Agglomeration and balance: the evolution patterns for regional economic divergence in the pearl river delta area

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Abstract. This study analysed the differences in the process of regional economic development and revealed the dynamic imbalance mechanism of regional economic development in Pearl River Delta (PRD). Based on the statistical yearbook of PRD 1978-2018 GDP and per capita disposable income (PCDI) data, using standard deviation, Gini index, range rate and clustering analysis methods, we analysed regional inequalities to the evolution dating back to nearly 40 years in the PRD. The cross-sectional data showed that the relative difference is stable and the absolute has always been rising in the evolution of the difference in GDP of PRD. However, in terms of PCDI, the relative difference shows a shrinking trend on the whole. Furthermore, the cluster analysis indicated that with the construction of the PRD Metropolitan Areas, the economic development is concentrated in the core cities. However, the PCDI between regions is converge. We suggested that the three major metropolitan areas should further expand and radiate outward to achieve the overall coordinated development of PRD. At the same time, less developed regions should not be afraid of the concentration of production factors in core cities. With the free flow of production factors, the gap between regions has actually narrowed.

1. Introduction

With the rapid development of urbanization and economic globalization, population and industries will become concentrated in some specific areas [1]. City-agglomeration areas have become the main units to participate in global competition [2]. PRD is one of rather mature metropolitan economic regions in China [3]. However, uneven regional economic development has always been an important feature of the PRD economy for a long time, which has seriously affected the health and sustainable development of the economy [4]. Since the 21st century, this severe imbalance has not been fundamentally changed and has a tendency to continue to intensify. The Third Plenary Session of the 16th Central Committee of the Party proposed to narrow the regional gap and coordinate regional development. Therefore, The PRD must seize the current favorable conditions, making full use of its own advantages, and get out of the predicament of serious imbalance in regional economic development.

In recent years, some scholars have done some useful research on the issue of regional economic differences in the PRD [5-6]. However, few studies have explored it from a spatial scale. In terms of time series, the selection period is generally short, regional economic differences are sensitive to time, and their dynamic changes are the result of long-term use of various factors. The economic development cycle and cyclic cumulative effects will have an impact on the regional development.
trajectory. Therefore, researches based on a short period of time often cannot truly reflect the evolution trend of regional economic differences.

2. Research on regional economic differences in the PRD

2.1. A situational analysis of GDP in the PRD

From the time-series data standpoint, the GDP of each city has risen sharply from 1978 to 2018. From the perspective of cross-section data, the evolution trend of GDP in the PRD can be analysed. In this study, we used indicators such as standard deviation, Gini index, and range rate to study the relative and absolute differences of GDP in the PRD [7]. As shown in Figure 1 and 2, we can draw the following conclusions.

The relative difference is relatively stable. The absolute value of the difference between the lowest and highest GDP cities is increasing year by year, but one of the relative differences between the two, range rate, has the characteristic of shrinking. Although there is a certain degree of volatility, it has started to show a stable trend since 1990. Using Gini coefficient to analyze the GDP of the PRD, the 40 years from 1978 to 2018 can be roughly divided into three different stages. In the first stage (1978-1991), the relative difference gradually narrowed, and the Gini coefficient decreased from 0.49 in 1978 to 0.36 in 1991. This result shows that during the 14-year period from the beginning of reform and opening up, the relatively backward cities in the nine PRD cities developed rapidly, and the GDP differences in the region gradually decreased. In the second stage (1992-2005), the relative difference gradually expanded, and the Gini coefficient expanded from 0.36 in 1992 to 0.44 in 2005. It is possible that the development of the Internet and the introduction of foreign capital have accelerated the development of some cities, and the relative difference in the overall trend has increased. In the third stage (2005-2018), the relative difference has gradually stabilized, and the Gini coefficient has been hovering around 0.45. This may be closely related to the construction of the PRD Metropolitan Area. The concentrated economic development has made the core cities such as Shenzhen and Guangzhou continue to increase their GDP share, but the relative difference has gradually stabilized.

