

Belitz, Heike; Gornig, Martin; Schiersch, Alexander

**Article**

## Productivity: Urban-rural differences affect productivity more than east-west differences

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AT A GLANCE

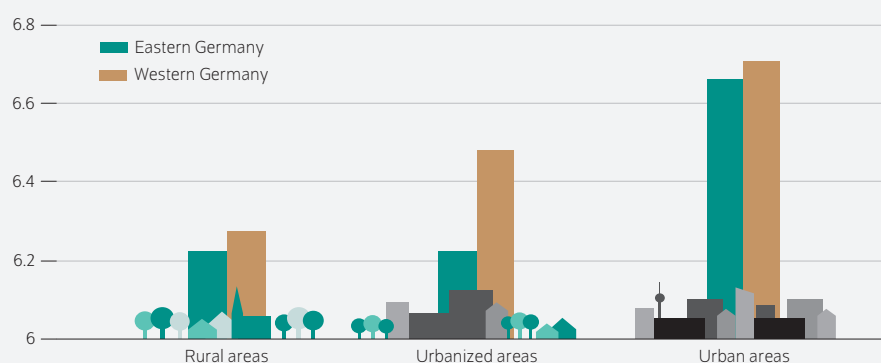
## Productivity: Urban-rural differences affect productivity more than east-west differences

By Heike Belitz, Martin Gornig, and Alexander Schiersch

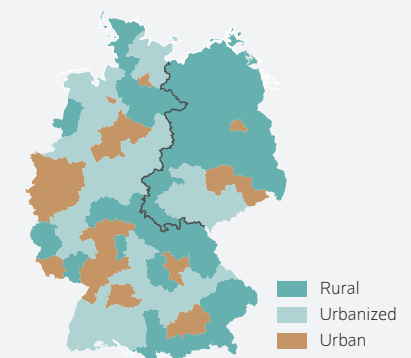
- East has closed productivity gap with west significantly, but narrowing has stalled
- Total factor productivity gap in manufacturing is around 20 percent
- Rural structure of eastern Germany significant cause of the remaining east-west productivity gap
- Urban-rural gap requires countrysidewide investment in rural infrastructure
- Manufacturing is significantly more productive in urbanized regions in western Germany, promoting clusters could unleash potential in eastern Germany

### Remaining east-west productivity gap primarily due to weak productivity in urbanized areas and the large share of rural areas in east

Total factor productivity in the manufacturing sector for 2014, arithmetic means of logarithmic values



Settlement structures of region types



Sources: Research Data Center of the Federal and State Statistical Offices; AFID Panel Industrial Companies; authors' own calculations (left-hand side); BBSR Bonn 2019, data used: ongoing spatial observation of the BBSR. Geometric basis: spatial planning regions (generalized), 12.31.2017, © Geobasis-DE/BKG (right-hand side).

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### FROM THE AUTHORS

*“There is still a marked difference in productivity levels between eastern and western Germany. However, this is also because the east is much more rural in structure compared to the west. Accordingly, when discussing productivity, we should not only focus on the east-west difference, but the urban-rural gap as well.”*

— Alexander Schiersch, study author —

# Productivity: Urban-rural differences affect productivity more than east-west differences

By Heike Belitz, Martin Gornig, and Alexander Schiersch

## ABSTRACT

Following reunification, productivity in eastern Germany grew rapidly. A strong industrial sector is key to a thriving German economy. However, the narrowing of the industrial productivity gap between eastern and western Germany has come to a standstill since the financial and economic crisis and the gap remains considerable today. Nevertheless, when comparing similar regions in eastern and western Germany, the productivity gap shrinks. In both eastern German cities as well as rural areas, industrial companies are using labor and capital almost as efficiently as their competitors in comparable regions in the west. However, the productivity level in urbanized areas in eastern Germany is significantly lower than in urbanized regions in western Germany. For this reason, these regions in the east should be strengthened by expanding research and infrastructure and by encouraging the creation and growth of clusters. Progress in closing the productivity gap between eastern and western Germany can also be made by implementing a sustainable, countrywide infrastructure offensive to increase the attractiveness and growth opportunities of rural areas. As the east is very rural in structure, it would profit from this in particular.

