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Spatial Difference in Labor Productivity between Beijing and the Wider South East Region of England

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In this study, we analyze the differences in labor productivity between the Wider South East region of England (WSE) (including London, the east, and the south east of England) and Beijing in an attempt to establish the reasons for the difference based on the deformation of the Cobb–Douglas production function proposed by Brandt *et al.* and the shift–share method. We use data from multiple sources, including remote sensing data, to reproduce smaller-scale spatial data of urban boundaries, urban land structures, and urban traffic structures. We found that there is not only a gap in productivity between Beijing and the WSE but also a more significant regional gap in productivity among Beijing's districts. From the perspective of the role of production factors, Beijing's productivity improvement over the past ten years has mainly depended on the total factor productivity and capital. To ensure the sustained growth of Beijing's productivity, we should pay attention to the geographical differences in labor productivity and the improvement of labor productivity throughout the entire urban area. Moreover, we should focus on the production factors that can accelerate the growth of labor productivity.

1. Introduction

On January 27, 2021, the *Fourteenth Five-Year Plan for Beijing's National Economic and Social Development* was adopted and implemented. In this plan, significantly improving the quality and efficiency of economic development is regarded as one of the six improvement goals. Specific economic indicators include an average annual growth rate of regional GDP of about 5%, total labor productivity of about 350000 yuan/person, and total labor productivity growth higher than GDP growth.

In addition, *Overall Urban Planning of Beijing* (2016–2035)[(1)] proposed that Beijing, as the capital of China and a megacity with 20 million permanent residents, should build a world-class harmonious and livable city. Beijing's government will strictly control the population size, optimize the population distribution, reduce the amount of land for urban and rural construction,

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and further relieve non-capital functions. In fact, an empirical study found a faster movement of migrant workers toward suburban areas since 2015.(2) Moreover, it is believed that the implementation of these measures will solve urban problems such as environmental pollution, imbalance of public services, and traffic congestion. Meanwhile, the scientific allocation of resources to achieve sustainable development has been proposed as part of Beijing's urban planning. However, in the 40 years since China's reform and opening up, Beijing's economic growth has been driven by population and the availability of land for construction. Therefore, under the current circumstances, Beijing's development must conform to the new requirements of volume reduction and quality improvement. With this context, this paper attempts to identify the differences between Beijing and the Wider South East region of England and Beijing's shortcomings to provide some suggestions for Beijing's future construction and development.

As the UK's capital, London has been a significant influence in the world since the first industrial revolution. London has always been an archetypal "world city," and its national status has been confirmed by the British government in reference to high labor productivity.(3) Since 2000, Beijing's urban planning has been learning from the British urban planning system, using London as an example. The two regions are highly comparable in terms of the position of their national capital and their long history, urban and population scales, environmental governance, traffic congestion, and other urban problems. Therefore, the analysis of the productivity in London and the surrounding regions over the past few decades has provided a useful reference for Beijing to improve its productivity and develop high-quality industries.

London is a typical city with a single center and radial development. For a long time in the past, Beijing developed with the old downtown area as the center. Therefore, the two cities showed a similar circular structure.(4) According to *Overall Urban Planning of Beijing* (2016–2035), Beijing is divided into three circles: the core area, the central urban area, and the city area. The corresponding circles of London are the central London area, the Greater London area, and the Wider South East region (WSE), which includes London, the east of England, and the south east of England. As of 2018, there are 21.54 million employed people in Beijing, which is close to the 24.38 million employed people in the WSE. In this paper, we select Beijing and the WSE as the research areas and conduct a study of productivity in both regions. We use data from multiple sources, including remote sensing data, to reproduce smaller-scale spatial data of urban boundaries, urban land structures, and urban traffic structures.

2. Comparative Methods of Productivity Growth

There have been many studies on productivity growth and cross-regional comparisons based on unified methods and currency pricing. For example, a recent study calculated China's productivity from 1979 to 2018 to analyze the reasons for the slowdown in productivity and the potential for future growth.(5) Moreover, using the Penn World Table (PWT), researchers have collated and calculated the income, output, input, and productivity of 182 countries from 1950 to 2017, providing scholars with a cross-border comparison of significant economic indicators based on a unified currency.(6) However, most of these studies involved a comparison of productivity between countries, and there is a lack of comparison at a more detailed geographical

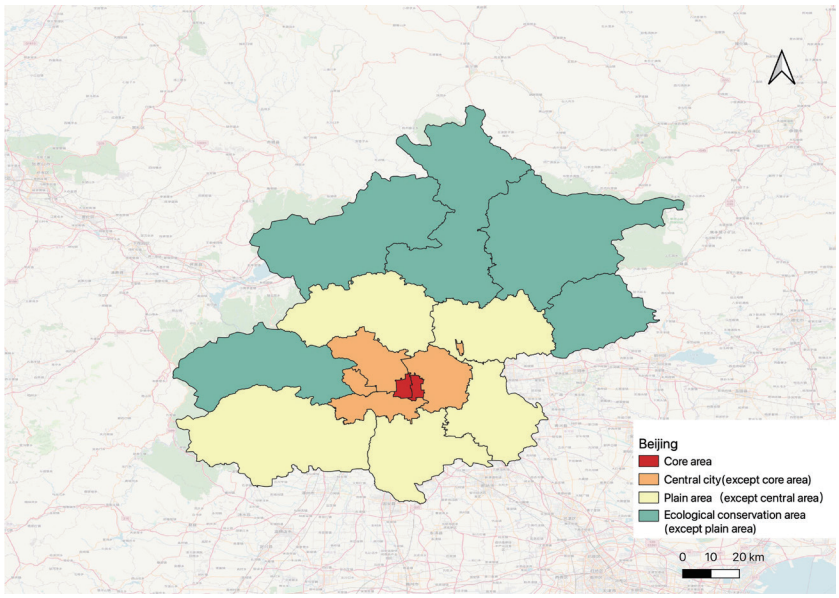
level, such as provinces and cities. Simultaneously, there was no spatial subdivision within research areas, making it difficult to perform further research on spatially balanced development within a region.

