searching for explanations for the success of cities, we should not neglect the shortcomings of urban life. Cities have two faces creating fundamental trade-offs:²⁷ they facilitate growth and innovation opportunities for firms and a better quality of life for its people; yet for some (groups of) people and firms the urban dynamics may reduce chances,²⁸ and they are by definition congested spaces. The question why people want to live in cities and why firms agglomerate is therefore central in a burgeoning literature.

Paradoxically, the twenty-first century sees an upscaling of the spatial arena within which people are active driven by modern transport and communication technologies, yet also an increasing recognition of the importance of (neighbourhoods in) cities as the fundamental sources of economic progress and sub-national governance bodies as the natural candidates to formulate socioeconomic policies. The interest in and recognition of the relevance of these trends are evidenced by thought-provoking best-sellers such as Thomas Friedman's *The World is Flat*, Edward Glaeser's *Triumph of the City* and Benjamin Barber's *If Mayors Ruled the World*.²⁹ Thus, geopolitical shifts within and between metropolitan regions, countries and continents guarantee an ever-changing playing field, with new challenges and opportunities.

2.2. *Regional integration, trade, and productivity*

The notion that space and distance matter in determining growth potential is by now widely acknowledged. Evidence on the importance of *trade* as one of the key determinants of economic growth is rather undisputed (since the important contributions in the economic growth literature in the early 1990s³⁰). It links to the notion of specialization according to one's comparative advantage. Generally, theory underlines the relevance of scale which can be enhanced by opening borders as an important determinant of economic growth and prosperity. Empirically, European regional integration and openness show to be important for economic development.³¹ Increased access to a diversity of inputs, increased access to markets enhancing the exploitation of economies of scale, traditional specialization according to comparative advantage, and enhanced competition among firms contribute to the development potential of regions.³² A complementary recent literature aims to identify the benefits of openness by means of microdata (viz. data at the individual level, where individuals can be workers or firms). This literature essentially focuses on the productivity of individual firms as a function of their interaction with the foreign world (either through exports or imports or foreign direct investments). There are clear associations between openness and productivity, but causality is also likely to run from productivity to openness: it is only the more productive firms that consider to incur the fixed costs that are associated with establishing a relationship with foreign firms. This essentially reduces the question about the relationship between trade and growth to the question what enhances the productivity of firms. That question is central in the burgeoning and more general agglomeration literature.

2.3. *Agglomeration economies are not the same everywhere*

Besides from trade, firms profit from an urban productivity premium exists associated with larger density – the agglomeration premium of approximately 5 percent. Theoretically, this literature goes back to the late 19th century when Alfred Marshall alluded to the relevance of linkages (less search costs for subcontractors), thick labour markets (less search costs for labour) and knowledge externalities (less search and transaction costs for knowledge) for explaining the success of cities in the industrialized United Kingdom. In the modern literature, the main mechanisms are typically referred to as learning, sharing and matching.³³ Although the advantage in productivity is on average 5 percent when cities double in size, this is an average figure³⁴ – the effect varies between sectors (it can, for example, be up to 15 percent for some service sectors), because of varying industry composition, composition of the labour force, or the spatial organization of economic activity. More advantage in cities is there for particular jobs (in high added value sectors) and for particular employees (for higher educated people); these particular effects for certain groups are called competition or sorting effects. For economic growth, heterogeneity and sorting effects are important in cities. Recent literature increasingly tries to unravel this heterogeneity. Relevant insights from this literature for policy are:

- Agglomerations externalities are higher in regions and countries where infrastructure is relatively underdeveloped.³⁵ This points at infrastructure being a (partial) substitute for density which is particularly relevant in a polycentric area such as the LRR;
- Agglomeration externalities are more relevant for high-skilled labour than for low-skilled labour.³⁶ This is most likely to be explained from the fact that agglomeration externalities for high-skilled mainly constitute knowledge spill-overs, viz. spill-overs of knowledge that is tacit in nature. It requires besides a favourable job supply, urban investments in the housing market and amenities that higher educated are attracted to;
- There are clear border effects: mass originating from regions belonging to a different country has a lower weight in determining the effective density.³⁷ This insight has been established in many different contexts, and clearly points at the relevance of soft barriers such as language, institutional and cultural barriers.³⁸

2.4. *The bridge between specialisation and diversity: related variety*

The urban productivity premium of 5 percent theoretically applies to the productivity level when a city doubles in density of cities. It does not necessarily mean that productivity *growth* is larger in larger cities as well. For growth analyses, a related literature exists. Since the findings of Glaeser et al.,³⁹ who studied sectoral agglomeration more than the aggregated effect, it has become commonplace to analyse growth in cities, suggesting increasing returns from sector structure. Sector-specific localization economies, stemming from input-output relationships and firms' transport cost savings, human capital externalities and knowledge spill-overs (the three Marshallian externalities), are generally suggested to work alongside the general urbanization economies that are fuelled by economic diversity instead of specialization. Jane Jacobs⁴⁰ in particular initiated the idea that the variety of a region's industry or technological base may positively affect economic growth. In empirical studies though, the relationship between agglomeration and growth is ambiguous with regard to whether specialisation or diversity is facilitated by (sheer) urbanization as context.⁴¹ A recent literature therefore introduces related and unrelated variety as more adequate concepts in the empirical modelling of growth across

European regions. This literature⁴² argues that companies from related branches of industry have overlapping knowledge bases. This overlap facilitates inter-company communication: shared knowledge, frames of reference and applied technology make it easier for them to understand one another. The fact that this overlap is only partial means that there is room for them to learn from one another. The presence of a high volume of related economic activities in a region thus facilitates the generation of new combinations of existing technologies. Related variety is also an important ingredient in the European smart specialisation debate. In fact, empirical research⁴³ indeed finds that for European urban regions, the positive results of knowledge spill-overs are higher in regions with strong related variety. For employment growth, this effects is stronger in medium-sized (second tier) city-regions with a more polycentric character, than in the larger and capital regions. An interesting theoretical contribution to the specialization-variety debate that focuses on these explained variables has been provided by lifecycle theory, which holds that industry evolution is characterized by product innovation (and more employment growth) in a first stage and process innovation (and more productivity growth) in a second stage.⁴⁴

These interesting lines of research show that the combination of specialization (clusters), sectoral variety and good connections to the global world together make up urban regions' growth potentials. Relatedness in networks of technology and markets to be served should be sufficiently high to warrant crossovers by variety between sectors, but sufficiently low to warrant economies of scale by specialization in clusters in later stages of the life-cycle of industries.⁴⁵ The Rhineland regions are characterized by an interesting blending of emerging and mature industries.⁴⁶ This means that local projects and policies should ideally focus more on the evolution of existing sectoral strengths in the region, but also on new cross-over potential to sectors closely related to these specializations.

2.5. *Agglomeration and policy*

This is not an easy task for policymakers. A productivity premium of 5 percent in denser cities does not come by itself. In this section we summarised that it depends on the level of interregional trade integration and specialization, on the industrial composition of and life cycle stages of industries in the region, on skills of knowledge workers, on relatedness in and crossovers of innovative technologies combining economies of scale of specialization and economies of scope of diversification, on infrastructure as a possible substitute for agglomeration, and on border effects. We will return to these differences in section 3 with a numerical application to the Lower Rhineland Region.

Because of this complexity and exogenous character of many of these aspects, a general advice to policymakers regarding agglomeration economies is to "go with the flow" on innovation, labour market and housing market dynamics.⁴⁷ Still, basic economic and spatial conditions have to be met in every region, but in the LRR the basics seem to be sufficiently present. And it requires the capacity and restraint from policy makers to accept sectoral or regional decline and refrain from rowing against the tide in such situations. The latter may clearly benefit from coordination of policies internalizing the costs and benefits at the spatial level where they accrue; typically, a higher (up to EU) level is needed to maximize benefits.

Traditionally, public investments in physical infrastructure were importantly justified to foster economic growth. Especially the influential early work by Robert Barro⁴⁸ suggests that public investments in infrastructure can encourage growth by raising productivity in the private sector or by increasing access to health and educational facilities.⁴⁹ This initial focus in the literature on infrastructure as a key factor driving competitiveness has gradually expanded, and the current research frontiers lie in the fields of networks, related variety, smart specialisation, innovation and human capital. The switch from a more traditional macro- and international trade orientation to a more urban and geographical economics orientation has strongly enriched the debate.⁵⁰ There is an increasing awareness that, for example, the focus of cohesion policy on infrastructure investments to foster the development in backward regions is delivering insufficiently without other economic preconditions being met.⁵¹ A relative shift is therefore visible from infrastructure to other policy areas as additional drivers of spatial development and equality. However, the concepts of accessibility and transport infrastructure remain strongly in the spotlight in two recent approaches: firstly in discussions of borrowed size and urban network conceptualisations, and secondly in the discussion on interregional corridors.

2.6. *Borrowed size*

Borrowed size is a new kid on the block in the agglomeration literature, and it looks at agglomeration in a regional network perspective. It basically suggests that several medium-sized cities in each other's vicinity may function as a larger metropolitan region by borrowing each other's functions.⁵² Especially in Europe, the opportunities and potential of polycentric urban regions are emphasized in this literature.⁵³ According to place-based development strategists, economic growth is not uniquely related to (monocentric) mega-cities.⁵⁴ Instead, growth may be distributed across various urban systems in different ways in different countries. Barca et al. emphasise the simultaneous role of medium-sized ('second tier') urban regions and argue that these are over-represented in Europe. Many highly productive urban regions in the EU are indeed small- to medium-sized whose dominant competitive advantage is that they exhibit high degrees of connectivity compared to urban or home market scales.⁵⁵ The Dutch, Belgian and German Lower Rhineland regions actually are prime examples of such urban scales. In empirical research⁵⁶ it is indeed found that in terms of economic growth good connected medium-sized cities can function as one large city, and hence can also benefit from an agglomeration premium,⁵⁷ but this is conditional on the quality of physical connectivity, local amenities and the housing markets (especially for higher educated workers). Applied European research further reveals that the relationship between related variety and employment growth is in fact *predominantly* present in such medium-sized cities in European polycentric regional settings. Interestingly, when we look at technological profiles (or 'regimes') across European regions,⁵⁸ the high-technology regional profiles, which are typically found in many Rhineland economies, are better at embedding productivity and productivity growth. In other words, as was the case with agglomeration (city size) and productivity, there are identical sorting effects in borrowed size toward high-skilled knowledge and human capital in innovative regions.⁵⁹

This conditionality is also confirmed in other studies on polycentricity and borrowed size performed on European regions.⁶⁰ In a study on productivity, productivity growth and employment in 142 European regions, it is shown that there are many factors that co-determine

growth – spatial structure being one of them. As suggested in previous sections, the knowledge intensity of firms, market accessibility, the degree of economic openness of the local economy (in terms of imports and exports), specialisations and clustering in important industries and the degree of diversification of an economy play a crucial role. Still, involvement in polycentric urban regions can add to the competitiveness and economic growth of a city – which is interesting for the typically polycentric regions of the LRR. In fact, this may indeed offset the lack of agglomeration advantages related to larger (monocentric) cities, while simultaneously avoiding the agglomeration disadvantages (soaring land prices, traffic congestion, health effects). Yet it only works out when the co-determining conditions of accessibility, knowledge relations, openness, diversification and specialization are met as well. Moreover, medium-sized cities can only combine their resources when they are economically complementary and institutionally related.⁶¹

2.7. *Corridors and bottlenecks*

Physical connectedness remains the key to capitalize on common agglomeration economies in polycentric regions like the LRR. Often such connectedness is supposed to be realized in *corridors* – a special case of borrowed size. In the case of the Rhineland region, a major corridor is the so-called CODE24 corridor, connecting Rotterdam and Genoa via the Ruhr area. Traditionally, such transport corridors are viewed as a promising way forward in EU transport policy, since they are assumed to positively contribute to regional economic development. However, the validity of this assumption is not evident. Recent research⁶² empirically tested whether agglomeration economies along this corridor are positively related to regional economic development, and found that corridors in Europe come in many guises when it comes to growth and agglomeration – in other words, what works for one corridor does not necessarily do so for another.