The 30th anniversary of the fall of the Berlin Wall and the Iron Curtain is a fitting opportunity to analyze socio-political issues in Germany, especially the discrepancies between east and west. Economic factors play a significant role in this discussion. Usually, the focus is primarily on the economic living conditions of the population. Therefore, many studies refer to per capita income<sup>1</sup> or disposable income.<sup>2</sup>

In contrast, this study focuses on the economic performance of companies.<sup>3</sup> Government transfers and state financial compensation are therefore not the focus; instead, it is productivity, the key indicator for economic performance.

The starting point is labor productivity, which measures output per labor input. This study also analyzes regional differences in total factor productivity (TFP), which measures the productivity of the entire factor input (from labor and capital).

Spatial development processes are increasingly heterogeneous. Urban areas are often considered centers of innovation and growth while rural regions are frequently in danger of being left behind. When assessing the differences in economic performance between eastern and western Germany<sup>4</sup>, differences in settlement structures must be taken into account.<sup>5</sup> Accordingly, spatial differentiations within eastern and western Germany will also be examined. Regions are categorized as urban, urbanized, or rural using the system established by the Federal Institute for Research on Building,

<sup>1</sup> Cf. Martin T. Braml and Gabriel J. Felbermayr, "Regionale Ungleichheit in Deutschland und der EU: Was sagen die Daten?" *ifo Schnelldienst* 7 (2018): 36–49 (in German).

<sup>2</sup> Cf. Clemens Fuest and Lea Immel, "Ein zunehmend gespaltenes Land? Regionale Einkommensunterschiede zwischen Stadt und Land sowie West- und Ostdeutschland," *ifo Schnelldienst* 16 (2019): 19–28 (in German).

<sup>3</sup> This study is based on a research project funded by the Bertelsmann Stiftung. The results are published in Heike Belitz, Martin Gornig, and Alexander Schiersch, "Produktivitätsentwicklung in Deutschland – Regionale und sektorale Heterogenität," *Serie Produktivität für Inklusives Wachstum*, vol. 2 (Gütersloh: Bertelsmann Stiftung, 2019).

<sup>4</sup> "Eastern Germany" or "east" includes the former German Democratic Republic (East Germany) and the entire city of Berlin. Western Germany or "west" includes the former Federal Republic of Germany (West Germany) minus West Berlin.

<sup>5</sup> Cf. Michael Hüther, Jens Südekum, and Michael Voigtländer, "Die Zukunft der Regionen in Deutschland – Zwischen Vielfalt und Gleichwertigkeit," *IW-Studien – Schriften zur Wirtschaftspolitik aus dem Institut der deutschen Wirtschaft* (Cologne, 2019).

Urban Affairs, and Spatial Development (*Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR*).<sup>6</sup>

### Catch-up of labor productivity stagnating

There was a strong boost in productivity in eastern Germany immediately after reunification,<sup>7</sup> but around the turn of the millennium, growth began to slow. The official figures of the National Accounts of the Federal States (*Volkswirtschaftlichen Gesamtrechnungen der Länder, VGRL*) provide an overview of labor productivity development in the new and old federal states from 2000 onwards.

Following the turn of the millennium, labor productivity in the business economy<sup>8</sup> in eastern Germany rose from almost 26 euros to 37 euros per hour in 2017, measured in 2010 prices. Productivity experienced almost near continuous growth, only interrupted by the global financial and economic crisis (Figure 1). Productivity in western Germany grew as well, however, so that the gap between east and west only narrowed slowly. In 2000, hourly productivity was 35 percent below the western German level; in 2017, it was still 25 percent below. The gap has not narrowed continually: between 2002 and 2011, it stalled and since 2015, it has more or less been at a standstill. Since then, the east has remained at 75 percent, or three quarters, of the west's level.

Labor productivity in the industrial sector developed similarly. In both eastern and western Germany, the industrial sector is traditionally viewed as a driver of growth and economic competitiveness. In this sector, hourly productivity in eastern Germany increased somewhat more strongly than in the business economy as a whole. However, western German industry has also been growing strongly; thus, the gap between east and west only decreased by six percentage points from 35 to 29 percent (Figure 2) between 2000 and 2017. Following the global financial and economic crisis, the productivity gap between eastern and western German industry grew before beginning to shrink again in 2013. Recently, however, the catching-up process came to a standstill.