2.1 Regional comparison method

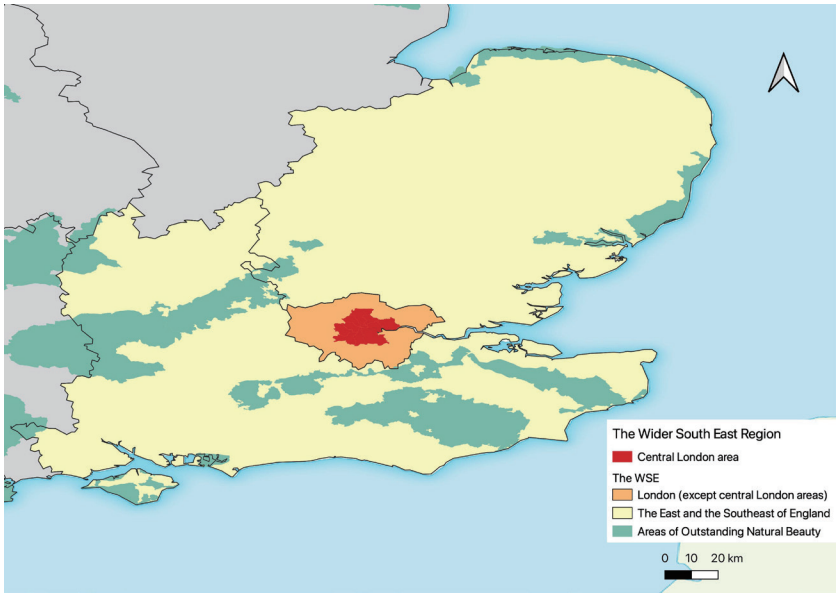
Given the above background, we aim to develop a method to compare productivity between Beijing and the WSE in the three dimensions of space, time, and industry and to give further suggestions according to the regional characteristics and industry development. First, we select data with a relatively detailed geographical breakdown. In Beijing, the district is the smallest spatial unit, while in the WSE, we conduct the study at a regional and county level. The regional comparisons in this study are based not only on the smallest spatial unit but also on the regional circles shown in Table 1 and Fig. 1. When analyzing the reasons for the differences in labor productivity, we also use remote sensing data to reproduce smaller-scale spatial data, including urban boundaries, urban land structures, and urban traffic structure data. From the perspective of the time dimension, we collected data from 2008 to 2018 in Beijing and from 1998 to 2018 in the WSE. From the perspective of industry division, the applied industry classification refers to the industrial classification for national economic activities. On this basis, according to the role of production factors, the tertiary industry is further divided into the capital-intensive industry, labor-intensive industry, and knowledge-intensive industry.(7) Furthermore, to carry out a cross-regional comparison, the currency pricing of GDP, productivity, and capital of the two research regions are unified by converting figures into a constant purchasing power parity (2011 Intl$). The international dollar (Intl$) is used to convert the currencies of different countries into a common currency for multilateral purchasing power parity comparison. In other words, an international dollar in a cited country buys a comparable amount of goods and services as a U.S. dollar would buy in the United States.

Table 1
Regional circles.

Beijing	Regions	WSE	Regions
Core area	Dongcheng District, Xicheng District	Central London area	Inner London
Central city	Core area	Greater London area	London
	Chaoyang District, Haidian District, Fengtai District, Shijingshan District		
City wide	Central city	WSE	London, the south east of England, the east of England
	Plain area outside the central city (Tongzhou District, Fangshan District, Shunyi District, Changping District, Daxing District, Beijing Economic Technological Development Area) are referred to as the plain area		
	Ecological conservation areas (Mentougou District, Pinggu District, Yanqing District, Miyun District, Huairou District)		



(a)



(b)

Fig. 1. (Color online) Regional circles of (a) Beijing and (b) the WSE.

2.2 Method of analyzing factors driving labor productivity improvement

To analyze the factors driving productivity improvement, we select two methods. The first method is the shift–share method.[8] The growth of productivity is affected by the change in productivity within industries ("within"), labor mobility among industries ("between"), and the cross of the two changes ("cross"). The function of productivity is given by

$$\Delta P = \sum_i P_i^T - P_i^0 S_i^0 + \sum_i S_i^T - S_i^0 P_i^0 + \sum_i P_i^T - P_i^0 S_i^T - S_i^0 , \tag{1}$$

where P_i^T is the productivity of industry i at time T, P_i^0 is the productivity of industry i at the initial time, S_i^T is the proportion of employment of industry i at time T, and S_i^0 is the proportion of employment of industry i at the initial time.

From the function of productivity, we can see that the improvement of an industry and the resource reallocation between industries are important for improving productivity. The first part of the function is the change in productivity caused by the improvement of productivity within an industry, the second part is the change in productivity caused by labor mobility among industries, and the third part is the change in productivity resulting from the two changes. In this paper, Beijing's productivity is calculated according to the GDP in *Beijing Statistical Yearbook* and the employment population of various industries in the economic census data bulletin. Productivity in the UK is calculated from the gross value added (balanced) (GVA) data and employment data of various industries published by the Office of National Statistics (ONS).

The second method is to use the Cobb–Douglas production function to analyze the factors driving productivity improvement. The Cobb–Douglas production function gives a method of quantitatively calculating the contributions of capital, labor, and technology to output. In the basic form of the Cobb–Douglas production function, labor input is the size of the labor force. To reflect the impact of labor quality on output, we adopt the deformation of the Cobb–Douglas production function proposed by Brandt *et al.*[5] The production function is given by

$$Y = AK^{\alpha}\left(LH\right)^{1-\alpha}, \tag{2}$$

where Y is the output (GDP), K is the capital input (capital stock), L is the size of the labor force, A is the total factor productivity (TFP), and H is the education index. The education index was calculated by the following function:[9]

$$H = e^{\varphi(x)} \tag{3}$$

$$\varphi(x) = \begin{cases} 0.134 * x, & x \le 4, \\ 0.134 * 4 + 0.101 * (x-4), & 4 < x \le 8, \\ 0.134 * 4 + 0.101 * 4 + 0.068 * (x-8), & x > 8, \end{cases} \tag{4}$$

where X is the average number of years of education in the labor force. The two sides of the above production function are divided by L, then the logarithm is taken on both sides and the difference between the two periods is calculated. The resulting function is

$$\Delta \ln\left(\frac{Y}{L}\right) = \Delta \ln A + \Delta\alpha \ln\left(K / L\right) + \Delta\left(1-\alpha\right)\ln H . \tag{5}$$