This heterogeneity has been little recognized in EU policies or in regional policies.⁶³ It is mostly the cities along the corridor that induce growth within their territory and in their direct surroundings; there is no effect elsewhere along the corridor. Hence, agglomeration advantages are bound to the urban centres more than to the transport axes. This suggests that “borrowing size and functions”, as suggested in the polycentricity argument, is *not* served by the larger corridors per se. Instead, the borrowed size mechanism builds upon local and regional urban growth conditions. These facilitate localized initiatives and cooperation, and they have much in common with the classical mechanisms already identified before in the international trade literature, here operating at a lower spatial scale.

We can therefore conclude that cities in the LRR do not have to be gigantic to profit from agglomeration advantages. Instead, urban functions can be specialized and diversified over a larger regional area, profiting from economic complementarities in (institutionalized) networks. However, borrowing size, intuitively appealing in its argumentation, is little researched. The empirical evidence discussed above suggests that the localized urban level and its determining (complementary) economic, knowledge, intra-urban accessibility and institutional conditions are more crucial for agglomeration economies to flourish in the LRR than connectedness (in urban networks or corridors) between the cities itself. This also implies that bottlenecks in local transport infrastructure are to be removed for optimal functioning of the polycentric urban region, especially within cities (with a focus on “first and last mile” connections,⁶⁴ and accessible milieus for higher

educated). Yet there has been no comprehensive, consistent and especially integrative framework to analyse and evaluate bottlenecks in transport networks and to interrelate it with economic, spatial and governance issues. This becomes more poignant when we realize that bottlenecks are cumulative in character. Local spatial planning structures thus have a large impact on the solution of these bottlenecks, but are embedded in complex societal and (multilevel) governance structures.

2.8. *New network realities of cities*

The previous arguments signalled the need for new, smart and broader dimensions related to economic and societal transitions in (European) cities to overcome fragmentation. Besides agglomeration in larger cities, social (urban) network relations of people and firms become commonplace in urban environments and regions, involving governmental and network providing stakeholders on various levels ranging from the EU to regions and locations. This adds the important and essential dimension of governance and network policy to any urban agenda. This section elaborates on which dimensions the literature suggests important for these new network realities of cities.

Recently it has been argued that (urban) location factors are not sufficient to explain the concentration of people and business. The *new science of cities* argues that in order to understand cities, we should not conceptualize them merely as places, but much more as systems of networks and flows.⁶⁵ Flows of talent, of foreign investments, of information, in social networks, across cultures. Flows that require embedding within local infrastructures,⁶⁶ linking local with regional⁶⁷ and (inter-)national infrastructures.⁶⁸ Networks that co-determine how individuals and entrepreneurs function in cities and urban regions, how a quality of life is created that makes people happy and firms productive and competitive, or what hampers their well-being. Multilevel micro-macro relations of people and firms, networks and flows and quality of life are all central elements in the current urban debate.⁶⁹ At least six “new” (and interrelated) realities can be distinguished:⁷⁰

1. *New societies* refer to an increasingly powerful civic and globalised society, suggesting opportunities and diffusing fashions in an ever faster way. Increasing emphasis on individualism, growing disparities between rich and poor,⁷¹ and an increasing individual time-space complexity because of transitional labour, jobs of partners and social activity schemes of family.
2. *New economies* refers to innovative urban economies, that generate increasing productivity and improves urban competitiveness in incubator micro-environments of small firms as well as in larger-scale multinationals able to upscale renewal. Resilience and smart specialisation are key concepts, merging the two dimensions of adaptation and adaptability.
3. *New mobilities* refers to factors that stimulate the formation of networks and flows of people (migration, daily-life, transit, talent), knowledge (cooperation, knowledge workers) and other production factors (capital, trade and FDI).
4. *New technologies* refers to innovative cooperation between people and firms, facilitated by information- and communication technologies (ICT) and ICT-infrastructure, that may manage the ever more complex networked (infra)structures in cities of people and entrepreneurs. “Smart cities” and smart grids facilitate networked solutions in the increasingly crowded cities.⁷²

5. *New governance* refers to the self-organising powers of civic societies and economies and how to govern this. Social entrepreneurship, civic initiatives, peer-to-peer economies and the social network organisation of people and firms create and maintain new networks of interaction. The capacity to adjust to the opportunities and threats emerging in the complex global network society is becoming much more crucial for (smart) governance success.⁷³
6. *New scarcities* refers to climate change, natural hazards, energy and land-use issues in urban regions. Sustainability has a clear relation to the (future) availability and quality of these resources.

When recognized and facilitated well, the new societal conditions inhabit important opportunities for urban development. Appealing as these new realities are – the economic application of it in cities in regions is strongly dependent on firms', people's and governments' capacity for absorption and adaptation. This shows that the urban agenda is not only concerned with agglomeration, density and accessibility, but also with social, economic and governance network interaction. On every geographical level stakeholders are involved in this interaction: firms, knowledge institutes, consumers and governments operation at the European and international level, the national level, the regional level (a special case concerns border regions), and the local level, as well as physical and digital network providers. Agglomeration economies and accessibility are important necessary preconditions for this interaction – but sufficient conditions simultaneously are identified in social, institutional and governance disciplines.

3. THE LOWER RHINELAND REGION AS CASE STUDY

3.1. *Determinants of interaction*

From the concise overview in the previous section of urban economic and development theories and empirics, we learn that in the LRR several morphological, economic, social and institutional determinants of development operate simultaneously in the trade-off between agglomeration economies and accessibility (borrowed size). Important determinants are:

- Population and economic density of cities and regions;
- The morphological structure of urban regions;
- The physical connectivity of cities within the region (by infrastructure and corridors);
- The economic structure of cities and agglomerations; reflected in degrees of specialisation and sectoral diversity, life-stages of sectors, and international orientations of sectors;
- The degree of economic complementarities between cities in the region;
- The willingness of cities to focus on complementarities instead of competition;
- The existence of (national and regional) borders in the region, with differences in culture, institutions and spatial organisation.

Although we do not have information on all these aspects in the same detail, we translate these determinants with varying emphasis on agglomeration and connectivity in nine spatial-economic interaction scenarios for the LRR. We first briefly describe this region in terms of mass, density, economic structure and connectedness. We then present our scenario exercise, and discuss the outcomes.

3.2. *The Lower Rhineland Region*

LRR is a region with almost 40 million inhabitants, stretching out over three countries, which is one of the largest urban deltas in the world. It has a rich economic history, going back to the sixteenth century, when this region was already flourishing and leading in the world economy. Figure 1 presents the employment density of labour market regions (NUTS3) in LRR as we define it for this essay, consisting of economically significant parts of the Netherlands, Belgium and Germany. It clearly reveals the complex polycentric structure of the region with no single city exceeding 1.5 million inhabitants, but being closely connected and together more sizeable than regions such as Paris and London. Figure 2 presents the recent dynamics in these regions as captured by population growth. Figure 3 shows growth in value added. These figures reveal the heterogeneity in development paths of the various sub-regions, with national border still clearly visible. As said heterogeneity in development is driven by heterogeneity in sectoral composition. Figure 4 presents the extent of over- or underrepresentation of types of industry in the LRR.⁷⁴

