On the spatiality of digitalization: Migration of the highly-skilled and interregional disparities[1]

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1. Death of distance and the hope for the inequality decreasing effect of digitalization

There is a broad consensus in the scientific debate that digitalization as a continuing megatrend has massive and partly irreversible effects of an economic, social and technological nature. The related economic effects of this digital transformation are the focus of the presentation and are meanwhile assessed by most scholars, not only economic geographers, as not spatially neutral, i.e. they influence the economy in sub-national regions in different ways (Spellerberg 2021). Since the disparities between urban and rural regions are particularly pronounced in many countries, the reduction of inequalities, especially between these two types of regions, is also in the interest of many regional policy strategies in several countries, as politicians often see digitization as an opportunity to reduce inter-regional disparities (BMI 2019; Grimes 2005).

With regard to the spatial economic effects of digitization, a simplified distinction can be made between two opposing positions in theory, emblematic of the numerous "paradoxical geographies of the digital economy" (Moriset/Malecki 2009, see also Tranos 2016). The death of distance hypothesis argues that in regions that have previously been largely excluded from markets or value chains, digital technologies based on the internet could enable the better inclusion of firms (Galloway et al. 2011). The assumption of growing opportunities for these firms was based on the expectation of a decreasing importance of physical proximity (Cairncross 1997). Once internet infrastructure was sufficiently available in all regions, it was expected that firms could digitally exchange knowledge, services or even products. Firms in marginalized rural regions could thus overcome disadvantages through integration into previously-inaccessible networks and value chains. According to this argumentation, digital accessibility alone would be decisive, so that proper location decisions would no longer apply or become unimportant, the exchange of information and knowledge and the organization of production processes ("Industry 4.0") would become cheaper (in the medium term) through digitization and thus no longer decisive for location. Moreover, value chains could be spatially split even more easily and cheaply, many services could be created and distributed "footloose", and work and residence could no longer be separated (working-from-home) (Thonipara et al. 2020).

The opposing position argues that there are many mountains in the flat world: "the world is spiky" (Rodríguez-Pose/Crescenzi 2008). Spatial proximity also and especially plays an important role in digitization, the tacit knowledge indispensable for innovation processes requires face-to-face contacts, spatial proximity corresponds with social proximity and

digitization (therefore) increases economic inequalities between regions, because availability and use of digital technologies are not equally distributed in quantity and quality, with economically weaker regions being additionally (relatively) weakened (dichotomies such as rural vs. urban regions, high-income vs. low-income countries, high-tech vs. low-tech regions would manifest themselves) (Haefner/Sternberg 2020). In fact, digitization-induced catch-up processes of backward regions have hardly been witnessed. One prominent explanation for the absence of catch-up processes of laggard regions is the digital divide among firms (and its employees) in rural and urban regions (Salemink et al. 2017), for which two levels can be distinguished (Büchi et al. 2016; Scheerder et al. 2017). The first-level digital divide refers to access: while nowadays most firms in rural regions have access to the internet, the quality of the connection often trails behind that in urban regions (Briglauer et al. 2019; Prieger 2013), which thus limits rural firms' opportunities of digital participation. The second-level digital divide refers to usage, whereby the adoption of not only the internet but also other digital technologies is lower in rural firms compared with their urban counterparts. This is due to unfavorable socio-demographic characteristics of many rural regions and their inhabitants and employees: high income, high professional qualification levels and a young population and labour force are central determinants in fostering the regional usage intensity of digital technologies (Blank et al. 2018; Billon et al. 2016; Prieger 2013; Schleife 2010) and they are often deficient in rural regions (Thonipara et al. 2020).

However, the empirical research gaps are considerable, especially with regard to the spatial economic consequences of digitization, which is largely due to the longstanding lack of data on the spatial distribution of digital infrastructure (1st level digital divide). This lack of data is even more pronounced when it comes to regional data on the digital skills of people and companies (i.e., their employees), by which is meant the effects of the actual use of digital infrastructure (2nd level digital divide). The latter is considered by some observers to be more influential for the regional effects of digitalization than the mere availability of digital infrastructure. Personal digital competence is at least age-, education- and occupation-dependent, as is also shown in the working-from-home during COVID19 (Arntz et al. 2019). These individual attributes are not evenly distributed in space either, but favor the otherwise economically stronger regions.