The equation implies that changes in productivity are due to changes in TFP, available capital per labor, and labor quality. For Beijing's output, we use the GDP data from *Beijing Statistical Yearbook*. The capital input is estimated according to the gross fixed capital formation data and fixed capital consumption data of *Beijing Statistical Yearbook*. The employment refers to the economic census data, and the education level data refers to the education level of the employed population in *Beijing Labor Statistical Yearbook*. The UK's output uses the GVA data and the employment data published by the ONS. The capital input is referred to the data estimated by Cambridge Econometrics.[10]

3. Economic Status and Development of the Study Areas

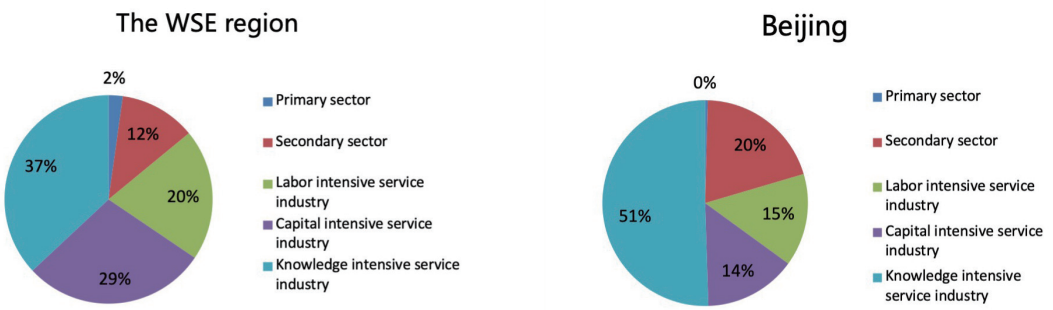
3.1 Current situation of GDP/GVA and productivity

To make the GDP/GVA and productivity of the two regions comparable, we converted the currency pricing of GDP/GVA and productivity into the constant purchasing power parity (2011 Intl$). The GVA of the WSE is 1423.2 billion Intl$ and its productivity is 104000 Intl$ per year. Beijing's GDP is 742.5 billion Intl$ and its productivity is 52000 Intl$. The GVA and productivity of the WSE is clearly much higher than those of Beijing as of 2018.

Figure 2 shows that the industrial structures of the two regions are similar. The tertiary industry is the dominant industry, and the proportion of the primary industry is close to zero. However, there is a difference between the two study areas. The ratio of secondary industry in Beijing (20%) is higher than that in the WSE (12%).

From the perspective of detailed geographical differences, the regional gap in Beijing's GDP and productivity is much larger, whereas in the WSE, the industrial structure in each region is relatively similar. In addition, in Beijing, there are both quantitative and structural differences among different regions. As shown in Fig. 3, in Beijing and the central city of Beijing, the tertiary industry is the dominant industry. In contrast, in the plain area of Beijing, the secondary industry is the main industry.

In the WSE, London has the highest productivity of 123000 Intl$. By contrast, the east of England has the lowest productivity of 86000 Intl$; London's productivity is 1.5 times higher



(a) (b)

Fig. 2. (Color online) GVA/GDP of (a) the WSE and (b) Beijing in 2018.

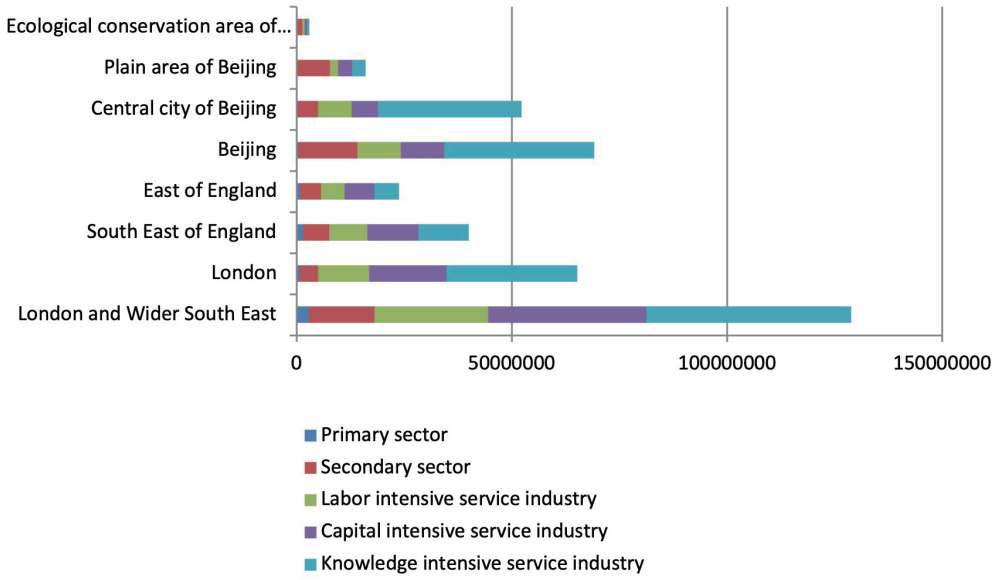


Fig. 3. (Color online) Productivity of the WSE and Beijing in 2018.