A closer look at regional industrial productivity trends reveals that some regions have particularly high levels of productivity (Figure 3). In 2000, there was only one region with exceptionally high labor productivity; by 2017, there were eight. In light of the current discussion on company productivity polarization, we refer to these regions as “superstar regions.”<sup>9</sup> All of these superstar regions are located in western Germany and are key locations for large industrial

Figure 1

### Labor productivity in the business economy

Hourly productivity in 2010 prices (left axis)



Sources: VGRL; authors' own calculations.

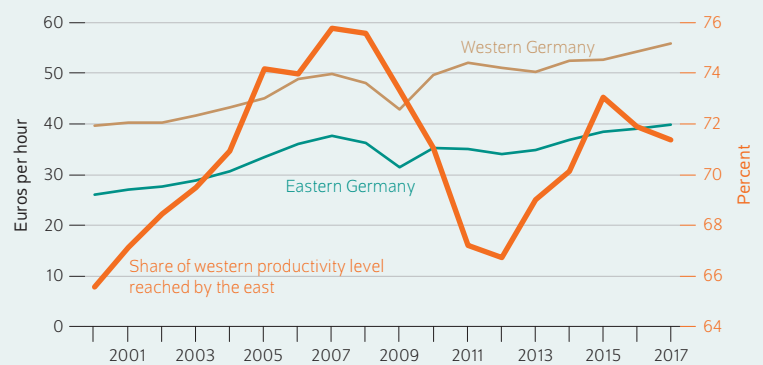
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The initially rapid catching-up process of eastern German industry has been stagnating since 2015.

Figure 2

### Industrial labor productivity

Hourly productivity in 2010 prices (left axis)



Sources: VGRL; authors' own calculations.

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The global financial crisis negatively affected the catching-up process of eastern German industry in particular.

<sup>6</sup> Ongoing spatial observation by the BBSR on regional classifications and settlement structures of different region types. For the definitions of the area types compared here, see the website of the BBSR (in German). Accessed on October 21, 2019. This applies to all other online sources in this report unless stated otherwise.

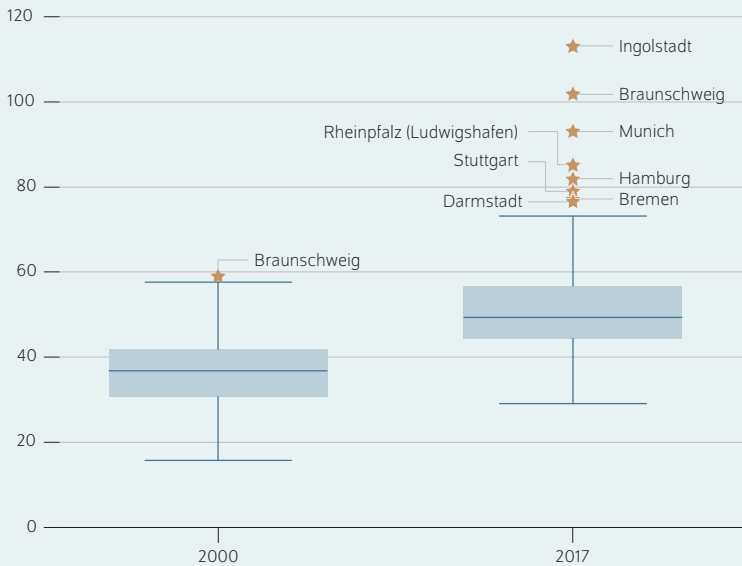
<sup>7</sup> Cf. Reint E. Gropp and Gerhard Heimpold, "Ostdeutschland 30 Jahre nach dem Mauerfall. Erreichtes und wirtschaftspolitischer Handlungsbedarf," *Wirtschaftsdienst* no. 7 (2019): 471–482 (in German).

<sup>8</sup> The commercial economy includes industry, construction, trade, and services. Due to the statistical data, the term "services" here includes financial and insurance services.

<sup>9</sup> Their labor productivity is more than 1.5 times above the third interquartile range.

Figure 3

**Industrial labor productivity box plots according to spatial planning regions, 2000 and 2017**  
Hourly productivity in 2010 prices



Sources: VGRL; authors' own calculations.

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In 2017, there were eight very productive "superstar regions."

companies. Of the eight, six are urban regions. However, the two at the top of the ranking are the automotive centers Ingolstadt and Braunschweig, which are considered to be urbanized regions.