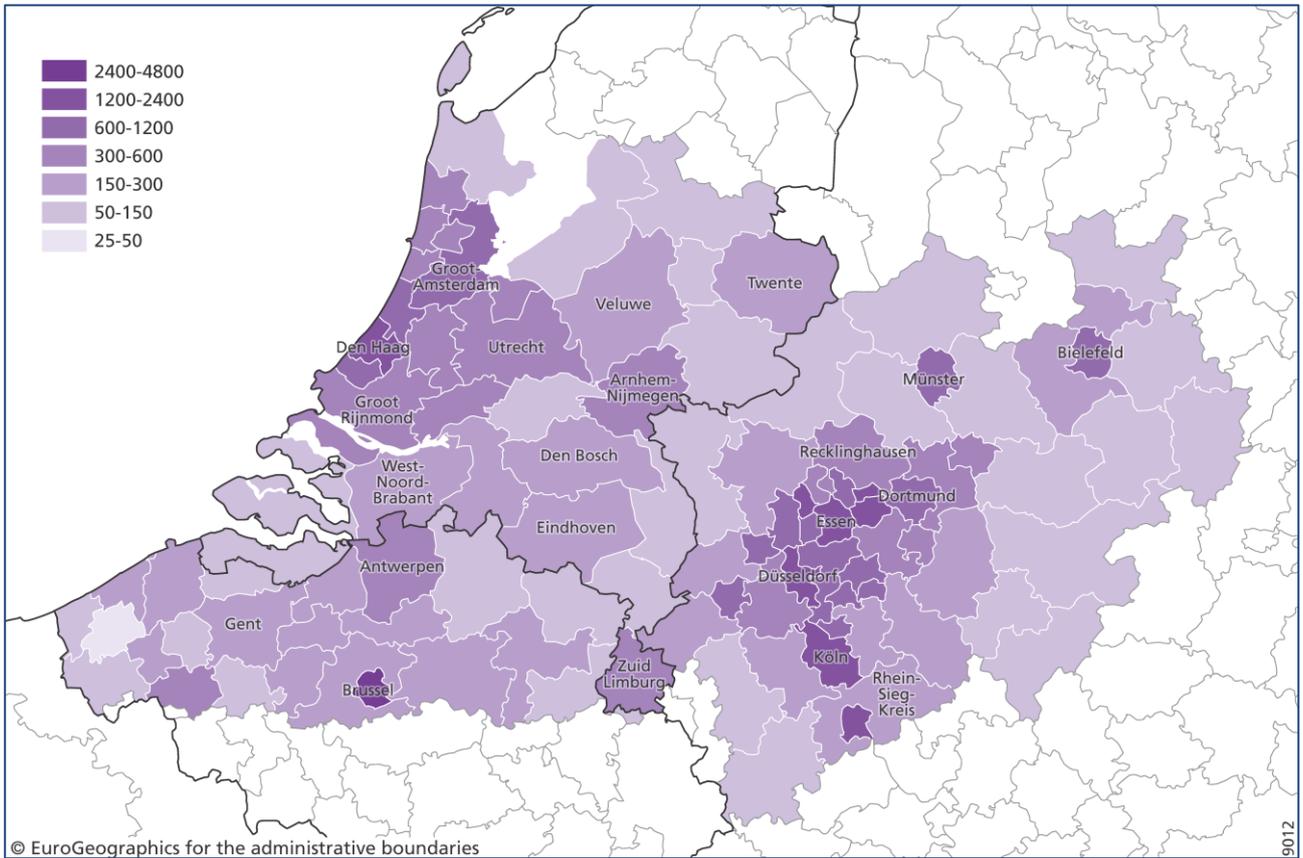
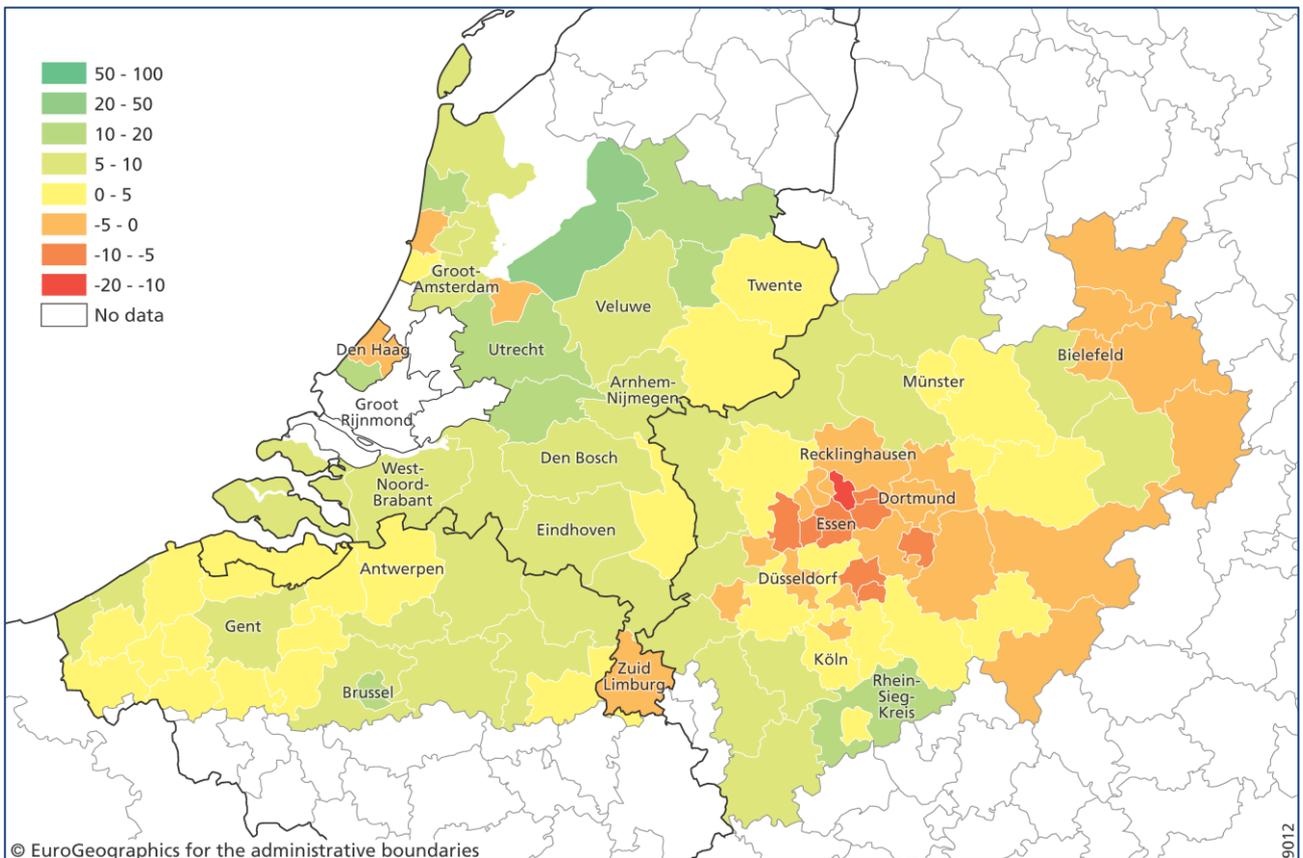
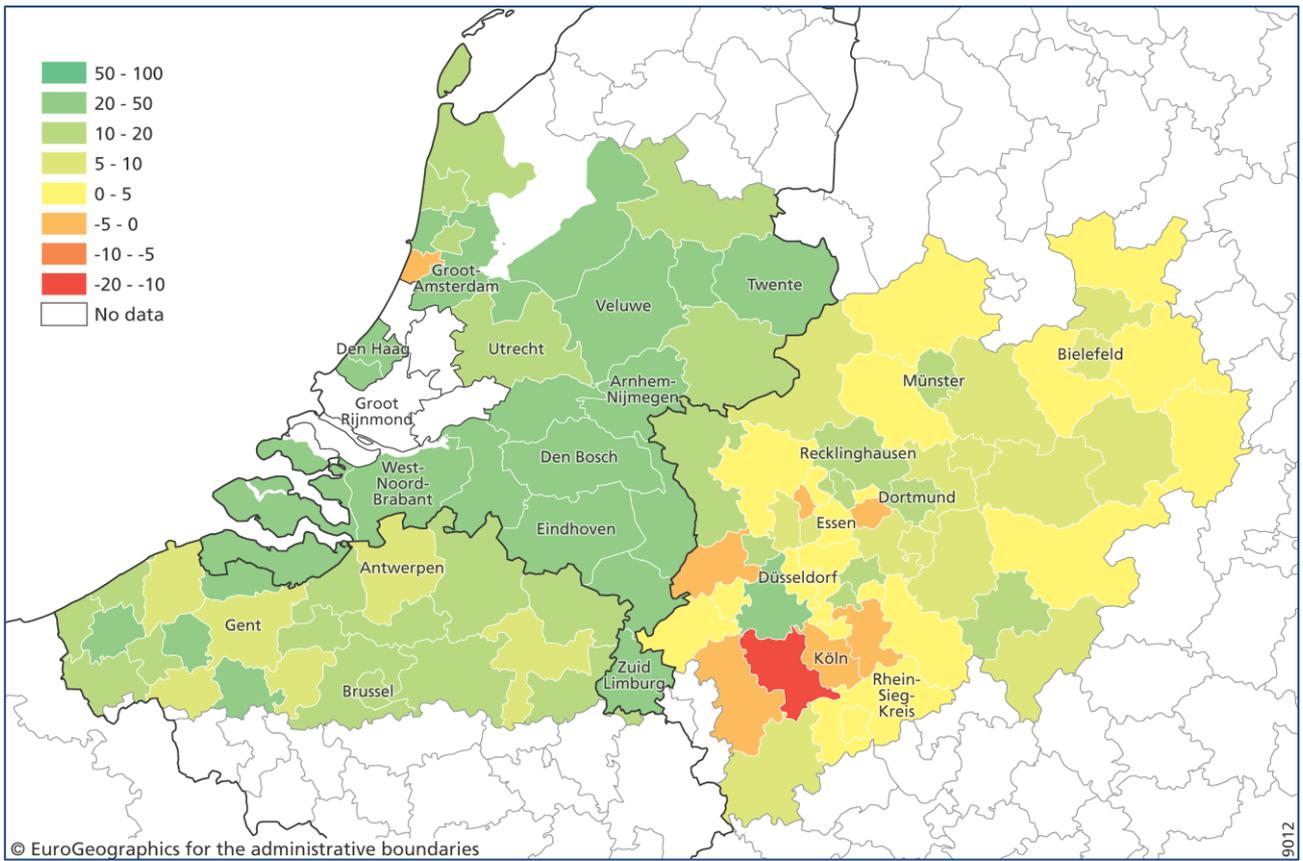


Figure 1. Employment densities in the region





Figures 2 and 3. Growth of population (density) and productivity (value added per employee)

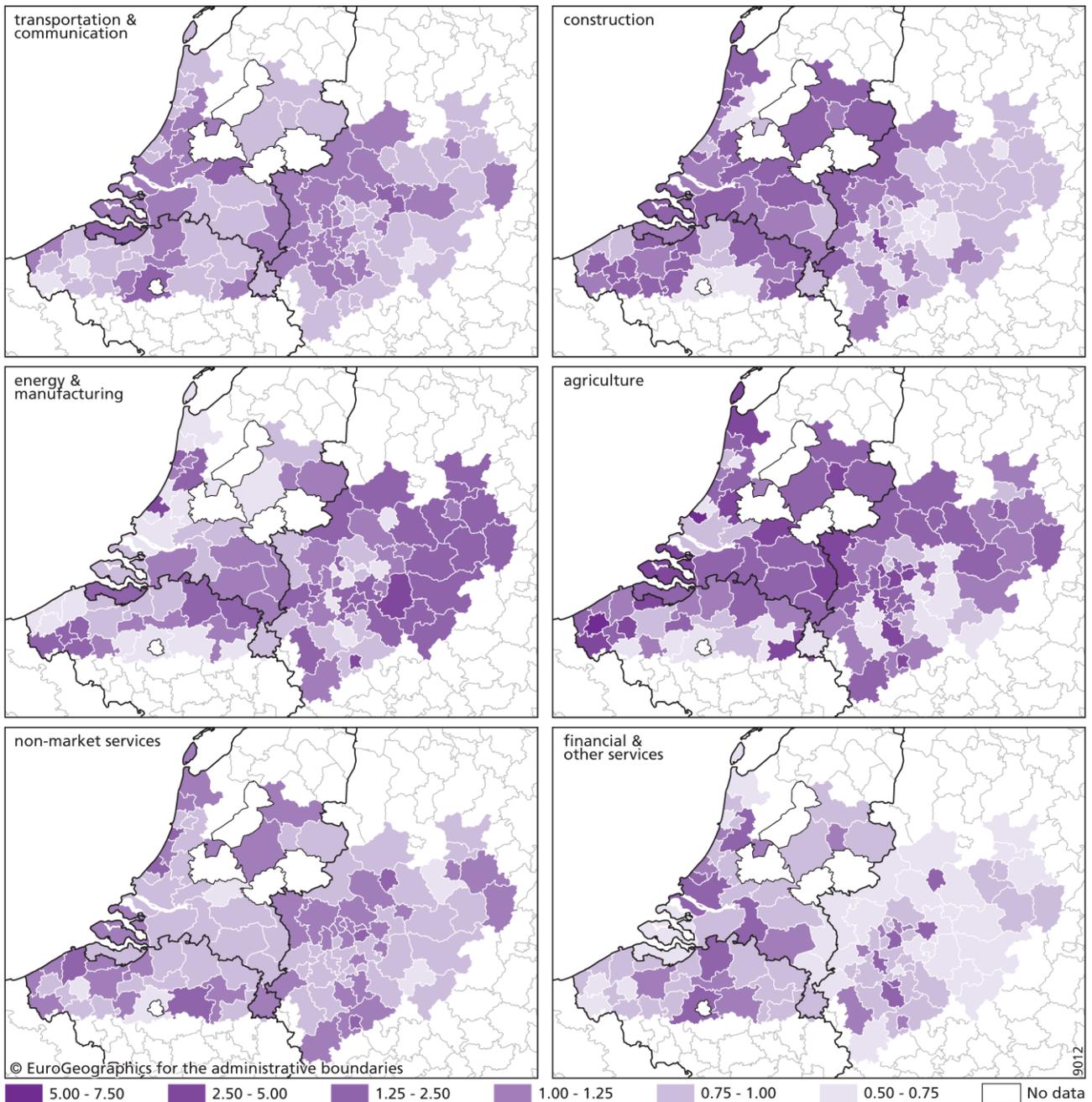


Figure 4. Concentration of sectors in 2010 (location quotients)

In such a densely populated yet polycentric area, infrastructure is essential to connect the various sub-regions and has for long been the focal point of many policy initiatives. Figure 5 shows the high motorway density in the area, in particular in the Randstad and Ruhrgebiet. Major infrastructural investments are made by various governmental levels in the different countries. Both Germany and Belgium are federations; the Netherlands is not. Hence, the share of government budget that is spent at the regional level differs wildly. Germany and Belgium both have higher shares of public expenditure at the regional level; yet the Netherlands spends a relatively large part of the regional budget on economic affairs.⁷⁵



Figure 5. Road (green) and rail (purple) links in Northwest Europe (based on the Espon Atlas 2014, p. 53).

