The Assessment on Industrial Synergistic Effect in Pearl River Delta Metropolitan Area: A Comparative Perspective

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Abstract. Metropolitan area has already become a new economic growth poles. As one of the earliest metropolitan area in China, Pearl River Delta metropolitan area acts as one of the largest producer and export base of electronic and consumer goods in the world on one hand. On the other hand, decelerated growth in this area also indicates that the development of Pearl River Delta metropolitan area is currently stuck in bottleneck. Based on this, the article measures economy and industry associations inner this group, evaluate the overall effect of specialization and diversity in order to give theoretical reference for future strategy formulation which optimize industrial division and harmonious development.

Introduction

With the releasing of middle reaches of mid-Yangtze River Urban Agglomerations plan in 2015, china have officially formed five metropolitan area at national level, which makes cities get to further integrate based on network infrastructure, and contribute to be the new economic growth pole. As one of the earliest metropolitan area in China, Pearl River delta metropolitan area (PRD for short in later part) has high density harbor, long coastline, low population density, facilitate road network, as well as human capital and good ecotype, and already becomes an ideal place for developed country transferring their capital and technology intensive industry.

However, cities in PRD perform respectively in their own way without advantage complemented for long time. Beneficial industrial structure is hard to form on agglomeration and scale advantage. Moreover, the traditional developmental difference and spatial distance between coastal areas of Pearl River Estuary made synergistic effect between them impossible, and ultimately impeded the economic development. In the meantime, Yangtze River Delta metropolitan area (YRD for short in later part) has becomes the strongest and highest marketization degree economy relying on the opportunity of Pudong Development since nineteen nineties. With one-hour economic circle formed, the effect of linkage development in the whole region is gradually stronger, and population float more frequently. Based on this, the paper aims to measure economy and industry associations inner PRD, choose YRD as the reference to evaluate the overall effect of specialization and diversity from 2005-2015 in order to give theoretical reference for future strategy formulation which optimize industrial division and harmonious development.

According to the “Pearl River Delta Reform and Development Plan 2008-2020” issued by the State Council, the PRD mainly includes nine cities in GuangDong Province, Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou and Zhaoqing. Meantime, Hongkong and Macau always keep frequent interaction with neighboring province. Therefore, in this study, Hongkong and Macau included 11 cities will be defined as the PRD.

Research Methods, Selection of Indicators, Data Source

Measurement of Inner Economic Relation Intensity

Economic links between cities depends on population, economies scale and actual distance, also largely influenced by difference in industrial composition. Based on Newtonian gravity model, the author introduces Krugman index (K) which reflects the composition difference between cities.
Since big gap exists in economic development levels inner PRD, so here’s positive correlation between the economic link and Krugman, Model built as follows:

\[ p_{ij} = \frac{k_{ij}^{G}G_{i}^{P}P_{j}^{G}}{F_{ij}} \quad (k = \sum_{k=1}^{n}|S_{jk} - S_{ik}|) \]  

Wherein, Rij behalf of Economic Relation Intensity between cities, P represents population size, G on behalf of urban economy scale, Dij represents distance between cities, Sjk represents economic share of k industry in city j, n is the number of cities in all industrial sectors.

Use experience of LiXuexin (2014) for reference, the paper set non-agricultural population to reflect population size, GDP to reflect economy scale, the shortest inter-city highway mileage to reflect distance between cities.

**Measurement of Industrial Isomorphism Level**

Industrial isomorphism reflects structural similarity between cities, and it used to be represented by industrial structure similarity coefficient.

\[ S_{ij} = \frac{\sum_{i}x_{ijn}}{\sqrt{\sum_{i}x_{ijn}^{2}\sum_{j}x_{ijn}^{2}}} \]  

Wherein, Xn denotes percentage of GDP of N departments in each city, Sij is regional industrial structure similarity coefficient, 0 ≤ Sij ≤ 1, the higher regional industry isomorphic level, the weaker regional complementarities exist.

**Measurement of Overall Effect in Specialization and Diversity**

First, do logarithm transformation on Cobb-Douglas production function, get:

\[ \ln Y = \ln A + \alpha \ln K + \beta \ln L \]  

(3)

\[ \beta = 1 - \alpha \]  

(4)

Wherein, Y represents output, K is capital, L is labor, estimated by least square method can work α, β out, and technological progress increase rate (GI) and contribution rate of economic growth by technological progress(CI) of PRD.

\[ GI = \frac{\Delta Y}{\bar{Y}} - (\frac{\alpha }{\bar{K}} \frac{\Delta K}{\bar{K}} + \frac{\beta }{\bar{L}} \frac{\Delta L}{\bar{L}}) \]  

(5)

\[ CI = \frac{\frac{\Delta Y}{\bar{Y}} - (\alpha \frac{\Delta K}{\bar{K}} + \beta \frac{\Delta L}{\bar{L}})}{\frac{\Delta Y}{\bar{Y}}} \times 100\% \]  

(6)

Wherein, industrial output value reflects total output, fixed assets original value and current assets annual average balance of total capital investment reflects capital input, number of workers is used to reflect situation of labor input.