**Marked urban-rural differences in total factor productivity**

Factor productivity measures, such as labor productivity, are always affected by the degree with which other input factors are used in the process. In contrast, the general level of technical efficiency, the total factor productivity (TFP), is not affected by this bias. Instead, it is the main driver of labor productivity (Box). The TFP, however, is not a directly observable variable; it can only be estimated using econometric methods.<sup>10</sup> The calculations were performed using company data from official statistics, which are available for 2003 to 2014 for companies with over 20 employees in the manufacturing sector.<sup>11</sup> The data were expanded to include the key figures of the BBSR for the types of regions available at district level (Figure 4). This way, it is possible to compare the productivity of industrial companies in urban, urbanized, and rural areas of eastern and western Germany.

<sup>10</sup> In this study, a structural estimation approach was used. Cf. Daniel A. Akerberg, Kevin Caves, and Garth Frazer, "Identification properties of recent production function estimators," *Econometrica*, 83, no. 6 (2015): 2411–2451.

<sup>11</sup> Federal and State Statistical Offices, Metadata Report Industrial Companies (2015).

Box

**Total Factor Productivity (TFP)**

To conduct this microeconomic analysis, a Cobb-Douglas production function is estimated.

$$(1) \quad Y_{it} = \Omega_{it} L_{it}^{\beta_l} K_{it}^{\beta_k}$$

where  $Y_{it}$  is gross value added,  $K_{it}$  physical capital stock,  $L_{it}$  labor input,  $\Omega_{it}$  total factor productivity (TFP), and  $\beta_l$  and  $\beta_k$  the elasticities of the labor and capital inputs, respectively. The indices define the company  $i$ , and the observation time  $t$ . Economic literature uses TFP as an indicator of technological capacity and the overall efficiency of all factor inputs in production.

Assuming constant returns to scale,  $\beta_l$  and  $\beta_k$  add up to 1 and formula (1) can be modified as follows:

$$(2) \quad \frac{Y_{it}}{L_{it}} = \Omega_{it} \left( \frac{K_{it}}{L_{it}} \right)^{\beta_k}$$

where  $Y_{it}/L_{it}$  is labor productivity and  $K_{it}/L_{it}$  capital intensity.

While the TFP is a dimensionless indicator, labor productivity measures output in euro per capita or euro per hour worked. For this reason, direct comparisons between both indicators is impossible.

Formula (2) illustrates the relationship between the two productivity indicators. When TFP increases by one percent, labor productivity increases by one percent. At the same time, labor productivity also increases when capital intensity increases. Labor productivity therefore increases as a result of capital

intensification of production and does not require that TFP, the overall efficiency of production, increase.

Beginning in 2003, the development of industry TFP differs only slightly between eastern and western Germany (Figure 5) from the development of labor productivity shown above (Figure 2). Until 2008, TFP grew markedly in both the east and west, allowing eastern German companies to catch up to their western German counterparts. By 2008, they had reached approximately 79 percent of the western German level. Since then, however, the catching-up process has come to a standstill.

The differences in settlement structures between the east and west continue to contribute to the productivity gap. While urban areas generate half of industrial gross value added in western Germany and rural areas only generate 15 percent, most industrial production in eastern Germany is in rural areas. Forty percent of gross value added of industrial companies in eastern Germany is generated in rural areas (Table 1). Thus, eastern German industry is characterized by rural areas overall.

Table

**Industrial gross value added in eastern and western Germany according to region types, 2017**

Shares in percent

	Urban areas	Urbanized areas	Rural areas	Total
<b>Share of industrial gross value added by region type</b>				
Eastern Germany	29.8	28.9	41.3	100.0
Western Germany	49.0	36.0	15.0	100.0
<b>Share of industry contribution to regional gross value added</b>				
Eastern Germany	11.7	22.7	17.5	16.2
Western Germany	21.8	30.0	26.9	25.0

Sources: VGRL; authors' own calculations.

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Agglomeration effects influence companies' productivity.<sup>12</sup> *Inter alia*, regional economics has highlighted the role of urbanization economies in fostering productivity. The positive effect is due to the fact there is a larger and more differentiated labor market in densely populated areas, making it easier for companies to fill job vacancies with skilled workers best suited for the job. Moreover, agglomerations are often places of knowledge formation and transfer. Localization economies can also enhance productivity. They occur when an industry is concentrated in a region. Because of that concentration, companies benefit from a large labor force with the necessary qualifications for their respective industries. The high level of competition in such an area leads to greater innovative pressure on individual companies. However, close physical proximity also means that companies are able to adopt innovations much more quickly (spill-over effect). Empirical research has shown that such agglomeration effects positively influence TFP.<sup>13</sup>