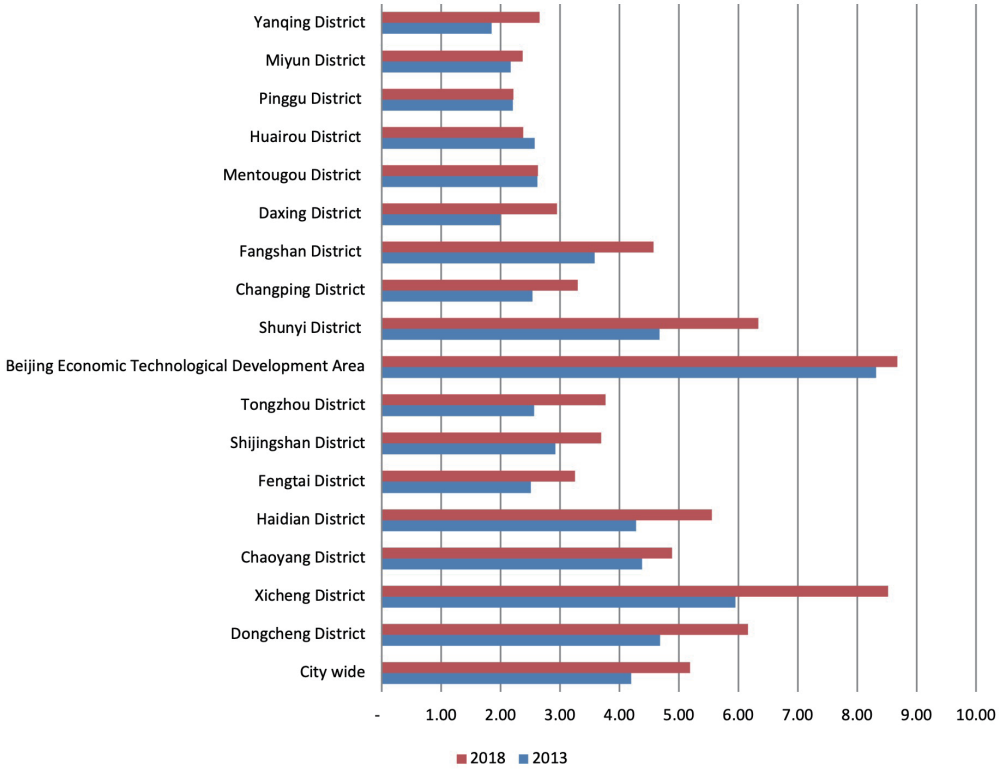


Fig. 4. (Color online) Productivity in Beijing by district in 2013 and 2018.

than that of the east of England. However, there is a greater difference among Beijing's regions, for which the highest productivity is three times the lowest productivity. According to Fig. 4, Beijing's productivity appears to be related to the positioning of the regional function. The

ecological conservation area's productivity is much lower than that in other areas, and the growth rate from 2013 to 2018 has been relatively slow. The central city of Beijing has great advantages in developing the tertiary industry owing to its strong service sector base and agglomeration economies, while the plain areas outside the central city have advantages in developing the secondary industry given cheaper land rents and lower resident density.

3.2 Development of GDP/GVA and productivity

From a temporal perspective, Fig. 5 reveals that Beijing's GDP growth has been comparable to that of the WSE over the past decade. Further comparison of each layer in the two study areas shows that the GDP growth of Beijing's central city is faster than that of London. Although the GDP growth of Beijing's plain district is slightly lower than that of the central city, it is higher than that of the east of England, and it is close to that of the south east of England. Beijing's ecological conservation area has the lowest GDP and GDP growth.

As shown in Fig. 6, over the past five years, Beijing's productivity growth has been significantly higher than that of the WSE. Greater productivity growth is observed in Beijing's central city and plain area than in other regions. It is also greater than that in all three regions of the WSE.

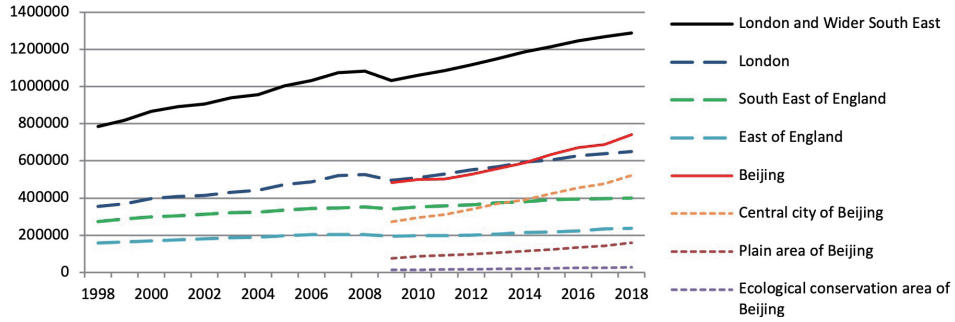


Fig. 5. (Color online) Changes in GDP/GVA in Beijing and the WSE from 1998 to 2018.

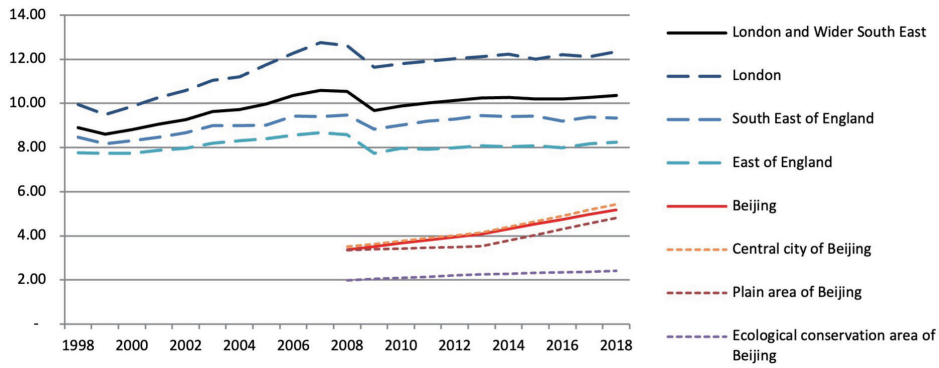


Fig. 6. (Color online) Changes in productivity in Beijing and the WSE from 1998 to 2018.

4. Factors Driving Productivity Growth in Beijing and WSE

Although the trends of productivity growth in Beijing and the WSE are similar, the factors driving the improved productivity are different. This section looks at the differences in detail.

4.1 Impact of labor mobility among industries on productivity

Using Eq. (1), we calculated the influence of productivity changes within industries and cross-industry labor mobility on the improvement of productivity for the two study regions. In general, the results show that the improvement of productivity in the WSE up to 2008 is mainly due to productivity improvement within industries. However, after 2008, the improvement primarily depends on labor flows from industries with lower productivity to those with high productivity. In contrast, the increase in productivity in Beijing in the past decade has been mainly driven by the improved productivity within industries, similarly to the improved productivity in the WSE before 2008.