3.3. Scenarios on agglomeration and accessibility

To illustrate the empirical relevance of the mentioned effects of agglomeration and accessibility, we present a simulation exercise in which we take the empirical evidence on agglomeration externalities and border effects into account in the given context of the LRR. We develop a range of scenarios to illustrate the quantitative impacts of differences in spatial organization of economic activity and connectedness on productivity.

Our analysis starts from the spatial allocation of people across the LRR (NUTS3) regions and their average productivity levels as evidenced by known data.⁷⁶ Considering the 5 percent agglomeration externality on density found in the literature, an increase in population density increases productivity in a region, and thus total production. We include population from neighbouring regions in the population density as ‘visitors’ (i.e., we assume they carry out part of their activity in a region or that they generate spill-overs to neighbouring regions), but to a lesser extent for regions across the border.⁷⁷ We then develop a series of comparative statics exercises to illustrate the quantitative importance of the varying situations in morphology, agglomeration, density and physical connectivity (see figure 6 for a schematic representation of the scenarios):

- I. A national scenario in which we use real-life effective densities, but assume no effects across the border. Effects are therefore purely within a country. This is our baseline; we assume this conforms closest to current-day reality.
- II. Down from the baseline scenario, we construct a zero scenario, where only the own population (“closing regional borders”) is included, without any ‘visitors’. All regions thus lose a bit of productivity.

- III. In a uniform scenario we redistribute the population: that is, cities and rural regions now all get the same density, and there are no ‘spikes’ of agglomeration any more. Mainly, rural regions are hypothesized to gain from this.
- IV. We then construct a scenario with moderate border effects, in which we allow for some interaction across the national borders, compared to the baseline.⁷⁸
- V. A scenario without borders adds full interaction across the national borders, with equal weights for regions in the same country and across the border.
- VI. In our borrowed size scenario, we further decrease distance decay within the country compared to the scenario without borders, but we leave the cross-border interaction as it is.
- VII. We simulate further urbanization by shrinking the population of rural regions (with a density below average) by 25%, and moving the displaced inhabitants to the more urban regions within the same country, with the settings as in scenario IV.
- VIII. There are strong and intuitive suggestions in the literature⁷⁹ that the higher educated benefit more from interactions, both across larger distances and with a higher increase in productivity. We simulate this by a scenario where the higher-educated benefit from the borrowed size of scenario VI, but where the lower-educated are restricted to the effects of scenario IV.⁸⁰
- IX. Following the plea of some policymakers to double the size of the largest, primate cities,⁸¹ we calculate what happens if we do so for Amsterdam, Brussels and Cologne.⁸²

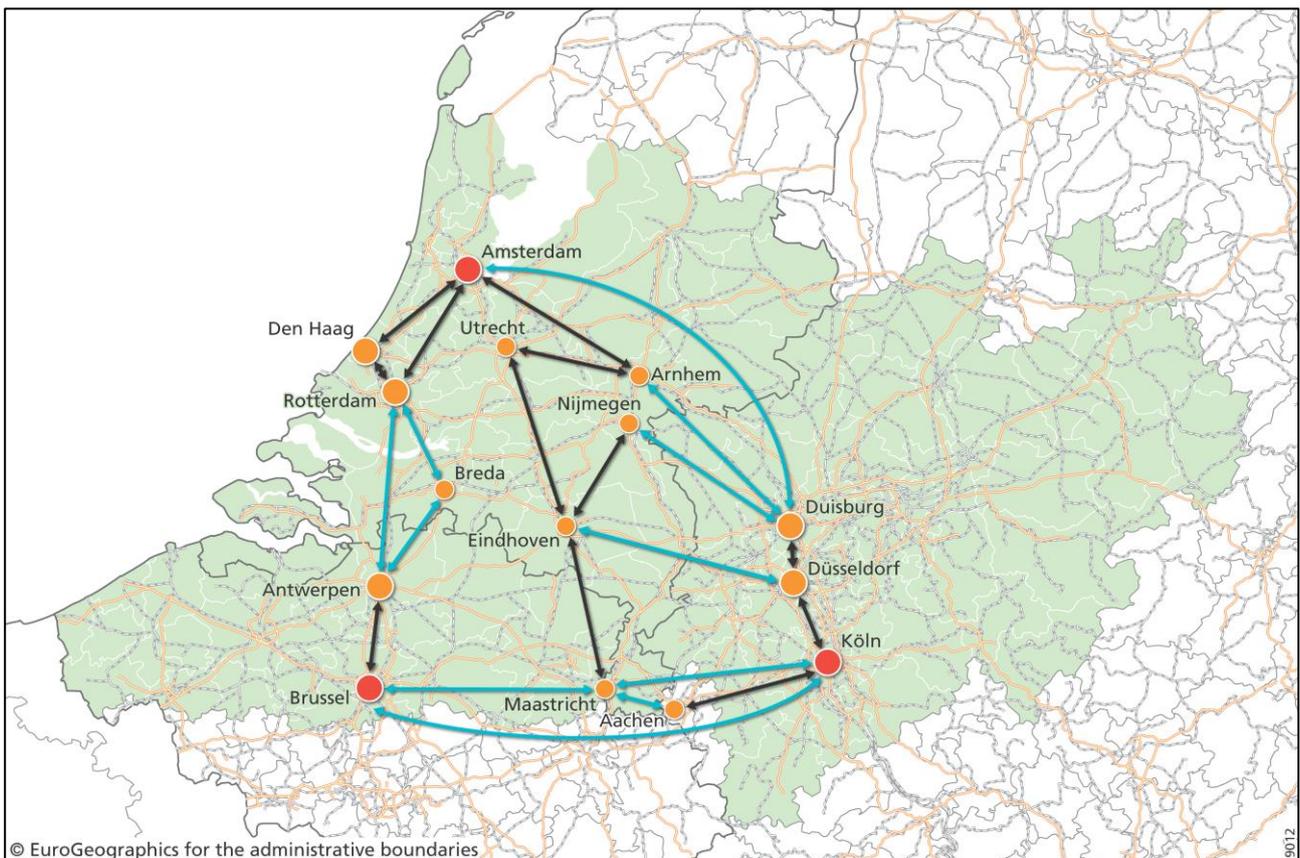


Figure 6: Scenarios in the LRR. Blue lines indicate some of the cross-border links; black lines some of the within-country effects. The largest three cities are indicated in red.

3.4. Outcomes

Table 1 summarises the outcomes of the agglomeration and accessibility scenario analyses in terms of total production gains and losses per capita. Without interpreting the total absolute value of production gain, the relative impact of the scenarios vis-à-vis each other is quite clear (in table 1 the average across all regions, in figure 7 the spread of the regions). Scenario I (business as usual), II (closing regional borders) and III (uniform distribution across all locations in the LRR) do not result in gains for total production; even worse, scenarios II and III result in net losses. The gains from removing the borders in scenarios IV (moderately) and V (complete) are relatively small.

The total gain in production is largest when we allow for more interaction within countries as well: in scenarios VI and VIII, borrowed size ‘unlocks’ a total of € 4 or € 1.5 in yearly gross value added per capita, where the latter assumes only the higher educated benefit, making the total gains smaller but perhaps more realistic. Naturally, in all scenarios, gains are largest in the cities. However, the answer at this scale level does not lie with the largest, “primate” city; we show in scenario IX that a focus on solely the largest cities does not lead to the highest gains in the LRR as a whole. Although the return on knowledge workers is high in these largest cities, the cities are not that much larger than many other cities in the LRR, and such a focus reduces gains in the other cities in the region. In the real world, it will moreover lead to an unprecedented increase in agglomeration disadvantages, like congestion and pollution.

Table 1: Descriptive outcomes of scenario exercises, in euros per capita.

Scenario	Mean	St.Dev.	Minimum	Maximum
I.	0.00	0.00	0.00	0.00
II.	-0.55	0.24	-1.37	-0.17
III.	-0.45	0.75	-2.85	1.61
IV.	0.03	0.02	0.01	0.17
V.	0.38	0.22	0.12	1.49
VI.	3.84	1.49	1.38	10.34
VII.	0.49	1.11	-0.22	9.39
VIII.	1.45	0.59	0.54	4.67
IX.	0.25	0.38	-0.20	2.05

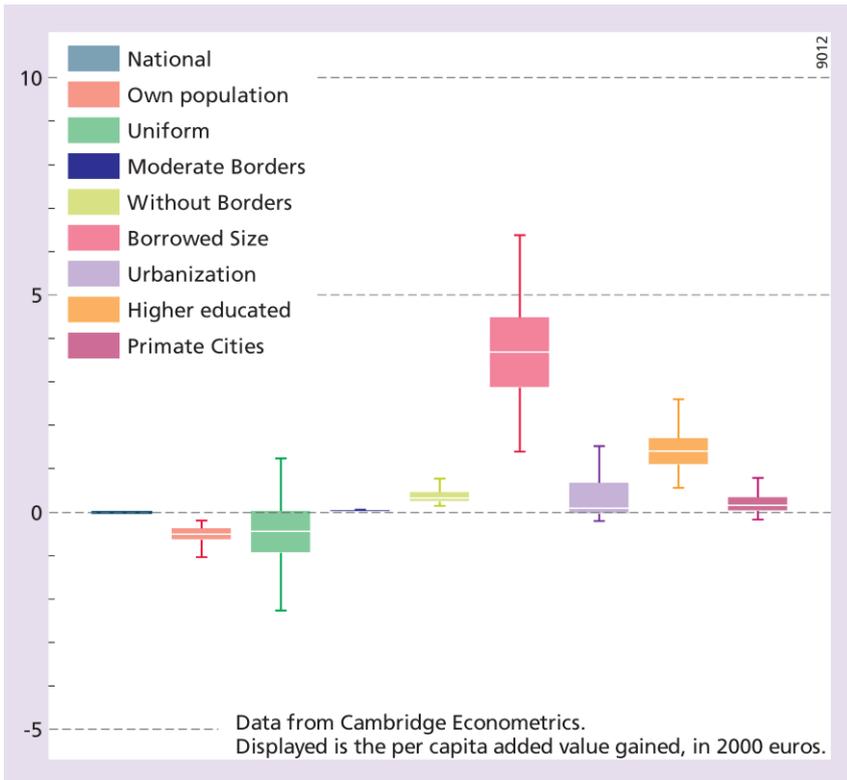


Figure 7: Outcomes of scenario exercises: spread, showing the heterogeneity of effects by region.