The data involved in this study mainly comes from the annual statistic yearbook of country, province and city from 2005 to 2015.

**Calculation Results and Analysis**

**Economic Relation Intensity**

To facilitate comparison, we respectively calculated several year relation intensity inner PRD (11 cities) and YRD (25 cities), in addition, we also measure the relative data inner Guangdong
Province (table 1), found that:

The value of YRD is obviously higher than value of PRD, It might due to the former having setting up international economical center, financial center, trade center and shipping center under the transnational capital leading. YRD has quite strong momentum of growth, and the development of high and new technology is in the lead. The value of PRD is higher than the value of Guangdong Province, but lower than YRD, it attributes to similar structure inner PRD which still focused on labor-intensive industrial, has higher industry structure similarity. Moreover, the immature transportation network also places constraints the shift for inner economic integration.

From time series, relation intensity inner PRD shows a gradually increasing trend, and increasing velocity is faster than the YRD in large extent to regional integration strategy and progressive elaboration of transportation network. The complementary relation on industry development among cities are dramatically enhanced especially following the issue of “Pearl River Delta Reform and Development Plan 2008-2020”.

Economic ties with Hongkong and Macau are strengthened. For special model of economic development in Hongkong and Macau, they have less relation intensity with the rest cities of PRD in primary and secondary industry, and closer relationship in tertiary industry. Meanwhile, since the special historic and cultural factor exist among Hongkong, Macau and Guangdong Province, the rule of “distant decay” seems doesn’t work.

Table 1. Relation intensity scale.

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relation intensity scale in PRD</td>
<td>3312.8</td>
<td>3672.1</td>
<td>3719.6</td>
</tr>
<tr>
<td>Relation intensity scale in YRD</td>
<td>10329.4</td>
<td>10892.3</td>
<td>12275.6</td>
</tr>
<tr>
<td>Relation intensity scale in Guangdong</td>
<td>2679.4</td>
<td>2979.6</td>
<td>3219.6</td>
</tr>
</tbody>
</table>


Industrial Isomorphism Level among Cities

According to the three industrial classification criteria, respectively calculates the structure similarity coefficient in secondary and tertiary industry. Found that:

Shanghai act as the center of YRD and several sub centers work simultaneously which have different develop emphasis, the value of structure similarity coefficient in YRD mainly distribute over 0.63–0.82, whereas the value of PRD is little higher than that in YRD, value of Guangzhou, Shenzhen with other cities are almost the same with value in YRD, whereas the coefficient among Pearl River West cities all exceed 0.8, especially the value between Zuhai and Jiangmen reaches 0.98, While the growth Hongkong and Macau have high proportion in tertiary industry, they have lower coefficient with other cities.

By industrial sectors similarity, well known for its largest base of comprehensive industries, YRD performed diversity in industry with orderly integral layout, the rapidly develop in the new-concept manufacturing industry also make the industrial isomorphism level maintained on 0.58–0.74, however it gradually goes up based on time limit, that might because all the cities pursue the high capacity manufacturing industry to their leading industry, such as electronic information industry, petrochemical industry, pharmaceutical industry, and so on. So the construction of industry gradually become converging. Meanwhile, for the rootedness of traditional processing trade, PRD also have problem of industry assimilation, the value of industrial isomorphism level reaches to 0.69–0.87. For instance, the value between Zuhai and Jiangmen reaches 0.7908, since they all treat manufacture of communication and electrical machinery as the two pillar industries which maintain high proportion in whole industry, led to terribly overlap industry construction and fierce competition.

On the service industry structural side, the coefficient in YRD is low, mainly because of the higher proportion of tertiary industry, the manufacturing renaissance obviously also lead to the diversification of service industry development. Among this process, Shanghai primarily focus on
developing knowledge-intensive and prominent-characteristic modern service industry, while 
Suzhou paying their attention to the producer services, so these two cities have relatively lower 
coefficient with other cities. The service industry in PRD mainly focus on producer services and 
consumer services, except Hongkong, Macau, Guangzhou and Shenzhen, all other cities have 
relatively higher coefficient in service structure.