The focus of our presentation is on whether digitalization can change interregional economic disparities between sub-national regions (not only, but also between urban and rural ones). Specifically: can it contribute to reducing these disparities or will it increase existing

disparities? We will first present the spatial pattern of the 1st and 2nd level digital divide for selected high-income countries (in Europe), and then outline the economic disparities (without digitization) in the same countries and for the same time periods. It then discusses, primarily exploratory without explicit empiricism (due to lack of data), whether the increased use of digitalization, especially by employees and private households in the form of working-from-home, as a result of the pandemic, could contribute to urban living and working locations losing importance in favor of rural (or more rural) locations. The presentation concludes with some hypotheses on the impact of digitalization on interregional disparities.

2. Empirical evidence: The spatial patterns of economic disparities and digital infrastructure

The empirical data in this chapter serve to provide an overview of how economic disparities and digital infrastructure (or its expansion) might be linked. The data are not extensive enough to establish a causal relationship. We use data on two European high-income countries – Germany and Norway. Both are large in area, but have completely different spatial conditions for the development of digital infrastructure. Despite having a more densely populated south and west compared with the north and east (including most regions of the former GDR), Germany has a comparatively evenly distributed population, with many medium-size and larger cities – often as county seats. In Norway, by contrast, a third of the population is located in the Greater-Oslo region. The second-most densely populated region already has only 10% of Oslo's density. One third of all regions even have a population density of fewer than 10 inhabitants per km² – much less than the most sparsely populated NUTS3 region in Germany (36 inhabitants per km²). This pattern creates a much higher challenge for the first-level digital divide – related to digital infrastructure, but it also limits the usage of certain digital technologies and could therefore increase the digital divide in terms of digital competences (second-level divide), as well.

2.1 The state and development of economic disparities

Since reunification in 1990 Germany is traditionally characterized by strong and persistent disparities between eastern (former GDR) and the western regions (Niebuhr, 2016). Germany still undergoes a process of restructuring from old heavy industries to high technologies. The formerly economically strong regions in the Ruhr area and other regions in northern Germany

(with strengths in mechanical engineering, e.g. automotive industry and shipbuilding), were and are increasingly being left behind by high-tech regions located rather in the south of Germany. Moreover, the shift towards a knowledge economy increases disparities between urban and rural areas, with the former becoming centers of service industries and the high-tech sector, and the latter being left-behind because of the increasing importance of human capital in the knowledge economy, for which rural regions have particularly unfavorable demographics. This creates a strong core-periphery structure in many regions, but also slightly reduces overall interregional disparities (Berthold & Müller, 2010). Albeit, the high demand for labor in the economic centers is leading to ever-expanding catchment areas, so that formerly very rural (sub-)regions are now within the commuting range of metropolitan areas.

Norway's wealth is due to the discovery of large oil and gas deposits in the North Sea and the start of extraction of these in the 1970s. These have brought significant growth in business, and thus employment and prosperity, first to the region around Stavanger and eventually to other regions (Acar & Karahasan, 2015). Still, in absolute terms the capital city of Oslo is by far the economic center of the country. However, in relative terms, and especially regarding household income (in contrast to GDP), the economic disparities are less pronounced (Acar & Karahasan, 2015). Nevertheless, there is a persistent south-north divide from the more densely populated areas to the sparsely populated regions in northern Norway.

2.2 The state and development of digital infrastructure and competences

For both, Germany and Norway the first-level digital divide is pronounced and strongly related to population density (Statistics Norway, 2021; Breitbandatlas, 2021). However, the degree of this core-periphery structure depends on the measure used. A certain minimum-level of access to digital infrastructure (broadband internet) has meanwhile reached nearly all households in both Norway and Germany, although only ten years ago, the interregional disparities were pronounced. However, the demand for a certain bandwidth increases continuously. 32 mbit/second are considered as the lower bound for fluent work from home with video calls, data synchronization and usage of cloud services (Horaczek, 2021). In this regard, still a considerable divide can be observed. On the larger scale (NUTS2 and NUTS3 regions), the disparities are larger in Norway compared to Germany. However, the lower the level of aggregation, the higher the heterogeneity in access (and actual subscription) to internet at a certain bandwidth in both countries. The larger the country and the more