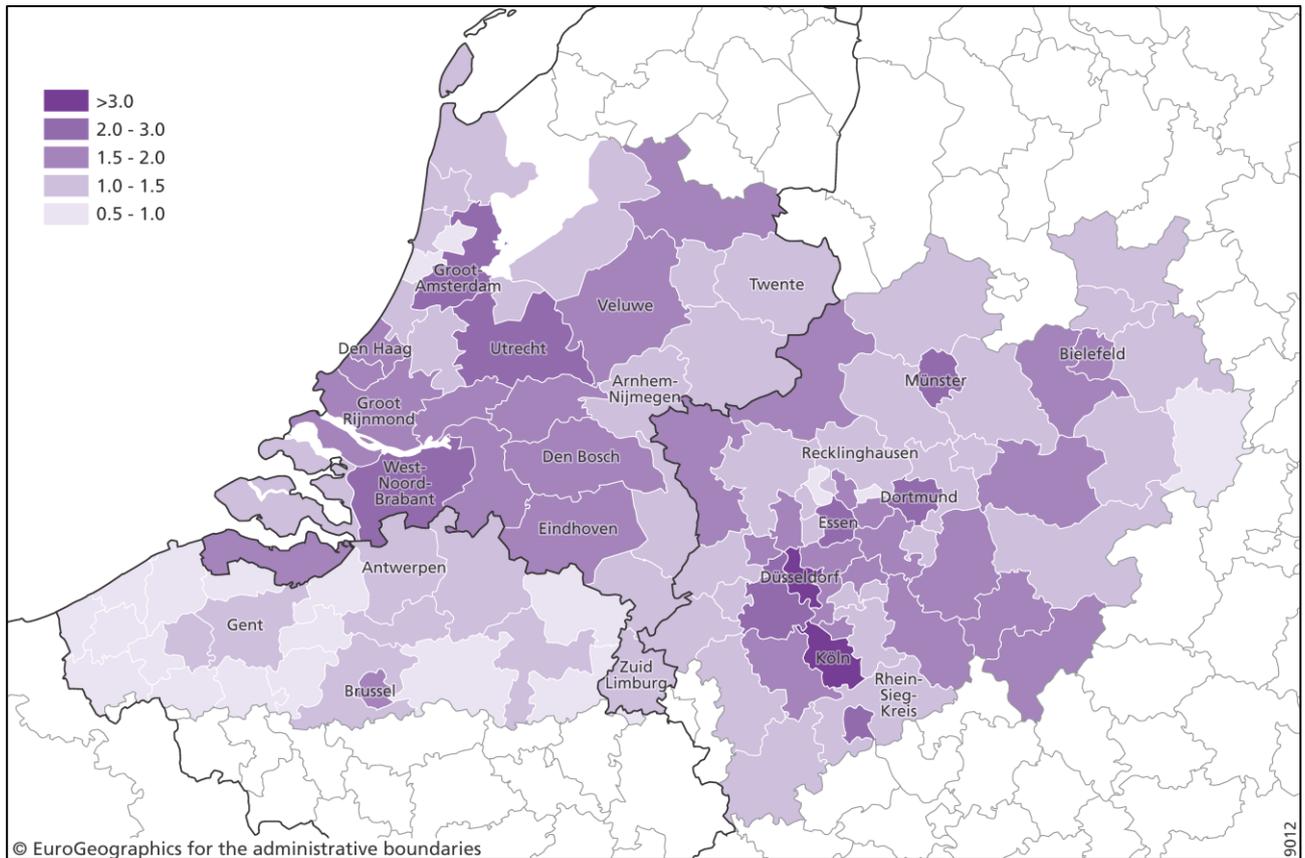


Figure 8: Map showing heterogeneity of effects for scenario VIII.

This stylized exercise can, of course, be illustrated by real-life examples of policy orientations on cross-border connections (Maastricht-Aachen-Liège-Hasselt), toward urban density (Amsterdam, Cologne, Düsseldorf, inter-urban accessibility) or focusing on borrowed size (Northwing of the Randstad, Ruhr region, Betuweroute connection, highway improvements). Most importantly, it confirms the hypothesis postulated in section 2 that a *combination* of borrowed size and local urban focus is most favourable for production gains in a polycentric mega-region like the LRR.

3.5. *Examples*

In three brief examples, we illustrate how enhanced cross-border connections have enhanced competitiveness, or where they could do so in the future. In all three examples, infrastructure is the key policy instrument deployed.

The Betuweroute was intended as a dedicated rail connection for freight trains connecting the Port of Rotterdam to Germany and beyond, and as such is part of the TEN axis toward Genoa. Its construction led to large protests in the Netherlands, and many predicted its use would fall far short of the necessary threshold to justify its construction. However, in the years since it was opened, traffic has gradually increased, and by 2015 the line had a market share of 60% of all cross-border freight traffic.⁸³ However it turned out to be difficult to coordinate policies on both sides of the border, and German capacity increases on the mixed line from the border to the Ruhr area have started only in 2015, necessitating deviations and limiting capacity until at least 2022.⁸⁴

One of the main projected effects of the Betuweroute was of course precisely the modal shift from truck to railroad, with environmental and health benefits, as well as more control over potentially dangerous substances. The construction of the second Maasvlakte in particular necessitated a capacity increase of some kind, and rail was chosen over road expansion. However, the case for the construction of the route did not take wider economic benefits explicitly into account; for example, the possibilities for new forward and backward linkages between industries in Rotterdam and the Ruhr area were not used as an argument in favour of its construction.⁸⁵ In fact, no such new linkages have been ascertained in the literature, so perhaps it was wise to disregard them in the cost-benefit analysis. The remaining effects are the environmental and health benefits described above, a decreased transit time for cargo, and an increase in the number of destinations that can be reached, due to the larger total mass. Finally, it is possible the entry of more transport companies led to increased competition and decreased prices, but figures are not available to support this.

Compared to the Betuweroute case, cross-border cooperation in the area Maastricht-Aachen-Liège-Hasselt is much more fragmented, both in terms of the spatial relationships and in terms of the fields in which interactions take place. Interreg programmes have striven to foster cooperation in this region since the very beginning in 1991, the year before the key Maastricht Treaty. Although a large number of projects has taken place, including over 50 in the 2007-2013 period, functional integration in the region is still small, with some 17.500 cross-border commuters – a very small number compared to Luxembourg (127.000), Basel (49.000), or even Lille (27.500).⁸⁶ This indicates there is a lot of potential for a more integrated labour market. Yet language, institutional, and cultural barriers are relatively strong in this area, and opportunities for cooperation are sometimes hampered by political considerations – e.g. in the Belgian territories, which include both a Flemish and a Walloon region. As one example, the airport of Maastricht links itself with Aachen, 40 km

away, and profiles itself as Maastricht-Aachen Airport; but it operates in competition with the similarly sized airport of Liège, which is also just under 40 km away.

Table 2 illustrates how in our scenarios above the area between Hasselt and Mönchengladbach benefits from cross-border effects in our model; in this scenario, we compare a situation with impenetrable borders with one where the borders don't exist at all. The effect for each region depends of course on the number of new connections that are made within the region we studied; the number of direct connections is indicated below, but regions also profit indirectly through the effect on their neighbours within the same country. Moreover, the effect depends on the population densities of the region and its neighbours; a rural region benefits most from gaining access to urban areas. In our simulation, estimated effects are particularly large for the Belgian and Dutch areas, with Maaseik and Tongeren taking the lead just before Noord- and Midden-Limburg. Zuid-Limburg, however, experiences the smallest effect; this is already a heavily urbanized region, and in our simulation, both Liège and Aachen are excluded by choice or because of data issues.

Table 2: Effects of scenario V on the Hasselt-Limburg-Mönchengladbach area

NUTS	Name	National neighbours	New neighbours in simulation	GVA gained (k€)	Population (thousands)	GVA/cap. gained
BE221	Arr. Hasselt	5	0	€640	411	€1.56
BE222	Arr. Maaseik	3	2	€871	240	€3.63
BE223	Arr. Tongeren	5	1	€671	199	€3.37
NL421	Noord-Limburg	4	2	€741	284	€2.61
NL422	Midden-Limburg	3	3	€791	246	€3.21
NL423	Zuid-Limburg	1	3	€492	586	€0.84
DEA1E	Viersen	5	2	€359	316	€1.14
DEA15	Mönchengladbach	4	0	€392	259	€1.51
DEA29	Heinsberg	5	2	€366	266	€1.38
DEA26	Düren	5	0	€321	277	€1.16

In our third example, we look at intra-city improvements in infrastructure: in this case, the Amsterdam orbital.⁸⁷ This ring road was closed in 1990 when the Zeeburgertunnel opened on the east side of the city. In the preceding years, the other sides had been gradually linked up, yet the IJ river and the Noordzeekanaal formed an expensive barrier between north and south. The tunnel increased the total crossing capacity by over 25%, and it allowed for new express bus lines during rush hours, connecting the work locations on the south side of Amsterdam with residential neighbourhoods and dormitory towns on the north side of the city.

In addition to travel time gains and reduced congestion, the cost-benefit analysis for the orbital project looked at the benefits for existing and new businesses, for office locations and their prices. It did so both with a quantitative model and a series of questionnaires among local businesses, but in both, the focus was mainly on the attractiveness of being located close to the new infrastructure. Benefits to the interconnectedness of the city and its functional urban area surely also existed, yet these were not analyzed at the time – possibly because the benefit-cost ratio was far above the critical value of 1.0 anyway. However, the connection made the part of North-Holland that is north of the IJ much more accessible from the Utrecht, Gooi, and Almere areas, thus substantially increasing the possibilities for commuting, business interactions, and industrial linkages. In short, improved intra-urban connections put the urban mass to better use.

4. POLICY AND RESEARCH AGENDAS: IN TANDEM FOR SYNERGIES

4.1. *The Lower Rhineland Region*

The LRR contains three major world cities: Amsterdam (NL), Brussels (BE) and Cologne (DE).⁸⁸ Because of these cities, it is sometimes referred to as the ABC region. All in all, the region contains some 40 million inhabitants, mostly in a dense setting. According to Richard Florida,⁸⁹ the region qualifies as one of the mega regions that define the future of metropolitan economic functioning. It is on this scale, it is argued, that agglomeration economies are most optimally present; infrastructure, housing and real estate have high returns on investment; and firms and employees profit from economic density via higher productivity and wages. Larger is better. Capitalisation on agglomeration economies are subject to debate for long already, with paradoxically ever larger scales of economic interaction in competitive city-regions co-evolving with smaller scales of governance, from (mayors of) municipalities to self-organizing citizens. This fuels the intriguing question which instruments and investments should be applied on which spatial scales to accommodate economic growth and competitiveness in the LRR, with evolving economic growth (up-scaling) and governance (down-scaling) paradigms and without large metropolitan cities?

4.2. *Agglomeration economies in cities and urban networks*

Agglomeration economies are persistently related to city size and density: a rule of thumb nowadays is that doubling the city size raises productivity with approximately 5 percent. More so for higher educated workers or more knowledge intensive sectors. This is mainly due to better opportunities of firms for matching (on the labour market), sharing (on subcontracting markets) and learning (from competitors and knowledge institutes). Two intervention views of this agglomeration premium in regions like the LRR recently emerged: (a) create larger metropolitan economies in a Europe where such cities are scarce, or (b) connect existing medium-sized cities better with each other in order for them to function as a larger agglomeration: a so-called borrowed size scenario. It has been hypothesized frequently that proximate cities, like the Randstad cities in The Netherlands, The Flemish cities in Belgium and the Ruhr-region cities in Germany, can in theory use each other's economic complementary specializations in order to profit from sharing, learning and matching opportunities – just as larger cities do.

4.3. *Physical connectivity and more*

William Alonso in 1973 pointed to the LRR:⁹⁰ “in certain European urban patterns, such as those of Germany and the Low Countries, whose cities, quite small by our standards, apparently achieve sufficient scale for the functioning of a modern economy by borrowing size from one another.” The main precondition according to Alonso is physical accessibility and connectivity by road and rail, for public and private transport. Also in present day policy thinking about borrowed size, physical transport linkages between the largest urban regions are usually envisioned. Also on the scale of the LRR, intercity connections come first to mind when thinking about individual cities borrowing size from each other. But in this essay it is argued that there should also be something substantial to be borrowed, like complementary economic knowledge, tradable products or skilled labour not available in one's own region, and that institutional, governance and cultural circumstances mould the degree of integration and cooperation capitalizing on borrowed size to a very large extent. Borrowed performance and borrowed functions thus, facilitated by cognitive proximity of economic agents and policy makers alike. Complex terminology – but the fact that the LRR is not

an optimal functional unit (yet) and we suspect untapped potential shows that barriers for development may be multiple and severe, and not just infrastructural.