Accordingly, the productivity gap between east and west can be viewed in a more differentiated way if a distinction is made between the settlement structure characteristics. In 2014, the average TFP of industrial companies in urban regions was around 28 percent above the level of similar companies in urbanized regions. In contrast, the average productivity of companies based in rural areas was 18 percent below the comparable value in urbanized regions.<sup>14</sup>

Therefore, an east-west comparison of region types with the same settlement structure is performed. Such comparison takes into account both the differences due to agglomeration effects as well as differences resulting from the different economic structures in the regions.<sup>15</sup>

<sup>12</sup> Cf. Walter Isard, *Location and Space-Economy—A General Theory Relating to Industrial Location, Market Areas, Land Use, Trade and Urban Structure* (New York: John Wiley & Sons, 1956) as well as Edward L. Glaeser et al., "Growth in Cities," *Journal of Political Economy* 100, no. 6 (1992): 1126–1152.

<sup>13</sup> Cf. Martin Gornig and Alexander Schiersch, "Agglomeration economies and firm TFP: different effects across industries," *DIW Discussion Paper 1788* (2019) as well as Richard Harris and John Moffat, "Total Factor Productivity Growth in Local Enterprise Partnership Regions in Britain, 1997–2008," *Regional Studies* 96, no. 6 (2015): 1019–1041.

<sup>14</sup> Cf. Belitz, Gornig, and Schiersch, "Produktivitätsentwicklung in Deutschland."

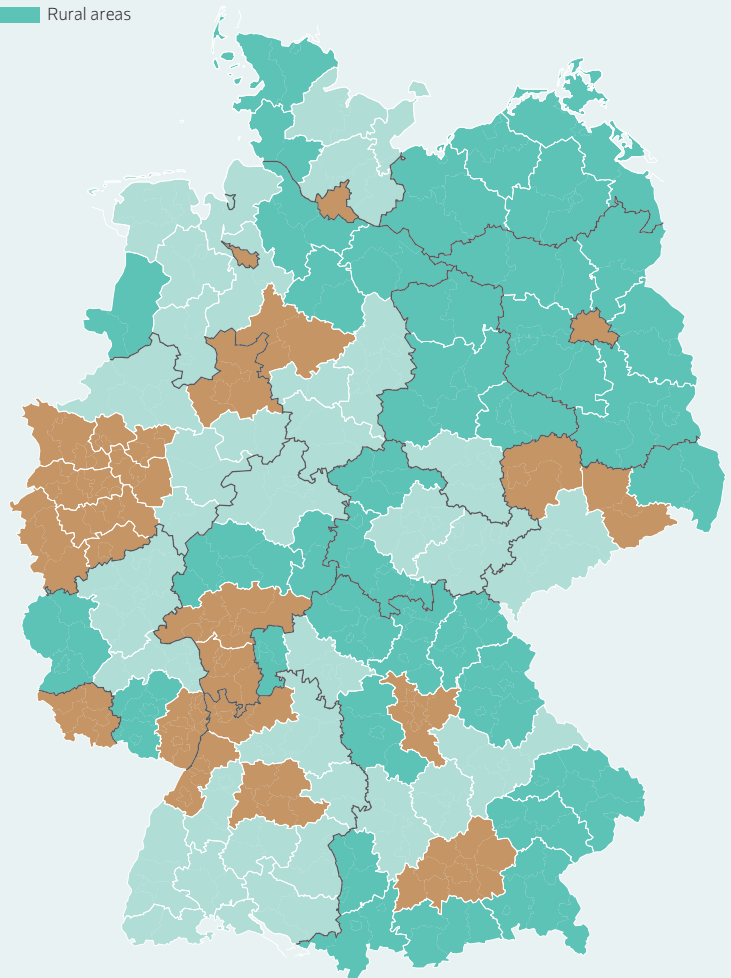
<sup>15</sup> Here we assume that the economic structures in the three spatial order categories (urban, urbanized, rural) in the east and west do not fundamentally differ.