dispersed the population, the more expensive broadband expansion is, since the same kilometer of cable in rural areas ends up reaching fewer people, who ultimately refinance the construction through their fees. Hence, especially rural areas depend on the political will to actively improve digital infrastructure and to remove existing disparities. This leads to regional differences in internet speed being much more pronounced within regions than between regions or even countries, not only in Norway and Germany (Pereira, 2016). For the same reason, besides with decreasing levels of aggregation, spatial disparities also increase with increasing bandwidth. At levels of 500mbit/sec or even gigabits per second the accessibility diminishes sharply outside (and even within) larger cities. But it is precisely these high internet speeds that will be needed in the future not only by companies but also by private households. In Germany, the traditional divide between east and west is only visible at certain bandwidths. While there are gaps in access to 100mbit/second in eastern Germany, these are also present in other rural areas of Germany (Figure 1). It is only at a much higher bandwidth of 1gbit/second that the divide between east and west becomes more clearly visible, again (Figure 2).

The second-level digital divide relates to digital competences and internet usage as well as social media. Even though empirical evidence is on a more aggregate spatial level (NUTS1), it shows particular differences between Norway and Germany that deviate from the first-level digital divide. All Norwegian regions belong to the most digitally "competent" within Europe, with the economically richer and digitally more accessed regions in the south and west scoring even better. However, the digital competences are also high in the sparsely populated north, even though bandwidth is still relatively low for a particular share of the population. Overall, the second-level digital divide is more pronounced within German federal states and it correlates with longstanding economic disparities between western and eastern states (Lucendo-Monendero et al., 2019). All states of the former GDR score lower than the other states, in both the usage of social media and the usage of e-commerce and other electronic services. However, the extent to which differences in digital skills are related to access to digital infrastructure or whether other, demographic factors, influence digital skills much more substantially needs to be further investigated. This is particularly important to better understand the relationship between digitization and spatial disparities. A high-speed connection can be installed in even the most remote location at great expense, but regions and their inhabitants cannot buy the necessary digital skills.