4.4. *Multilevel governance*

The increased-density versus borrowed-size *policy* discussion is partly artificial. Density in fact is not easy to increase drastically in medium-sized cities in the LRR – and in fact in most of Europe’s urban landscape – without sacrificing for example historical or natural amenities. Doubling the size of a city strongly increases agglomeration disadvantages such as congestion, pollution, crime and inequality. Hence, we can conclude that the polycentric reality actually calls for borrowed size solutions. Larger cities do form an important attraction for the higher educated, who like to sort themselves in “real” cities. This implies that multiple stakeholders should be involved, in order to simultaneously foster urban sorting processes on the one hand and borrowed size on the other. Network facilitators like national infrastructure providers (in The Netherlands: Rijkswaterstaat) care for infrastructural connections within and between nodes of the network, cities take care of for labour and housing markets plus amenities, the provincial level keeps an eye on natural amenities and regional accessibility, and the national level pays attention to the institutional embedding and global competitiveness. Theoretically, borrowing size in the LRR may also be cross-border in nature, but cultural and institutional differences still seem to hamper integration to a large degree, as we showed in section 3.⁹¹

4.5. *Towards an integral research and investment agenda*

Summarising the combined research and policy agenda, we want to ask attention for the following, that should be taken up on all scales and by all stakeholders:

1. Crucial infrastructural investments within cities (first and last mile) and on bottlenecks in corridors;
2. Maintenance of the inter-regional infrastructural network, with special attention for cross-border infrastructures;
3. Facilitate value-capturing in nodes and ports (as this is currently not always the case), by economic and spatial conditions important for value-adding economic activity;
4. Strategic planning for international nodes and their connectedness;
5. Determining and envisioning clusters, specialisations, innovation-intensity and complementarities of cities within urban regions. Smart specialisation in principle is focused on this, but (as usual) this is a policy concept ahead of science;
6. Providing amenities and housing for the knowledge intensive workforce locally (conditioned on sufficient labour demand from firms);
7. Enabling interregional governance and cooperation, and cultural exchange (and actually do it!);
8. Managing economic and technical transitions in ports and hubs (like 3D-printing application, bio-fuels, circular production, etc.) and assess its consequences for mainport and metropolitan economies;
9. Balancing private and public investments (e.g., in line with the Juncker investment plan let not all investment be public but aim for multipliers);
10. Identifying borrowed functions and urban-density functions (“form follows function”);
11. Not focussing on any of these issues in isolation, as that will be insufficient to overcome the disadvantages of fragmentation of the EU’s regional economies, institutions and societies, and will not enable European regions to spearhead societal and economic transitions that are inevitable to come.

Reflections

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The concept of borrowed size is theoretically convincing as explored in the excellent study. Without doubt, already today this region is economically fully integrated. The intense flows of goods, capital and people within the Lower Rhine Region are illustrating the interconnectivity. At the same time, the Lower Rhine Region is very diverse and fragmented. Each city has its own history, economic and social trajectory. The competitiveness levels are very different. On the one hand, the Lower Rhine Region is hosting one of the most innovative regions like the Randstad, on the other also regions with high unemployment levels like the German Ruhr region struggling with structural change since almost 50 years. The question about how to fully exploit the potential of a more systemic regional development is crucial and not an easy task.

On the German side of the Lower Rhine Region attempts were made to explore the potential of the polycentric conurbation. Already in 1995 the Rhine-Ruhr Metropolitan region was established which is the largest metropolitan region in Germany with around 10 Mio inhabitants. The Rhine-Ruhr Metropolitan region is characterized by large disparities. As documented in the last edition of the Prognos "Zukunftsatlas" the development perspectives of cities like Recklinghausen, Bottrop, Duisburg, Gelsenkirchen, Herne, Oberhausen, Krefeld, Mönchengladbach are considered as very risky. These cities which were part of the industrialization in the late 19th and early 20th century were characterized by heavy industry. Today, this former boom region is fighting with high unemployment and low competitiveness. Just a few kilometers away, the development prospects of cities like Cologne and Düsseldorf are much more promising. The economic structure of these cities is completely different from the Ruhr area with a strong specialisation in finance and insurance, high tech and multi media. After 20 years of working together in the Rhine-Ruhr metropolitan region the fragmented structure still persists. Apparently, positive externalities are not automatically spilling over from Cologne and Düsseldorf to the Ruhr area inducing a drastic structural change. Instead, cities often compete with each other and do not harmonize their investment policies.

The experience of the Rhine-Ruhr Metropolitan region demonstrates that the existing economic structures are difficult to link with each other. Innovative efforts need to be taken in order to break up regional trajectories trapped by lock in. Probably, a stronger focus on concepts like global value chains and global production networks could help to identify collaboration potentials across the regions within the Lower Rhine Region. Apart from policy makers and planners, firms need to be actively involved in order to understand entrepreneurial decisions and detecting impeding factors of fully exploiting the potentials offered by borrowed size.

Defining the most suitable scale to functionally understand and analyze the role of agglomerations in economic development is not a stable affair. Different technological paradigms express themselves differently in the spatial-economic fabric⁹² and this prompts continuous adaptation of our geographical categories. Theoretically-oriented research in the last 25 years has revealed that the spatial-economic expression of the current round of knowledge-based economic development incites processes of metropolization: a term that denotes the growing role of both regional agglomeration economies and the interconnectedness of urban regions in wider urban networks⁹³. The essay "Synergies between metropolitan, agglomeration, infrastructure and network policies in urban Europe: The case of the Lower Rhine Region" provides a valuable contribution to, and starting point of, empirical corroboration of theoretical claims based on this literature. What happens if you bracket the taken-for-granted national borders and actually start to look how urbanization transcends national borders across the Lower Rhine Region [LRR]? This reflection reviews this contribution 'from the Belgian underbelly'. By providing a perspective from the fuzzy bottom of the study region, and how that fuzziness might impact the study, some of the operationalization challenges of studying metropolization on different scales are speculatively identified.

A Belgian mindset immediately attenuates one to the regional concept. In Belgium, such a claim resonates with the gradual federalization process that has taken place in the last decades where the country was gradually subdivided in three regions (Flanders, Brussels and Wallonia) based on cultural and linguistic boundaries. Therefore, to one working from Belgium, this immediately begs the question whether applying these culturally-informed regionalizations are the most insightful scale to undertake empirical endeavors in understanding (cross-border) metropolization in Europe? If regions instead of states are indeed a better scale to understand agglomeration economies, what kind of regional scale do we mean? Regions are in many ways a foundational concept of geography and debates have long raged on how to demarcate them: as uniform regions based on shared properties or as nodal regions based on interconnection⁹⁴. Although the essay is unequivocally clear that nodal regions need to be the focal interest when studying agglomeration economies, the analysis still needs an outer boundary. That outer boundary is provided by projecting findings on the canvas of the historical international lower Rhineland, which by that definition qualifies as a uniform region based on a physical geographical property (a navigable riverbed).

The debates on urban polycentricity reveal how much inherited categories of cities and regions are put under stress in the current era of metropolization⁹⁵. Assessing the spatial structure and its constituent nodal points crucially depends on demarcation of the study area. A place could be part of a polycentric system at the LRR scale while simultaneously being part of a very monocentric system at a smaller scale⁹⁶. This is crucial, since the data we rely on if we want to empirically corroborate the role of cities in the current economic conjuncture is structured by historically defined demarcations and borders. For instance, the NUTS3 nomenclature is based on the historically-assessed nodality of regions in at least the Netherlands (COROP regions) and Belgium (Arrondissements). Since an important goal of the essay is to show that cities are more

interdependent than in the past, such a historical NUTS3 definition is somewhat contradictory: you try to challenge the very functional basis on which the data container you use relies. It should be stressed at this point that the choices an empirically-included researcher faces are fundamentally pragmatic. Defining cutoff points and boundaries of study areas and data containers are always trade-offs and simplifications. Therefore, the question ought not to be whether a demarcation is 'correct' (it never is), but whether a different demarcation would have produced a significantly different outcome in the assessment of our theories of how the world works. It is in this spirit we review the methodological choices of the essay from the Belgian perspective.

When reading the essay with Belgian glasses, eyebrows immediately start frowning upon seeing the absence of the Wallonia region in the analysis of functional polycentricity. Given the Belgian administrative geography such a choice might seem intuitive, but from a LRR perspective the demarcation choice is remarkable. Back in the 1960s, the Walloon Meuse and Sambre tributaries to the Rhine were not only included in similar analyses, they were even depicted as a core axis⁹⁷. Particularly since the Maastricht-Hasselt-Aachen-Liège region is discussed as an example of how an LRR geography might work, one cannot help but wonder what prompted the methodological choice to drop Aachen and Liège from the analysis, especially as Maastricht and Hasselt—equally dependent on the Meuse—were left in. Similarly, we have to acknowledge a main traffic and railroad trunk axis from France to the Ruhr area (The *autoroute de Wallonie* /E42) that largely runs parallel to the Sambre-Meuse. Accessibility and infrastructure analysis on the scale of the macroregion as a whole will undoubtedly be influenced by what happens here. Although this part of Wallonia is very urbanized, it is also heavily deindustrialized and therefore one might dare to argue that the old Walloon industrial axis is less relevant for knowledge-based economic development today⁹⁸. However, the same surely cannot be said for one of the three metropolitan anchors (see Figure 6) of the LRR: Brussels. Even when using the most-strict definition, the functional urban area of Brussels is situated in all three Belgian regions⁹⁹ but if one would like to properly gauge the Brussels weight in the LRR the whole Brabant-wallon province would need to be included. Moreover, from a knowledge-based development perspective, the omission of the technopole around Louvain-la-Neuve, in Brabant-wallon, is likely to distort analyses of the labor markets as they pertain to Belgium. Although it is outside the scope of this reflection to provide alternative calculations, it is interesting to speculate whether and to what extent some of the proposed scenarios would yield different results if this highly-dynamic part of the hinterland of Brussels would have been included. The caveats discussed above imply that the Brussels labor market is much thicker in reality than the analysis reveals and that this thickness is supported by an economic node outside the analysis. Hence it would influence both denominator and numerator in the scenario analysis. Although exact coefficients might change, it is unlikely that such an exercise would change the overall direction of the coefficients and hence of the conclusions of the essay. What it would change in the assessment, however, is that a currently invisible alternative interpretation of the results could appear with political relevance in the Belgian context. This interpretation could suggest that more spatial-economic gains could be reaped in Belgium by overcoming the internal borders of the language barrier than focusing on diminishing more remote external borders. Trade-offs, even those made for pragmatic methodological and operationalization choices, can have unintended political consequences.

The authors of the essay emphasize the importance of accessibility if borrowed size effects between cities are to be increased. For this, it is not only required to invest in inter-urban infrastructure but also in the 'last mile' connections within cities. However, from a Belgian perspective it is important to mention that there is a trade-off involved here as well. For historical reasons, a similar focus on accessibility and borrowed size had led to Brussels being (on paper, since accessibility attracts congestion) one of the most accessible cities thinkable¹⁰⁰. Local experts have called Belgium "the most mobile country in the world"¹⁰¹ expressing the completely institutionalized government-subsidized idea of commuting large distances to maintain rootedness in the community of origin while optimizing the thickness of the countrywide labor market. For Brussels, in the past this legitimized that large parts of the inner city were demolished to make the urban amenities and jobs accessible by car and train for the whole of the Belgian population, helping to create the large hinterland that the city currently has. This came at the cost of the local quality of life. Space once dedicated to King Car is very difficult and costly to recover for different land uses. As urban amenities and quality of life are increasingly regarded as important drivers of agglomeration economies, it begs the counterfactual question whether the economy of Brussels would be better off today if historically the policy priority would not have been borrowing size based on increased accessibility.