Figure 4

**Spatial planning regions according to settlement structure in Germany**

Region types according to settlement structure

- Urban areas
- Urbanized areas
- Rural areas



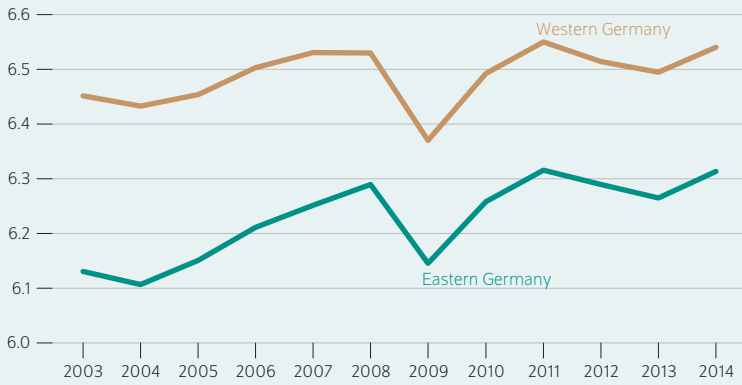
Sources: BBSR Bonn 2019, data used: ongoing spatial observation of the BBSR. Geometric basis: spatial planning regions (generalized), 12.31.2017, © Geobasis-DE/BKG.

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The new federal states are highly rural in structure.

Figure 5

**Total factor productivity of companies**  
Manufacturing sector, arithmetic mean, logarithmic values



Sources: BBSR; Research Data Center of the Federal and State Statistical Offices; AFID Panel Industrial Companies; authors' own calculations.

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Measured in terms of TFP, industrial companies in western Germany also produce more efficiently.

On average, the productivity of eastern German industrial companies in urban areas is below that of companies in western German urban areas (Figure 6). However, the difference is minimal. The situation is similar for rural areas, albeit productivity is at a considerably lower level than in urban areas, as the TFP of eastern German companies is only slightly below the western German average.

The situation is different for urbanized regions. As of 2014, the differences are still significant, markedly larger than in the other two types of regions. Examples of such urbanized areas in eastern Germany are the spatial planning regions of Halle/Saale, Central Thuringia (Weimar), and Southern Saxony (Chemnitz). In western Germany, urbanized areas include Braunschweig, Oldenburg, Ingolstadt, and the southern upper Rhine (Freiburg). The marked east-west difference in urbanized regions is partly because in western Germany, they are more often home to strong industrial centers. As a result, localization economies can be utilized.

**Conclusion: Industrial and infrastructure policies necessary**

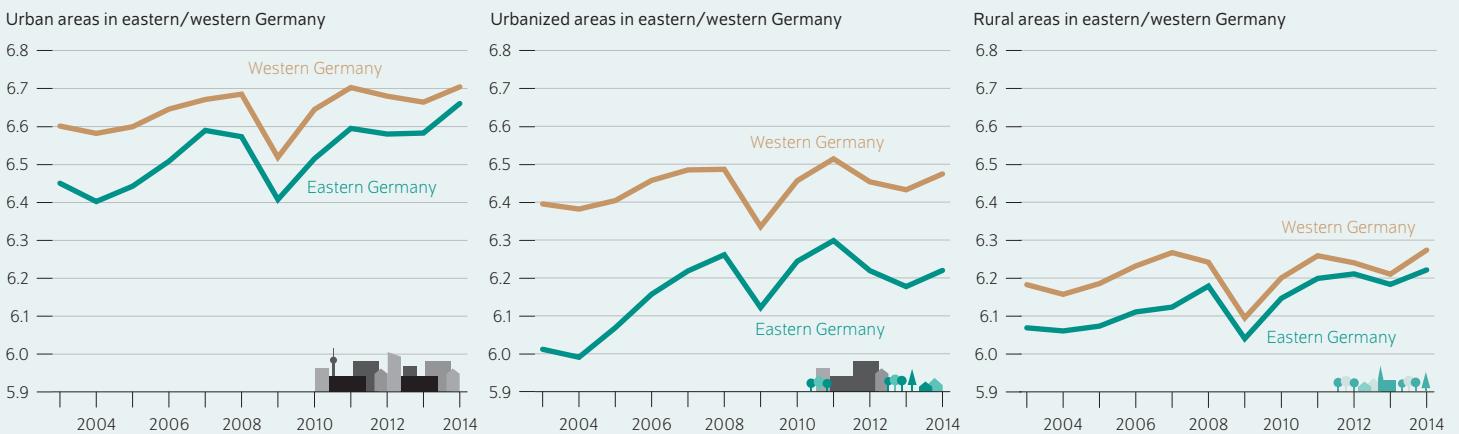
Productivity in eastern Germany grew rapidly after reunification, especially labor productivity, due to a historically unique inflow of capital.<sup>16</sup> However, following the financial and economic crisis of 2009, the catching-up process in industry came to a standstill. Although the productivity gap between the east and west remains considerable, including regionally specific features strongly relativizes this finding. It is becoming clear that the existing gap is to some extent because the east is more rural than the west. Furthermore, urbanized areas in the east do not utilize their economic potential to the same extent as in western Germany.