To be more specific, Eq. (1) can be divided into three parts: 1) the change in productivity caused by the change in productivity within industries ("within"), 2) the change in productivity caused by labor mobility among industries ("between"), and 3) the change in productivity caused by the cross of the two changes ("cross"). The value of "between" is the sum of the shift in the labor share multiplied by each industry's initial productivity. When the labor share of the industry rises, the value of "between" becomes positive. Therefore, when more labor flows into industries with high productivity, the value of "between" of the whole region is positive. The value of "cross" for each industry is the change in labor share multiplied by the productivity change. When the labor share and productivity of the industry rise or fall simultaneously, the value becomes positive. Therefore, when more labor flows into industries with faster productivity growth, the value of the "cross" of the whole region is positive.

As shown in Figs. 7 and 8, in the WSE, the value of "between" has been positive since 2003. However, the value of "cross" has been negative since 1998, which suggests a reduction in productivity growth driven by labor reallocation. The negative value of "cross" is mainly due to the decline in productivity within industries. In contrast, since 2008, the value of "within" for

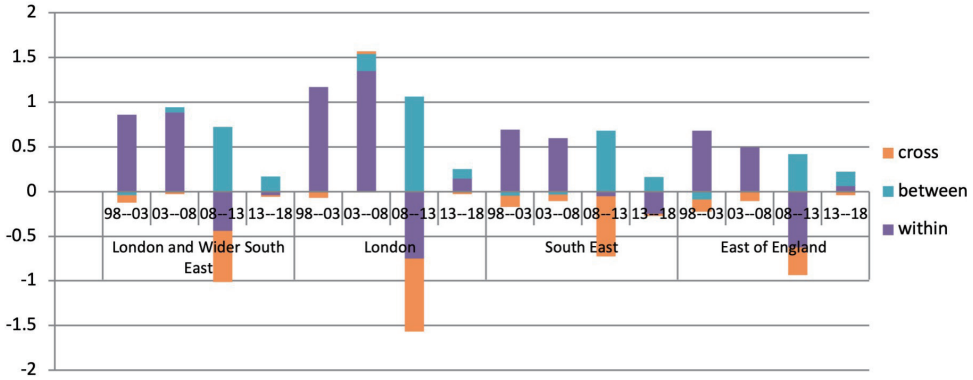


Fig. 7. (Color online) Factors driving productivity growth in the WSE from 1998 to 2018.

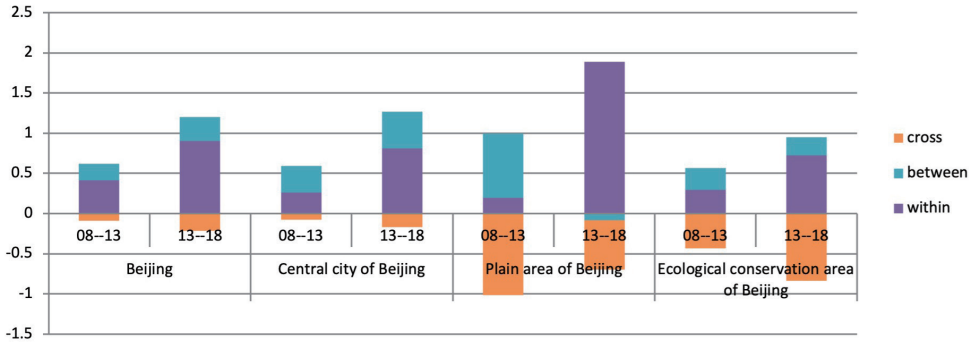


Fig. 8. (Color online) Factors driving productivity growth in Beijing from 2008 to 2018.

Beijing has been positive. Although the productivity within industries in Beijing is improving overall, the productivity of some high-productivity industries has declined. Meanwhile, the labor share of some high-productivity industries has fallen. As a result, the value of "cross" has been negative, which reduces the productivity growth driven by productivity growth within industries.

4.2 Influence of TFP, capital, and labor on regional productivity

According to Eq. (5), the productivity growth of the WSE over the last decade has been primarily driven by improving TFP, with labor and capital investment playing a smaller role. However, from 2008 to 2018, the growth of productivity in Beijing largely depended on capital input and labor input, while the role of TFP has only contributed one-third of the total growth.

As shown in Figs. 9–11, comparing the trends of TFP, capital, and labor in the two study regions from 1998 to 2018, it is found that the capital investment in Beijing has shown an upward trend from 2008 to 2018. By 2018, the value is much greater than that in the WSE. Since around 2005, TFP has shown an upward trend in the WSE. Although TFP has also been increasing in Beijing over the same period, there is still a gap compared with the WSE. In addition, the size of the labor force in Beijing is close to that in the WSE. However, the main difference is the labor quality, in other words, the education attainment level of the labor force. Note, however, that the average number of years of education of the labor force in Beijing has greatly improved since 2010 and is very close to that in the WSE in 2018.

The differences among the studied regions within the WSE have been studied in detail. In general, the east, London, and the south east exhibit similar long-term trends in the influences of TFP, capital, and labor on productivity. However, there is still a difference in terms of changes among the regions. London has had the highest TPF among the study regions since early 1998, whereas the TFP of the east has been the lowest. However, the differences in TFP between London and other regions have been increasing since around 2005. These large differences in productivity between London and other regions are consistent with the recent study by Harris and Moffat.[11]

An apparent upward trend of TFP can be seen in London, whereas, apart from the noticeable improvement in TFP, there has been no significant increase in the capital per labor in the studied

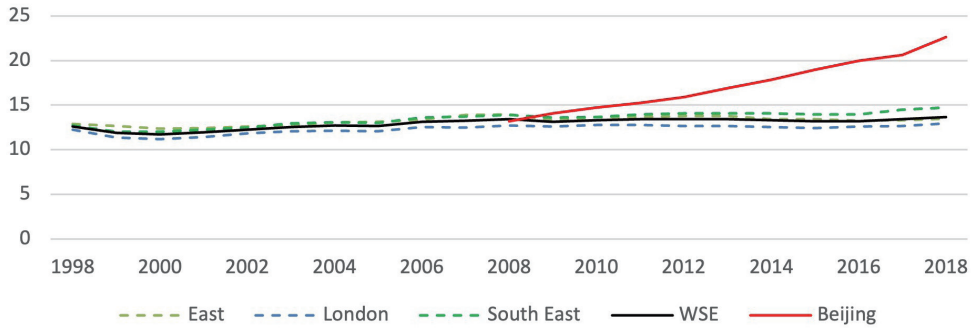


Fig. 9. (Color online) Capital input (K/L) of Beijing from 2008 to 2018 and the WSE from 1998 to 2018.