The absolute difference is increasing year by year. It can be seen from the figure that from 1978 to 2018, the GDP of the PRD showed a trend of expansion year by year. The standard deviation rose from 1.275 billion yuan in 1978 to 864.88 billion yuan in 2018 which has been increased by 678 times.

Figure 1. The GDP range rate and Gini coefficient variation trend to the PRD during 1978-2018.

Figure 2. The GDP standard deviation trend to the PRD during 1978-2018.
2.2. The spatial evolution of GDP in the PRD

In this study, 150%, 125%, 100%, 75%, and 50% of the average of GDP as the benchmark, the PRD is divided into high-GDP, medium high-GDP, medium-GDP, medium low-GDP, low-GDP areas [7]. We analysed the evolution of spatial patterns of GDP in the PRD by observing the position changes on three time-cross sections, 1980, 2000 and 2018. As shown in table 1-3, since 2000, Shenzhen has emerged as a core city alongside Guangzhou and the PRD has become a dual-core urban structure. Production factors has concentrated in core cities, which makes the GDP share of Guangzhou and Shenzhen in the PRD continue to increase. Although the economic strength of other cities is also increasing, they are increasing difference from dual core cities.

### Table 1. The spatial distribution of GDP in the PRD in 1980.

| Group          | City                        |
|----------------|-----------------------------|
| high-GDP       | Guangzhou                   |
| medium high-GDP| Jiangmen                    |
| medium-GDP     | Foshan                      |
| medium low-GDP | Huizhou, Zhaoqing           |
| low-GDP        | Shenzhen, Zhuhai, Dongguan, Zhongshan |

### Table 2. The spatial distribution of GDP in the PRD in 2000.

| Group          | City                        |
|----------------|-----------------------------|
| high-GDP       | Guangzhou, Shenzhen         |
| medium high-GDP| Foshan, Dongguan            |
| medium-GDP     | Jiangmen                    |
| medium low-GDP | Huizhou, Zhaoqing           |
| low-GDP        | Shenzhen, Zhuhai, Dongguan, Zhongshan |

### Table 3. The spatial distribution of GDP in the PRD in 2018.

| Group          | City                        |
|----------------|-----------------------------|
| high-GDP       | Guangzhou, Shenzhen         |
| medium high-GDP| Foshan                      |
| medium-GDP     | Dongguan                    |
| medium low-GDP | Jiangmen, Huizhou, Zhaoqing, Zhuhai, Zhongshan |
| low-GDP        | Shenzhen, Zhuhai, Dongguan, Zhongshan |

2.3. A situational analysis of PCDI in the PRD

From the time-series data point of view, the PCDI of each city has increased significantly from 1978 to 2018. From the cross-section data perspective, the evolution trend of PCDI in the PRD can be analysed. In this research, we used indicators such as standard deviation, Gini index, and coefficient of
variation to study the relative and absolute differences of PCDI in the PRD [7]. As shown in Figure 3 and 4, we can reach the following conclusions.

The relative difference has a tendency to shrink. The Gini coefficient dropped from 0.29 to 0.11 during the 40 years from 1978 to 2018. However, in different periods, the trend of its change is also different, which can be roughly divided into four stages. In the first stage (1978-1985), the relative difference increased, and the Gini coefficient rose from 0.29 in 1978 to 0.33 in 1985. In the second stage (1985-1994), the relative difference decreased sharply, and the Gini coefficient decreased from 0.33 in 1985 to 0.11 in 1994. In the second stage (1985-1994), the relative difference decreased sharply, and the Gini coefficient decreased from 0.33 in 1985 to 0.11 in 1994. In the third stage (1985-1994), the relative difference began to expand, and the Gini coefficient increased with wavy. During this period, the Gini coefficient increased from 0.11 in 1994 to 0.16 in 2004. In the fourth stage (2005-2018), the relative difference decreased sharply, and the Gini coefficient decreased from 0.33 in 1985 to 0.11 in 1994. The relative difference has gradually decreased and stabilized. The Gini coefficient dropped from 0.16 in 2004 to around 0.11. Similarly, another indicator of relative difference, range rate, dropped from 7.09 in 1978 to 1.95 in 2018.