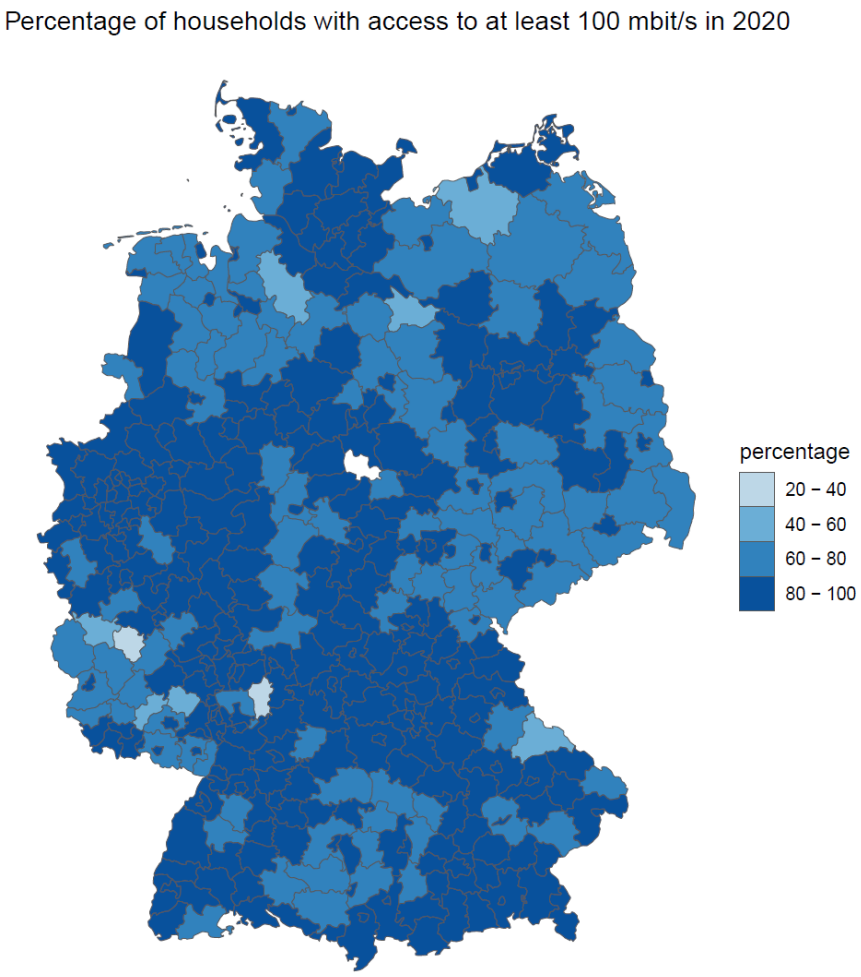

Figure 1: *Broadband access in German NUTS3-regions (100mbit/s)*

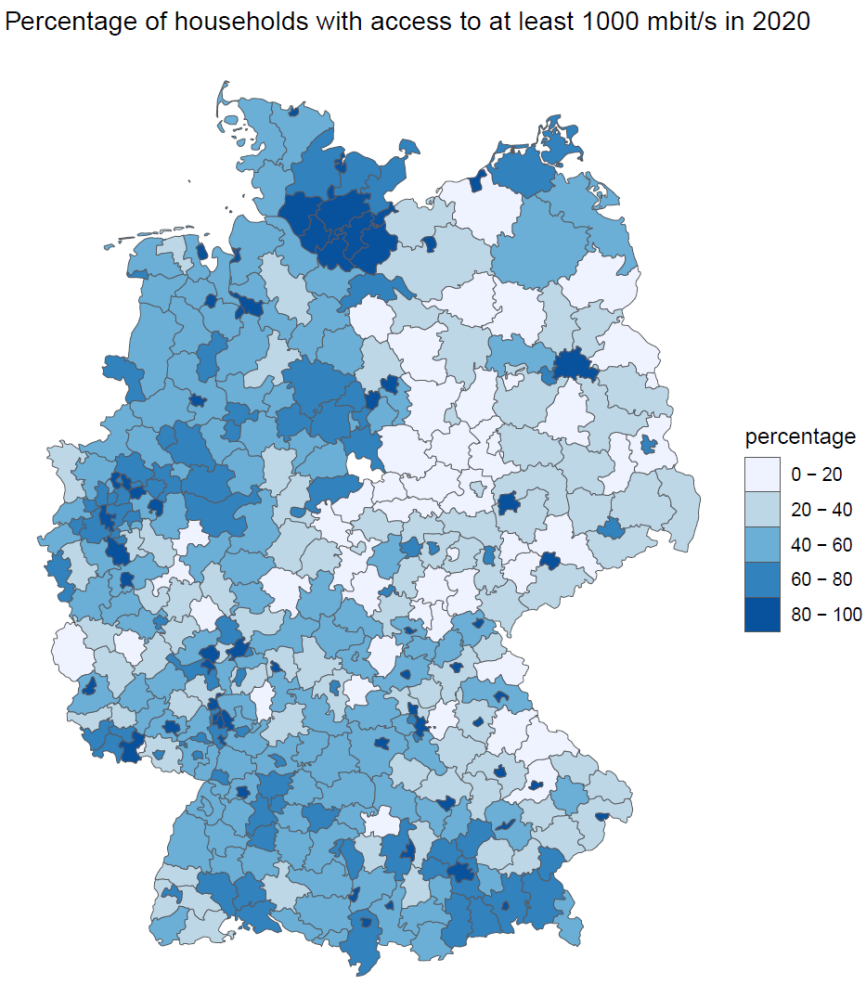

Figure 2: *Broadband access in German NUTS3-regions (1gbit/s)*

4. The locational preferences of the highly-skilled (digitals): spatial patterns and changing motivations?

Although the current pandemic is far from over and therefore its regional economic effects cannot be finally assessed, it is clear that COVID19 is acting as a catalyst for digitalization: Individuals, employees and firms have quickly learned that and how digitalization can be used to perform many (not all) work processes through working-from-home. Even if, after the pandemic, some of these activities temporarily shifted out of the company and into the homes of employees (and thus their locations) will move back into the companies, it can be assumed that this will only apply to some activities. Many companies and other employers have recognized the - long and medium-term - economic advantages associated with working-from-home instead of working in the company (Erdsiek 2021). But also vice versa, some employees and especially self-employed (not to mention digital entrepreneurs) have realized that working-from-home can bring some advantages (e.g. better reconciliation of work and family, etc.). The empirically and theoretically open, but from a regional policy perspective very relevant question is whether this could lead to a lasting and significant revaluation of living and working locations, away from expensive urban locations and towards cheaper, ecologically more compatible and safer rural locations. At least in some of the European high-income countries (incl. Germany) this has led to a lively debate, which, however, due to a lack of suitable data, usually lacks serious, scientifically sound empirical evidence. The literature on the geography of the highly-skilled has so far provided little insight into this question, but it is also mostly focused on international migrants and their location behavior and/or it ignores the role of the employees' digital competence as well as the role of the digital infrastructure at the place of residence and work and/or it focused on the role of amenities compared to other non-soft location factors (see, e.g., Arntz et al. 2021). In addition, empirical findings on the regional distribution of the highly-skilled dominate without explaining the individual reasons for their location decision.