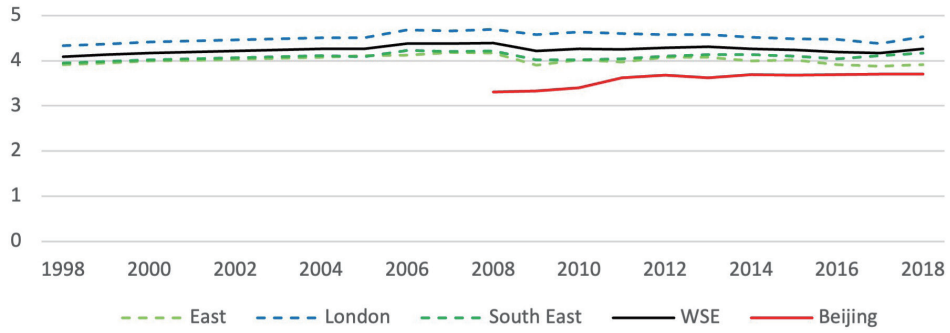


Fig. 10. (Color online) Education index of Beijing from 2008 to 2018 and the WSE from 1998 to 2018.

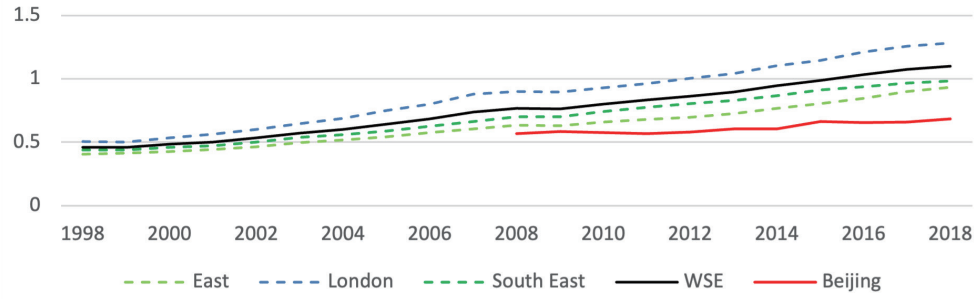


Fig. 11. (Color online) TFP of Beijing from 2008 to 2018 and the WSE from 1998 to 2018.

regions within the WSE. Regarding the educational attainment of the labor force, the labor force unsurprisingly had the longest education on average during the study period.

From the perspective of industry sectors, as shown in Fig. 12, for Beijing, the secondary industry has the fastest growth rate over the given period, and the rapid growth of capital investment has played a significant and decisive role. The productivity growth of the tertiary industry has been lower than that of the secondary industry. The primary factor driving its growth has been the increase in TFP, followed by capital investment and labor input.

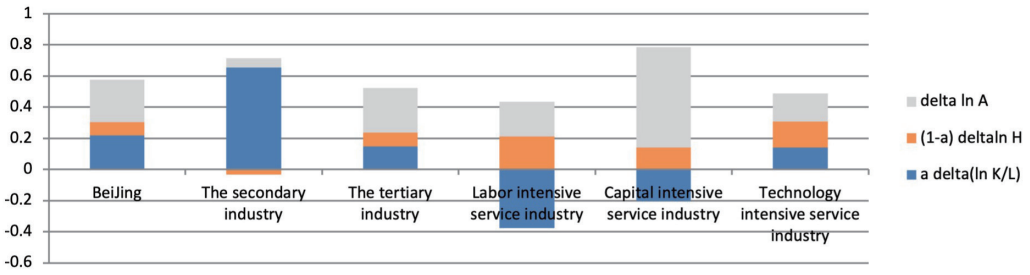


Fig. 12. (Color online) Factors driving productivity growth by industry in Beijing from 2008 to 2018.

Furthermore, the tertiary industry is subdivided into the labor-intensive industry, the capital-intensive industry, and the knowledge-intensive industry. The impetus of capital input is the least in the labor-intensive industry. Moreover, there have been few overall changes in the past decade. The educational attainment of the labor-intensive industry has been lower than that of other tertiary industries and has had a negative impact on productivity. Nevertheless, the TFP and capital input of the labor-intensive industry have increased the productivity. As a result, the general increase in productivity of the labor-intensive industry has been relatively small over the period.

It is unsurprising that the capital-intensive industry has the highest capital investment among all subgroups of the tertiary industry, despite no apparent growth over the past decade. Furthermore, the development of TFP is the primary driver of the overall productivity growth of the capital-intensive industry, and the driving efficiency of the quality of labor is negative.

Although the capital investment of the knowledge-intensive industry is lower than that of the capital-intensive industry, it has experienced rapid growth since 2013. As expected, the education level of labor in the knowledge-intensive industry is the highest among the tertiary industry groups. In general, the three aspects of the driving forces work together with almost the same amount of positive contribution to improving productivity over the given period.

Focusing on the changes in productivity and its driving factors in the WSE, as shown in Fig. 13, we can see that the productivity of all industries has maintained a similar growth rate. The productivity of the secondary industry and the tertiary industry has slightly decreased in the last decade compared with the previous decade. Similarly, in Beijing, capital is the leading factor of productivity growth in the secondary industry, and capital per labor has increased in the past two decades. However, the driving factors of productivity in the tertiary industry have changed dramatically in the past two decades. Labor has played a minor role, changing from the main driving factor to the secondary driving factor, and TFP has become the main driving factor. At the same time, the role of capital has become increasingly important. The tertiary industry is subdivided further. The improved TFP mainly drives the improved productivity of the labor-intensive industry, and the other two factors have little effect. The factor driving the productivity growth of the capital-intensive industry has been capital investment, and its role has become more critical in the past decade. Similarly to in the labor-intensive industry, the increase in productivity in the knowledge-intensive industry has mainly been driven by the increase in TFP.