Which brings me at my third and final pesky question from the underbelly, which interrogates the 'one size fits all' premise of some of the policy suggestions. The authors start from the premise that the national scale is losing relative relevance to that of the urban. Yet, particularly figures 2 and 8 show remarkable patterns in which the Belgian national borders scream through the color coding of the choropleth maps. Particularly, figure 8 is fascinating as it shows a very limited heterogeneity of effects in Belgium of scenario 8: the degree in which highly educated professions might benefit from Borrowed size. Could it be that in Belgium, the most benefits of borrowed size in terms of labor markets are already met through the above-mentioned accessibility policy, and that investments in more infrastructure might yield diminishing returns?

In the Dutch language, 'speaking from the underbelly' means expressing your 'gut feeling', which is exactly what I have done above. Corroborating my hunches, reflections and rants would require empirical rather than (more) rhetorical corroboration. Now that the old scales of agglomeration have been unsettled, new ones have to be defined, refined, corroborated and disputed. "Synergies between metropolitan, agglomeration, infrastructure and network policies in urban Europe: The case of the Lower Rhine Region" opens the floor to much debate yet to be had.

Endnotes

- ¹ The authors thank Ton Markus for his assistance in producing the maps.
- ² ESPON Atlas (2014), pp. 42–43 (“Regional dimension of the economic crisis”). See also: EC (2013), *The urban and regional dimension of the crisis*. Brussels: Report from the Commission.
- ³ ESPON Atlas (2015), pp. 40–41 (“Regional economic performance”).
- ⁴ ESPON Atlas (2014), pp. 38–39 (“Regional economic structure”).
- ⁵ S. Groot, J. Möhlmann, J.H. Garretsen & H.L.F. de Groot (2011), The crisis sensitivity of European countries and regions: stylized facts and spatial heterogeneity. *Cambridge Journal of Regions and Society* 4: 437–456; R. Martin (2012), Regional economic resilience, hysteresis and recessionary shocks, *Journal of Economic Geography* 12: 1–32; A. Pike, S., Dawley, and J. Tomaney (2010), Resilience, adaptation and adaptability. *Cambridge Journal of Regions, Economy and Society* 3: 59–70; R. Boschma (2015), Towards an evolutionary perspective on regional resilience. *Regional Studies* 49: 733–751, M. Thissen, T. de Graaff & F. van Oort (2015), Competitive regional network structures and European structural economic growth. *Papers in Regional Science* (forthcoming).
- ⁶ ESPON Atlas (2014), pp. 44–45 (“Territorial patterns of innovation”).
- ⁷ ESPON Atlas (2014), pp. 46–49 (“International comparison and connectedness”).
- ⁸ N. Charron, L. Dijkstra & V. Lapuente (2014), Regional governance matters: quality of governance within EU member states. *Regional Studies* 48: 68–90; T. Forole, A. Roderiguez-Pose & M. Storper (2011), Cohesion policy in the EU: growth, geography and institutions. *Journal of Common Market Studies* 49: 1089–1111.
- ⁹ R. Boschma & G. Capone (2015), Institutions and diversification: related versus unrelated diversification in a variety of capitalism framework. *Research Policy* 44: 1902–1914.
- ¹⁰ M. Thissen, F. van Oort, D. Diiodato & A. Ruijs (2013), *Regional competitiveness and smart specialization in Europe. Place-based development in international economic networks*. Cheltenham: Edward Elgar.
- ¹¹ ESPON Atlas (2014), pp. 20–34 (“Society and integration”).
- ¹² J. Rifkin (2011), *The third industrial revolution. How lateral power is transforming energy, the economy and the World*. New York: Palgrave MacMillan; J. Rifkin (2014), *The zero marginal cost society. The internet of things, the collaborative commons, and the eclipse of capitalism*. New York: Palgrave MacMillan.
- ¹³ D. Foray (2015), *Smart specialisation. Opportunities and challenges for regional innovation policy*. London: Routledge.
- ¹⁴ ESPON Atlas (2014), pp. 54–63 (“Accessibility”).
- ¹⁵ OECD (2015), *Governing the city*. Paris: OECD. See also the TANGO network (Territorial Approaches for New Governance).
- ¹⁶ Urbact II (2012), *Against divided cities in Europe*. Brussels: European Union.
- ¹⁷ EU (2011), *Cities of tomorrow. Challenges, visions, ways forward*. Brussels: EU. OECD (2015), *The metropolitan century. Understanding urbanisation and its consequences*. Paris: OECD. Urban Europe (2015), *Transition towards sustainable and liveable urban futures*. Brussels: Urban Europe.
- ¹⁸ Positive externalities or economic benefits present in cities but unpaid for by individual firms and consumers. Externalities can actually also be negative (like pollution, congestion).
- ¹⁹ H. Bathelt, A. Malmberg & P. Maskell (2004), Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation, *Progress in Human Geography*, 28 (1): 31–56.
- ²⁰ ESPON (2014), *Making Europe open and polycentric. Visions and scenarios for the European territory towards 2050*. Brussels: EU. See also: L. Dijkstra, E. Garcilazo & P. McCann (2013), The economic performance of European cities and city-regions: myths and realities. *European Planning Studies* 21: 334–354.
- ²¹ R. Florida, T. Gulder & C. Mellander (2008), The rise of the mega-region. *Cambridge Journal of Regions, Economy and Society* 1: 459–476.
- ²² CPB/SCP (2005), *Diverse Europe* (The Hague: CPB/SCP); G. Marlet, A. Oumer, R. Ponds & C. van Woerkens (2014), *Groeien aan de grens* (Utrecht: Atlas voor Gemeenten).
- ²³ H. Koster & J. Rouwendal (2013), Agglomeration, commuting and the internal structure of cities. *Regional Science and Urban Economics* 43: 352–366.
- ²⁴ F. van Oort, E. Meijers, M. Thissen, M. Burger & M. Hoogerbrugge (2015), *De concurrentiekracht van Nederlandse steden. Van agglomeratiekracht naar netwerkkracht*. Den Haag: Platform31.
- ²⁵ Eurostat (2013), “Updated urban-rural typology: integration of NUTS 2010 and the latest population grid”, *Statistics in focus* 16. http://ec.europa.eu/eurostat/statistics-explained/index.php/Urban-rural_typology_update.

- ²⁶ United Nations, Department of Economic and Social Affairs, Population Division (2014), *World Urbanization Prospects, the 2014 revision*. <http://esa.un.org/unpd/wup/>.
- ²⁷ E. Morretti (2013), *The new geography of jobs*. Boston: Mariner Books.
- ²⁸ J. Bakens, H.L.F. de Groot, P. Mulder and C.-J. Pen (2014), *Soort zoekt soort. Clustering en sociaal-economische scheidingslijnen in Nederland*. Den Haag: Platform31.
- ²⁹ T.L. Friedman (2005), *The world is flat. The globalized world in the twenty-first century* (London: Penguin Books); E. Glaeser (2011), *Triumph of the city: how our greatest invention makes us richer, smarter, greener, healthier, and happier* (Basingstoke: Macmillan); B. Barber (2013), *If mayors ruled the world: Why Cities Can and should govern globally and how they already do* (New Haven: Yale University Press).
- ³⁰ G. Grossman and E. Helpman (1991): *Innovation and Growth in the Global Economy* (Cambridge MA, MIT Press).
- ³¹ An interesting contribution by Straathof et al. shows that the benefits of European integration through the growth enhancing effects of international trade are equal to approximately 8 percent annually (as compared to a hypothetical situation without integration).
- ³² Identification is problematic in this literature. For an attempt to identify the benefits of diversity, see C. Broda & D.E. Weinstein (2006), Globalization and the gains from variety, *Quarterly Journal of Economics* 121: 541–585.
- ³³ G. Duranton & D. Puga (2004), Micro foundations of urban agglomeration economies. In: J.V. Henderson (ed.), *Handbook of Regional and Urban Economics – Cities and Geography*. Amsterdam, Elsevier: 2063–2118.
- ³⁴ P.S.C. Melo, D.J. Graham & R.B. Noland (2009), A meta-analysis of estimates of urban agglomeration externalities, *Regional Science and Urban Economics* 39: 332–342.
- ³⁵ R. Wang et al., Transport infrastructure and urban agglomeration economies: a meta-analysis” mimeo; also cf. P.C. Melo, D.J. Graham & R. Brage-Ardao (2013), The productivity of transport infrastructure investment: a meta-analysis of empirical evidence,” *Regional Science and Urban Economics* 43: 695–706.
- ³⁶ S.P.T. Groot & H.L.F. de Groot (2014), Estimating the skill bias in agglomeration externalities and social returns to education: evidence from Dutch matched worker-firm micro-data,” Tinbergen Institute Discussion Paper, Amsterdam-Rotterdam.
- ³⁷ J. McCallum (1995), National borders matter: Canada-US regional trade patterns. *American Economic Review* 85(3): 615–623.
- ³⁸ P. Dekker et al. (2006), *Diverse Europe* (Sociaal en Cultureel Planbureau, Den Haag).
- ³⁹ E. Glaeser, H. Kallal, J. Scheinkman & A. Shleifer (1992), Growth in cities. *Journal of Political Economy* 100: 1126–1152.
- ⁴⁰ J. Jacobs (1969), *The economy of cities*. New York: Random House.
- ⁴¹ P.C. Melo, D.J. Graham & R.B. Noland (2009), A meta-analysis of estimates of agglomeration economies. *Regional Science and Urban Economics* 39: 332–342.
- ⁴² K. Frenken, F.G. van Oort & T. Verburg (2007), Related variety, unrelated variety and regional economic growth. *Regional Studies* 41: 685–697.
- ⁴³ F. van Oort, S. de Geus & T. Dogaru (2015), Related variety and regional economic growth in a cross-section of European urban regions,” *European Planning Studies* 23: 1110–1127.
- ⁴⁴ G. Duranton and D. Puga (2001), Nursery cities: urban diversity, process innovation, and the life cycle of products,” *American Economic Review* 91: 1454–1477.
- ⁴⁵ T. Kemeny & M. Storper (2015), Is specialization good for regional economic development?, *Regional Studies* 49: 1003–1018; K. Frenken, E. Cefis & E. Stam (2015), Industrial dynamics and clusters: a survey,” *Regional Studies* 49: 10–27.
- ⁴⁶ C. Burkert, A. Garloff, S. Hell, A. Otto & P. Schaade (2013), Attraktivität der Standorte Hessen und Rheinland-Pfalz für (junge) Fachkräfte. *IAB-Regional. Berichte und Analysen aus dem Regionalen Forschungsnetz*. IAB Hessen, 02/2013); A. Otto, L. Nedelkoska & F. Neffke (2014), Skill-relatedness und Resilienz: Fallbeispiel Rheinland. *Raumforschung und Raumordnung* 72(2): 133–151.
- ⁴⁷ See, for example, H.L.F. de Groot et al. (2010) *Stad en Land*, H.L.F. de Groot, J. Poot & M.J. Smit (2015), Which Agglomeration Externalities Matter Most and Why?, *Journal of Economic Surveys*; CPB/PBL (2015), *Toekomstverkenning Welvaart en Leefomgeving*, Den Haag; SER (2015), *Agenda Stad*, Den Haag.
- ⁴⁸ R.J. Barro (1990), Government spending in a simple model of endogenous growth, *Journal of Political Economy* 98: 103–125.
- ⁴⁹ Y. Dissou & S. Didic (2013), Infrastructure and growth,” in *Infrastructure and Economic Growth in Asia* (Springer, Berlin): 5–45.