Figure 3. The PCDI range rate and Gini coefficient variation trend to the PRD during 1978-2018.

Figure 4. The PCDI standard deviation trend to the PRD during 1978-2018.

2.4. The spatial evolution of PCDI in the PRD
In the present study, 150%, 125%, 100%, 75%, and 50% of the average of PCDI as the baseline, the PRD is divided into high-income, medium high-income, medium-income, medium low-income, low-income areas [7]. We analysed the evolution of spatial patterns of PCDI in the PRD by observing the position changes on three time-cross sections, 1980, 2000 and 2018. As shown in Table 4-6, with the emergence of cities such as Foshan and Dongguan, the PCDI gap in the entire region is gradually narrowing, and the momentum of integration is strong after the 2000s. In the process of concentrated economic development and the construction of metropolitan areas, the PCDI of the PRD is converging.
Table 4. The spatial distribution of PCDI in the PRD in 1980.

| Group          | City                  |
|----------------|-----------------------|
| high-income    | Shenzhen, Guangzhou   |
| medium high-income | Zhuhai             |
| medium-income  | Jiangmen, Foshan      |
| medium low-income | Dongguan, Zhaoqing |
| low-income     | Huizhou, Zhongshan    |

Table 5. The spatial distribution of PCDI in the PRD in 2000.

| Group          | City                                    |
|----------------|-----------------------------------------|
| high-income    | Shenzhen, Guangzhou                     |
| medium high-income | Foshan, Zhongshan, Dongguan, Zhuhai |
| medium-income  | Foshan, Zhongshan, Dongguan, Zhuhai     |
| medium low-income | Huizhou, Zhaoqing, Jiangmen          |
| low-income     |                                        |

Table 6. The spatial distribution of PCDI in the PRD in 2018.

| Group          | City                                    |
|----------------|-----------------------------------------|
| high-income    | Shenzhen, Guangzhou                     |
| medium high-income | Foshan, Zhongshan, Dongguan, Zhuhai |
| medium-income  | Foshan, Zhongshan, Dongguan, Zhuhai     |
| medium low-income | Huizhou, Zhaoqing, Jiangmen          |
| low-income     |                                        |

3. Conclusions and recommendations
In this research, through our analysis and study on the evolution trend of GDP and PCDI gap in the PRD, we come to conclusions as follows:

In the evolution of the difference in GDP, the relative difference is relatively stable, while the absolute difference has a tendency to expand year by year. In addition, through cluster analysis, it is found that as production factors are concentrated in the core cities of Guangzhou and Shenzhen, the gap between other cities and the "dual core" is getting bigger and bigger. Therefore, the overall GDP development in the PRD is divergent. In the evolution of the difference in PCDI, the relative difference generally shows a shrinking trend, while the absolute difference has a tendency to expand year by year. Furthermore, it is found that the PCDI in the PRD is converging by cluster analysis. In the process of exerting agglomerative economies effect, Guangzhou and Shenzhen actually played a huge role in driving the surrounding underdeveloped small cities. At the same time, it will generate a large amount of demand for low-skilled workforce, and then attract the influx of low-skilled workforce to supplement its workforce, including the supply of workforce in the production and life service industries. This is also an important reason for the convergence of per capita disposable income between regions.
Based on the above research findings, in order to further narrow the PCDI gap between regions and further realize the balanced development in the PRD, we make the following recommendations:

1) The trend of economic concentration to high GDP regions is widespread. Low-GDP areas don’t be afraid of the concentration of production factors in core cities. With the free flow of production factors, the gap in regional PCDI has actually narrowed, which makes the regional development move towards balance. It also can help metropolitan areas to expand into low GDP areas and improve the economic strength of low GDP areas.

2) With the gradual improvement of the infrastructure in the PRD, the three major metropolitan areas must further expand and radiate outward and improve the uneven development of urban. These will help ultimately realize the overall coordinated and integrated development and urban agglomeration of the Pearl River Delta.

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