In light of these findings, there are two areas where concrete action is necessary. One starting point is the promotion of

<sup>16</sup> Cf. Michael Burda and Jennifer Hunt, "From Reunification to Economic Integration: Productivity and the Labor Market in Eastern Germany," *Brookings Papers on Economic Activity* 2 (2001).

Figure 6

**Total factor productivity of companies in urban, urbanized, and rural areas**  
Manufacturing sector, arithmetic mean, logarithmic values



Sources: BBSR; Research Data Center of the Federal and State Statistical Offices, AFID Panel Industrial Companies; authors' own calculations.

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The mean TFP of industrial companies differs most between urbanized regions in eastern and western Germany.

industrial development, specifically in urbanized regions of eastern Germany. An industrial policy including innovation, investment, and start-up support is needed. In urbanized areas in particular, industrial potential should be clustered in order to utilize possible localization economies. Strategies for decentralized concentrations of research and infrastructure accompanied by support of clusters seem fitting here.<sup>17</sup>

Yet, no one can change the basic fact that there are fewer large cities and more rural regions in eastern Germany. Seventy years of relative population loss to western Germany cannot simply be reversed. To forego the productivity advantages offered by the concentration of economic activities in Germany would also not be wise. It would be prudent to focus on creating a better balance between urban and rural areas in Germany by improving development opportunities in rural

areas. This, in turn, creates potential to narrow the productivity gap between eastern and western Germany further.

In light of this stark urban-rural contrast, however, financial equalization between local authorities alone cannot close the gap.<sup>18</sup> Federal government intervention is needed in order to improve the appeal of and growth opportunities in rural areas through a sustainable infrastructure offensive.<sup>19</sup> In this offensive, the focus should remain on the bigger picture, such as constructing a modern communication infrastructure. An industry that is competitive in the digital age requires an efficient broadband infrastructure. Without a strong communication infrastructure, new companies will not choose to locate their activities in more rural areas and existing companies, disadvantaged, will relocate.

<sup>17</sup> Cf. Erik E. Lehmann and Matthias Menter, "Public cluster policy and performance," *Journal of Technology Transfer* 43, no. 3 (2018): 558–592 as well as Uwe Cantner, Holger Graf, and Susanne Hinzmann, "Policy Induced Innovation Networks: The Case of the German 'Leading-Edge Cluster Competition,'" in *The Geography of Networks and R&D Collaborations*, ed. Thomas Scherngell (2013), 335–352.

<sup>18</sup> Cf. Martin Junkernheinrich, "Gleichwertigkeit der Lebensverhältnisse und Kommunalfinzen," *Wirtschaftsdienst (Jahrgang 99), Sonderheft Regionalpolitik neu denken* (2019): 36–43.

<sup>19</sup> Cf. Martin Gornig, "Infrastrukturinvestitionen statt Subventionen," *Wirtschaftsdienst (Jahrgang 99), Sonderheft Regionalpolitik neu denken* (2019): 44–48 as well as Alexander Eck et al., "Öffentliche Infrastrukturinvestitionen: Entwicklung, Bestimmungsfaktoren und Wachstumswirkungen," *Ifo Dresden Studien* 72 (Dresden: 2015).

**Heike Belitz** is a research associate in the Firms and Markets Department at DIW Berlin | [hbelitz@diw.de](mailto:hbelitz@diw.de)

**Martin Gornig** is research director Industrial Policy and deputy head at DIW Berlin | [mgornig@diw.de](mailto:mgornig@diw.de)

**Alexander Schiersch** is a research associate in the Firms and Markets Department and the Entrepreneurship Research Group at DIW Berlin | [aschiersch@diw.de](mailto:aschiersch@diw.de)



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DIW Berlin — Deutsches Institut für Wirtschaftsforschung e.V.

Mohrenstraße 58, 10117 Berlin

[www.diw.de](http://www.diw.de)

Phone: +49 30 897 89-0 Fax: -200

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