A significant reduction (or even reversal) of the economic disparities between economically weak (often rural) and economically strong (often urban) regions would require a new location assessment by the highly-skilled, who also have a high level of digital competence (i.e., the crucial employees regarding the 2nd level digital divide). If the majority of these (rather young) employees were to decide to work and live in the same location, and if this location is no longer in urban agglomerations but in (previously) economically weaker and

usually also geographically peripheral locations, then the latter locations could catch up. Of course, a prerequisite for this is that the highly-skilled are at least acceptably equipped with digital infrastructure, i.e. at least equivalent to that of the urban regions. The existing 1st level digital divide to the disadvantage of rural regions would therefore have to be eliminated. This can be expected in the medium to long term, at least in the high-income countries, since the political will and also the economic resources are often available there.

Unfortunately, previous research on the location preferences of the highly-skilled says little about this question. Moreover, digital infrastructure and digital competences of the highly-skilled or the companies have hardly been taken into account in such studies so far.

5. Conclusions and hypotheses

Based on the previous chapters, we draw the following conclusions for economically strong and weak regions. Economically strong regions will not lose strength and dynamism to weak regions as a result of progressive digitization. Instead they are at least absolute winners within countries, possibly even relative winners of digitization, and for them it is not peripheral regions in the same country that are the competitors in the global competition of regions, but rather other strong regions from abroad. For economically weaker and/or peripheral regions, on the other hand, the digital infrastructure is a necessary but not a sufficient condition for economic catching-up/restructuring processes compared to urban regions. More important for them will be the way the infrastructure is used, i.e. the digital competence of the users. Central to the digitization effects there is the retention or attraction of highly skilled people in these regions as well as their demands on their place of work and residence.

In view of the large empirical research gaps, especially with regard to the indicators of the 2nd level digital divide (related to digital competences), the two theoretical positions outlined at the beginning regarding the effects of digitalization on the development of interregional economic disparities can currently neither be verified nor falsified. However, our empirical findings have at least shown that both in terms of the two levels of the digital divide (digital infrastructure and digital competences) and in terms of relevant economic indicators (as GDP per capita or growth of GDP per capita), the classic urban-rural disparities in high-income countries clearly still exist. Whether this will continue to be the case in the future or whether it will be changed by the deliberately altered motives of highly-skilled (incl. digitally

competent workers) to choose a location in favor of an economic catching-up of weaker regions depends on many factors, e.g. the speed of expansion of digital infrastructure (rural vs. urban), the development of real estate prices in the aforementioned types of regions, regional policy measures in favor of economically peripheral regions and the social (re)evaluation of residential location factors (e.g. access to cultural offerings, security, monetary costs, ecological attributes), but also very fundamental things such as the importance of work vs. leisure or the work-life balance. If, over a longer period of time, a sufficient number of highly-skilled people (who in future will also tend to have high digital competence) are able and willing to opt for working-from-home and then prefer locations far away from the urban agglomerations, digitization could indeed contribute to a reduction in urban-rural economic disparities. Moreover, the reversal of the "people follow jobs" thesis postulated in times before the current pandemic (and before digitalization) could become reality.

Our concluding hypotheses are intended as a suggestion for later empirically oriented work in which these hypotheses can be tested, provided that data are available.

1. Digitalization is not and does not have a spatially neutral effect, but will influence the economic performance of sub-national regions differently.

2. Digital entrepreneurship (through new businesses) has the potential to reduce urban-rural disparities in employment and economic development

3. Digitalization and working-from-home will be the winners of the pandemic, leading to spatial expansion of metropolitan areas but not to a reduction of urban-rural disparities (intra-regional rather than inter-regional decentralization)

4. In the long run, the spatial effects of the 2nd level digital divide are more important for spatial inequality than those of the 1st level digital divide (policy overestimates infrastructure effects)

5. Digitization can only contribute to the economic catching-up of truly peripheral rural regions if many digitally competent people live and work there (willing and able).

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