- ⁵⁰ See for example R.E. Baldwin & P. Martin (2004), "Agglomeration and Regional Growth", *Handbook of Regional and Urban Economics*, edited by J.V. Henderson & J.-F. Thisse, pp. 2671–2711, Amsterdam: Elsevier.
- ⁵¹ R. Crescenzi & A. Rodríguez-Pose (2012), "Infrastructure and Regional Growth in the European Union", *Papers in Regional Science* 91: 487–513.
- ⁵² M. Burger, E. Meijers, M. Hoogerbrugge & J. Tressera (2015), 'Borrowed size, agglomeration shadows and cultural amenities in North West Europe'. *European Planning Studies*; F. van Oort, S. de Geus & T. Dogaru (2015), Related variety and regional economic growth in a cross-section of European urban regions," *European Planning Studies* 23: 1110–1127.
- ⁵³ ESPON (2013), *Making Europe open and polycentric. Vision and scenarios for European territory towards 2050*. Luxemburg: ESPON.
- ⁵⁴ F. Barca, P. McCann, & A. Rodríguez-Pose (2012), The case for regional development intervention: place-based versus place-neutral approaches. *Journal of Regional Science* 52: 134–152.
- ⁵⁵ L. Dijkstra, E. Garcilazo & P. McCann (2013). The economic performance of European cities and city regions: Myths and realities, *European Planning Studies* 21: 334-354.
- ⁵⁶ F. van Oort, E. Meijers, M. Thissen, M. Hoogerbrugge & M. Burger (2015), *De concurrentiepositie van Nederlandse steden: Van agglomeratiekracht naar netwerkkracht*, Den Haag: Platform31, N. Cortinovis & F. van Oort (2015), Variety, economic growth and knowledge intensity of European regions: a spatial panel analysis, *Annals of Regional Science* 55: 7-32.
- ⁵⁷ E.L. Glaeser, G.A.M. Ponzetto & Y. Zou (2015), Urban networks: spreading the flow of goods, people and ideas. *Papers in Regional Science* (forthcoming).
- ⁵⁸ Based on R. Wintjes and H. Hollanders (2011), Innovation pathways and policy challenges at the regional level: smart specialisation, <http://collections.unu.edu/view/UNU:220>.
- ⁵⁹ In Van Oort (2015), *Spatial planning determinants of the Rhinecon economy* (Beyond Plan B) it is argued that spatial planning structures are influenced by and influencing both the technological regimes and polycentric urban structures.
- ⁶⁰ F. van Oort, E. Meijers, M. Thissen, M. Hoogerbrugge & M. Burger (2015), *De concurrentiepositie van Nederlandse steden: Van agglomeratiekracht naar netwerkkracht*, Den Haag: Platform31.
- ⁶¹ Van Oort et al. (2015), *ibid*.
- ⁶² P. Witte (2014), *The corridor chronicles. Integrated perspectives on European transport corridor development*. Dissertation, Utrecht University.
- ⁶³ L. Albrechts, & O. Coppens (2003) Megacorridors: striking a balance between the space of flows and the space of places, *Journal of Transport Geography* 11: 215–224; H. Priemus & W. Zonneveld (2003) What are the corridors and what are the issues? Introduction to special issue: the governance of corridors, *Journal of Transport Geography* 11: 167–177; H. Sichelschmidt (1999) The EU programme TEN's – a critical assesment, *Transport Policy* 6: 169–181; R. Vickermann K. Spiekermann & M. Wegener (1999) Accessibility and economic development in Europe, *Regional Studies* 33: 1–15.
- ⁶⁴ Roads that have the largest contribution to local welfare are often those first and last mile connections, see M. Thissen, P. van de Coevering & H. Hilbers (2006), *Roads to economic growth*. The Hague: Ruimtelijk Planbureau.
- ⁶⁵ M. Batty (2013), *The new science of cities*. Cambridge: The MIT-Press.
- ⁶⁶ T. van den Boomen & T. Venhoeven (2012), *De mobiele stad*. Rotterdam: nai010 Uitgevers.
- ⁶⁷ Platform31 (2013), *Knooppuntontwikkeling in Nederland. (Hoe) moeten we transit-oriented development implementeren?* Den Haag: Platform31.
- ⁶⁸ S. Iammarino & P. McCann (2013), *Multinationals and economic geography. Location, technology and innovation*. Cheltenham: Edward Elgar.
- ⁶⁹ Both the Dutch and the European governments presently work on urban agendas (Agenda Stad, JPI Urban Europe).
- ⁷⁰ F. van Oort (2015), Beyond Plan B in the Rhine Corridor: towards spatial-economic strategies in new urban realities. Den Haag, Beyond Plan B.
- ⁷¹ T. Piketty (2014), *Capital in the twenty-first century*. The Belknap Press, Cambridge Mass.
- ⁷² A. Townsend (2013), *Smart cities: big data, civic hackers, and the quest for a new Utopia*. New York: Norton & Co.
- ⁷³ K. Emerson et al. (2011), An integrative framework for collaborative governance. *Journal of Public Administration Research and Theory* 22: 1–29.

⁷⁴ The location quotient is defined as the industry share in a particular region relative to the share of that same industry in the whole Lower Rhineland region. A location quotient equal to 1 means that the presence of an industry is equal to its presence in the aggregate economy. A location quotient equal to 2 means that the share of an industry in the regional total is twice as large as the same share in the Lower Rhineland region as a whole.

⁷⁵ OECD (2013), *Regions at a Glance 2013*. Paris: OECD Publishing.

⁷⁶ Cambridge Econometrics, *European Regional Database*, <http://www.camecon.com/SubNational/SubNationalEurope/RegionalDatabase.aspx>.

⁷⁷ In fact, we use the inverse distance to weigh population from neighboring regions, varying the exponent in $1/d_{ij}^\alpha$ between regions within the same country and regions outside. We use NUTS3 data for the Netherlands minus the three Northern provinces, for Flanders and Brussels, and for Nordrhein-Westfalen.

⁷⁸ To be precise, scenario IV uses cross-border distances to the power of 1.5; scenario V uses a power of 1 for both; finally, scenario VI decreases national effects to 0.5 compared to scenario V.

⁷⁹ D.W. Adamson, D.E. Clark & M.D. Partridge (2004), Do urban agglomeration effects and household amenities have a skill bias?," *Journal of Regional Science* 44: 201–224; S.P.T. Groot & H.L.F. de Groot (2014), Estimating the skill bias in agglomeration externalities and social returns to education: evidence from Dutch matched worker-firm micro-data," Tinbergen Institute Discussion Paper.

⁸⁰ For this calculation we make some rather heavy assumptions: we assume 60 percent of the population of cities is higher educated, but only 40 percent of the other areas; that the higher educated receive a 7.5 percent agglomeration benefit on their productivity, the lower educated only 2.5 percent. Finally as baseline for the higher educated we use scenario I, as everywhere else, but for the lower educated we choose scenario II.

⁸¹ H. Obbink, "Pleidooi voor flinke groei Amsterdam," *Trouw*, June 17, 2015.

⁸² We take this new urban population proportionally from all other regions within the respective countries.

⁸³ Algemeen Dagblad (2016), "Meer goederentreinen over Betuweroute", 7 January 2016. Rivierenland edition.

⁸⁴ Prorail (2016), "Aanleg Derde Spoor Duitsland gaat verder op 16 april", 5 April 2016.

⁸⁵ O. Betancor, A. Hernández & M.P. Socorro (2013), *Revision of Infrastructure Project Assessment Practice in Europe regarding Impacts on Competitiveness*, deliverable 2.2 of the I-C-EU project for the European Commission.

⁸⁶ T. Chilla et al. (2010), *METROBORDER: Cross-border Polycentric Metropolitan Regions*, ESPON Targeted Analysis 2013/2/3, Final Report, p. 38.

⁸⁷ J. Kiel, R. Smith & B. Ubbels (2013), *Database of Case Studies and Screening Methodology, Annex 1: Amsterdam Orbital*, deliverable 2.1 of the I-C-EU project for the European Commission.

⁸⁸ Note that it there are more major cities: Rotterdam, Antwerp, and Düsseldorf also often feature on lists of World Cities.

⁸⁹ Florida looks at regions with a combined GDP of at least \$100 billion; at over €1100 billion (2014), the LRR clearly qualifies. R. Florida, T. Gulden & C. Mellander (2007), The rise of the mega-region. *Cambridge Journal of Regions, Economy and Society* 1: 459–476.

⁹⁰ W. Alonso (1073), Urban zero population growth. *Daedalus* 102: 191–206. The quote appears on p. 200.

⁹¹ G. Marlet, A. Oumer, R. Ponds & C. van Woerkens (2014), *Groeien aan de grens. Kansen voor grensregio's*. Nijmegen: VOC Uitgevers; A. Weterings & G. van Gessel (2015), *Arbeidsmarkt zonder grenzen*. Den Haag: Planbureau voor de Leefomgeving.

⁹² R. Boschma (1994) *Looking through a window of locational opportunity*. Amsterdam: Thesis Publishers.

⁹³ S. Krätke (2007), Metropolisation of the European economic territory as a consequence of increasing specialisation of urban agglomerations in the knowledge economy, *European Planning Studies* 15: 1–27; M. van Meeteren, K. Boussauw, B. Derudder & F. Witlox (2016a), Flemish Diamond or ABC-Axis? The spatial structure of the Belgian metropolitan area, *European Planning Studies* 24: 974–995; M. van Meeteren, Z. Neal, Z. & B. Derudder (2016b), Disentangling agglomeration and network externalities: A conceptual typology. *Papers in Regional Science* 95: 61–80.

⁹⁴ E.L. Ullman (1953), Human geography and area research. *Annals of the Association of American Geographers* 43: 54–66.

⁹⁵ M. Burger, E. Meijers & F van Oort (2014), Multiple perspectives on functional coherence: Heterogeneity and multiplexity in the Randstad. *Tijdschrift voor Economische en Sociale Geografie* 105: 444–464.

⁹⁶ M. van Meeteren, A. Poorthuis, B. Derudder & F. Witlox (2016c), Pacifying Babel's Tower: A scientometric analysis of polycentricity in urban research. *Urban Studies* 53: 1278–1298; Specifically as it regards Brussels

see: C. Vandermotten, L. Halbert, M. Roelandts & P. Cornut (2008), European planning and the polycentric consensus: Wishful thinking? *Regional Studies* 42: 1205–1217.

⁹⁷ W. Zonneveld (2003), Visioning North West Europe as a networked space. In B. Lambregts & W. Zonneveld (Eds.), *Polynuclear urban regions and the transnational dimension of spatial planning* (pp. 58–81). Delft: Delft University Press, p. 72.

⁹⁸ Van Meeteren et al. (2016a *op cit*) suggests that such a depiction is ill-advised.

⁹⁹ S. Luyten & E. Van Hecke, (2007), De Belgische stadsgewesten 2001. *Statistics Belgium Working Paper*; for a critique on how the Brussels agglomeration is codified in European nomenclature: IGEAT (Lead partner, Ed) (2007), p.30, *ESPON 1.4.3: Study on Urban Functions, Final report*, Brussels/Luxembourg: ULB/ESPON Monitoring Committee.

¹⁰⁰ See for instance, M. Rycckewaert (2011), *Building the economic backbone of the Belgian welfare state.*

Infrastructure, planning and architecture 1945–1973. Rotterdam: 010. pp: 185-196; van Meeteren (2016a) *op cit*.

¹⁰¹ T. Vanoutrive and K. Boussauw (2014) *Het Mobielste Land Ter Wereld*. Antwerpen: Garant.