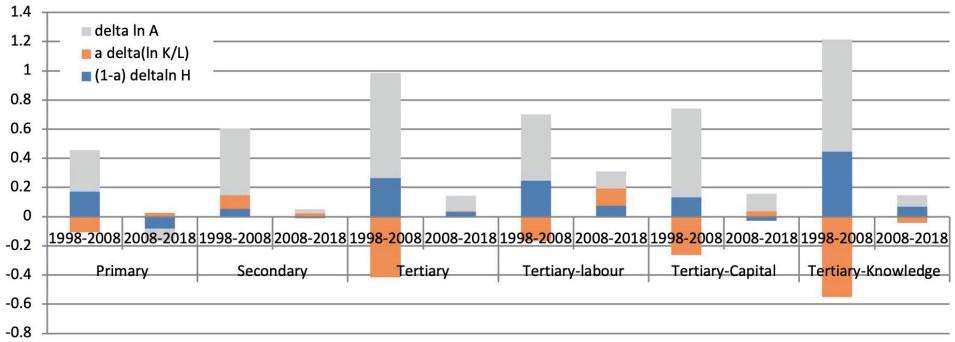


Fig. 13. (Color online) Factors driving productivity growth by industry in the WSE from 2008 to 2018.

5. Proposals to Improve Productivity of Beijing

5.1 Labor reallocation among industries

As shown in Fig. 14, the negative impact on labor productivity growth in Beijing mainly originates from the manufacturing industry and the wholesale and retail industry. Since the non-core functions of capital have been relieved, the labor share of the manufacturing industry and the wholesale and retail industry has decreased in recent years, and the labor may have flowed to other industries. Nonetheless, the productivity of the manufacturing industry is high and it has maintained rapid growth in recent years. In addition, the labor flowing out of the manufacturing industry and the wholesale and retail industry has not entered the industries with high labor productivity. To counteract the adverse effects of this process, we should improve the level of digitalization and automation in other industries so that the labor can enter the industries with higher labor productivity through short-term training. Moreover, we should cultivate and encourage more highly skilled professionals to enter high-productivity industries, such as finance and scientific research, thereby increasing productivity through labor reallocation.

5.2 Improvement of the main factors affecting productivity

Firstly, in the past decade, capital has played a significant role in improving Beijing's productivity. The level of capital investment in Beijing exceeds that of the WSEs. To further improve productivity, we can learn from the British experience and increase capital investment in information technology, such as software and hardware, and improve enterprise digitization and automation. The studies by Inklaar *et al.*[12] and Derbyshire *et al.*[13] show that high-income countries tend to invest more in short-term assets, such as computers and software, and less in long-term assets, such as office buildings and roads. The studies also show that short-term assets play a more significant role in increasing output and productivity. Therefore, in addition to increasing capital investment in infrastructure such as housing, Beijing should increase short-term asset investments such as in communication and automation software.

Secondly, the education level of labor in Beijing is very close to that of the UK in 2018, and it is not easy to improve it further in the short term. Therefore, we should place greater emphasis

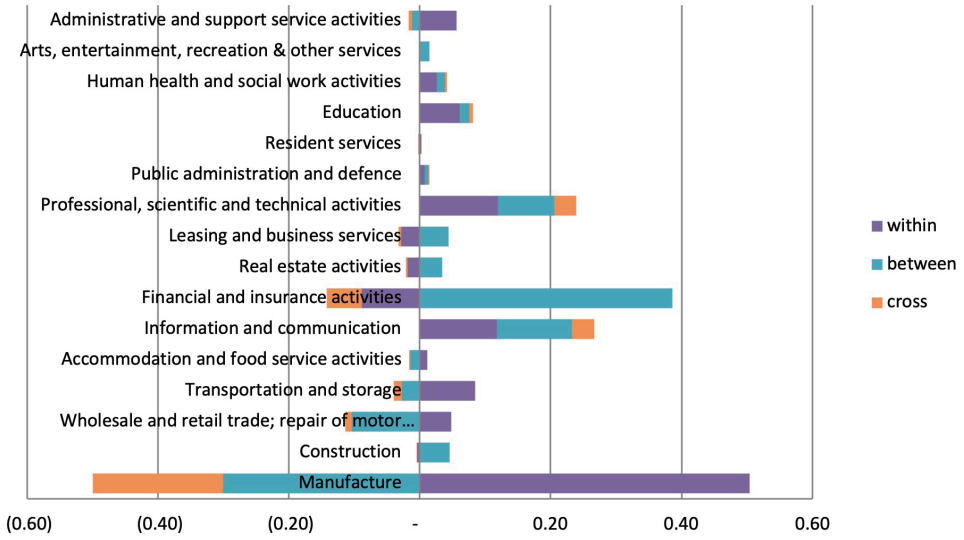


Fig. 14. (Color online) Factors driving productivity growth by industry in Beijing from 2008 to 2018.

on aligning the talent structure with the upgraded industrial structure. In the future, we should cultivate and introduce more talented labor for high-end manufacturing, finance, information technology, and other industries with high productivity to meet the needs of the upgraded industrial structure.

Finally, the improvement of TFP is a critical factor for Beijing to continue improving productivity. At present, the TFP of Beijing is only half of that of the WSE, and its growth rate is also lower than that of the WSE. According to research,[14–16] TFP not only reflects the level of science and technology but also has a significant correlation with the comprehensive quality of the public infrastructure, enterprise management efficiency, and policy mechanisms. Therefore, we can improve TFP by increasing the regional transportation infrastructure and road density and improving the enterprise management system.

5.3 Reduction of regional productivity gap

From the analysis in Sect. 3.2, we can see that Beijing's regional productivity gap cannot be disregarded. Moreover, the gap between the ecological conservation area and other areas has continued to widen over time. However, the gap between the plain area and the central area has been narrowing. The main reason for this is that the plain area, including Shunyi District, Daxing District, Yizhuang District, Changping District, and Fangshan District, is responsible for undertaking the central city's corresponding functions and serving the capital. These areas have experienced intensive and efficient development in recent years and are constantly promoting high-tech and emerging industry clusters. It is expected that industrial agglomeration will dramatically improve the productivity of industries, scientific research, and technical services.

In contrast, there is no apparent leading industry in the ecological conservation area, and its productivity is low compared with all industries. Moreover, its remote location makes it difficult

to attract emerging industries and talent. The 2035 zoning plan specifies the industrial positioning of the ecological conservation area. Therefore, without interfering with the ecological conservation function, the ecological conservation area should encourage distinctive industries and the formation of complete industrial chains. In addition, improving the quality of urban infrastructure and public service facilities can also help facilitate the employment of highly skilled labor in the leading industries.

Regarding conversation areas, the UK has also been facing the challenge of prioritizing natural beauty and rural heritage while pursuing socio-economic development and residents' well-being. In that case, it is important to adopt planning strategies that ensure conservation and promote local production and income.[17] One category of the designated protected landscape is Area of Outstanding Natural Beauty (AONB), which is considered comparable with the ecological conservation districts in Beijing in terms of its priority of conservation. At the same time, the British government attaches great importance to the green belt. The fundamental purpose of the green belt policy is to prevent urban sprawl and improve urban quality,[18] although it is predicted that the enforcement of a green belt in Beijing would have negative impacts on economic wellbeing.[19] As shown in Fig. 15, there are 46 AONBs in the UK, 12 of which are within the boundary of the WSE. Simultaneously, there are 14 areas of green belt in England. Among them, the green belt around London has the largest area of about 5160 km^2.[20]

The counties of Berkshire, Buckinghamshire, Oxfordshire, Sussex, Surrey, and Kent in the WSE are comparable to Mentougou District, Huairou District, and Pinggu District in Beijing in that they contain extensive AONBs and green belt. However, in these counties, the productivity is close to that of the WSE, and in some counties, it exceeds the average productivity of the

Fig. 15. (Color online) Distribution of AONBs and green belt in the WSE.

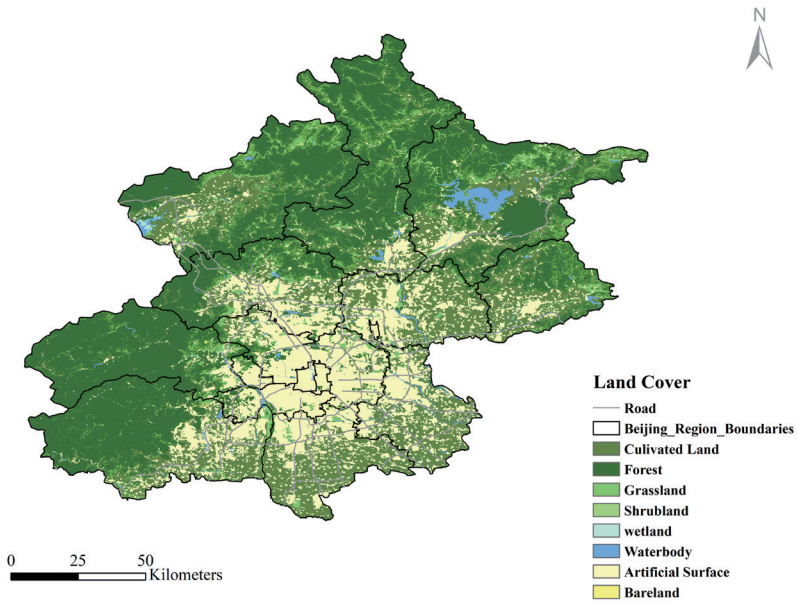


Fig. 16. (Color online) Land cover of Beijing.

WSE. Except for East Sussex and East Kent, the productivity of the tertiary industry is close to the average productivity of the study area. In some counties, the efficiency of specific industries is even slightly above the regional average.

As shown in Figs. 15 and 16, by mapping and comparing the urban boundary, land use structure, and traffic structure data derived from remote sensing data in Beijing and the WSE, it is possible to conclude two reasons for the small gap in productivity between the protected areas and other areas in the WSE. The first reason is that the WSE has a radial traffic network centered on London, which significantly improves London's accessibility to the surrounding areas and reduces the travel time. Furthermore, this transportation system enhances the accessibility of the areas surrounding London and London's industrial clusters, thus promoting the industrial development of London's surrounding areas. Simultaneously, in the areas covered by AONBs and green belts, such as East Sussex, West Surrey, and East Kent, industrial land is fragmented and scattered. However, due to the low transportation cost, it is easier to select industrial sites that allow the environment to be protected and industry to be developed at the same time. The second reason is that in each AONB, there is a planning strategy to promote its distinctive industries. The ecological conservation area in Beijing can learn from how the AONBs in the WSE are managed, especially in terms of local industries such as entertainment, tourism, and green agriculture.

6. Conclusion

Beijing is in the transformation stage of its industrial upgrade, and the government has implemented controls on the population and construction scale. Therefore, it is unsustainable to continue to rely on high-intensity labor input and large-scale investment expansion to promote

economic growth. However, it is possible for economic growth to continue in the context of reduced development simply by improving productivity. We, therefore, analyzed the differences in economic productivity between the WSE in the UK and Beijing from three dimensions of space, time, and industry, as well as the factors that drive productivity growth. Finally, we were able to identify the shortcomings of regional development and provide some policy recommendations for the future development of Beijing.

Through the study, we found that there is not only a gap in productivity between Beijing and the WSE, but also a larger regional gap in productivity among Beijing's districts. From the perspective of driving factors, the productivity growth in Beijing depends on improving labor productivity within the industry. However, the role of labor reallocation among industries is relatively weak. Therefore, by 2018, the adjustment of the industrial structure has not substantially increased productivity. From the perspective of the role of production factors, Beijing's improved productivity in the last ten years has mainly depended on TFP and capital input. However, there is still a large gap between Beijing and the WSE in these two aspects.

In conclusion, to ensure the sustained growth of productivity, we should pay attention to labor reallocation in the process of industrial upgrading and transformation so that labor can enter industries with high productivity through short-term training. In addition, we should focus on production factors that can accelerate the growth of productivity. First, we suggest increasing capital investment related to information technology. Secondly, it is also necessary to improve TFP by increasing the regional transportation infrastructure and road density and improving the enterprise management system. Thirdly, we can train and introduce talented labor in industries such as high-end manufacturing, finance, and information technology to satisfy the requirements of industrial upgrading in Beijing.

In further work, more remote sensing data related to economic and urban growth based on the theoretical model in this paper should be collected to monitor the expansion of the city regions, especially to measure the rates of industry growth through the intensity of land use and the flow of population, goods, and vehicles. The detection of changes will then provide an opportunity to model and predict the changes in regional labor productivity.

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