Thus, industrial isomorphic degree is high, while correlation is low, that will directly affects 
regional industrial structure adjustment and optimization, and constraints the improvement of 
regional comprehensive competitiveness.

**Group Effect in Specialization and Diversity**

Obtained by the least squares method to estimate the specialization of industrial upgrading and 
technological progress of model is:

$$\ln z = 0.795 + 0.66 \ln z$$

(7)

In the formula, correlation coefficient between variables R = 0.636, showing high positive 
correlation, with confidence level of 90%, capital elasticity coefficient (α) and labor flexibility 
coefficient (β) valued as follows (Table 2):

<table>
<thead>
<tr>
<th>Overall industry</th>
<th>Enterprise unit number</th>
<th>R</th>
<th>α</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialized</td>
<td>28491</td>
<td>0.604</td>
<td>0.580</td>
<td>0.432</td>
</tr>
<tr>
<td>Unspecialized</td>
<td>16986</td>
<td>0.493</td>
<td>0.517</td>
<td>0.498</td>
</tr>
</tbody>
</table>


According to the estimation results elasticity coefficient, get corresponding result as average 
growth rate of technological progress, capital growth, labor growth, technological progress 
contribution rate (as Table 3), shows that:

<table>
<thead>
<tr>
<th>Item</th>
<th>region</th>
<th>year</th>
<th>O</th>
<th>C</th>
<th>L</th>
<th>T</th>
<th>C'</th>
<th>L'</th>
<th>T'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialized</td>
<td>PRD</td>
<td>2005-2015</td>
<td>18.6</td>
<td>18.4</td>
<td>5.3</td>
<td>6</td>
<td>54.9</td>
<td>12.7</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>42.1</td>
<td>43.7</td>
<td>8.8</td>
<td>13.9</td>
<td>57.6</td>
<td>9.3</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YRD</td>
<td>2005-2015</td>
<td>15.2</td>
<td>10.6</td>
<td>9.7</td>
<td>4.8</td>
<td>51.4</td>
<td>16.7</td>
<td>31.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>33.7</td>
<td>20.6</td>
<td>18.6</td>
<td>13.6</td>
<td>45.1</td>
<td>14.5</td>
<td>40.5</td>
</tr>
<tr>
<td>Unspecialized</td>
<td>PRD</td>
<td>2005-2015</td>
<td>23.6</td>
<td>22.1</td>
<td>5.2</td>
<td>7.3</td>
<td>61.7</td>
<td>7.5</td>
<td>30.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>49.4</td>
<td>42.8</td>
<td>8.6</td>
<td>18.3</td>
<td>57.1</td>
<td>5.9</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>YRD</td>
<td>2005-2015</td>
<td>16.3</td>
<td>11.1</td>
<td>10.4</td>
<td>5.4</td>
<td>40.6</td>
<td>21.7</td>
<td>33.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>37.4</td>
<td>21.2</td>
<td>19.7</td>
<td>16.6</td>
<td>33.8</td>
<td>21.8</td>
<td>44.4</td>
</tr>
</tbody>
</table>

Data source: Guangdong statistical yearbook of 2005-2015

Note: O=output value growth rate, C=capital growth rate, L=labor growth rate, T=technology progress growth rate, C'=capital contribution rate, 
L'=labor contribution rate, T'=technology contribution rate;

Vertical perspective, technological progress growth rate remains in stable increase in PRD, 
specialized growth rate is greater than both overall level and non-specialized industry, same as 
technological progress contribution rate;

Lateral view, technological progress growth rate in PRD is higher than YRD, while the 
contribution rate is relatively lower than the latter, for which mostly based on comprehensive 
influence from historical basis, location and policies differences. With large scale of foreign 
investment and technology spillover effect, The PRD reaches as higher marketization as YRD; the 
gap on technological progress contribution rate in specialized industry in PRD is lightly more than 
unspecialized part. PRD only stays on medium level in industry diversity. Nevertheless, with 
deepening of specialization, group economic benefits are gradually up now.
Reginal Economic Development Proposals

As a whole, PRD has not fundamentally change the “large and complete” state, cities in this area performed respectively, the phenomena of industry structure similarity is outstanding, that isn’t conductive to form market mechanisms and resource allocation efficiency. From the perspective of the regional division, inter-regional division and cooperation based on resource endowment will be helpful for implementation of “orderly” and “efficiency”.

Form functional complementary modern metropolitan area: Now Pearl River estuary modern city circle that consist Hongkong, Macau and nine cities in Guangdong province has already formed, and need further improvement in functional substitution, Guangzhou should fully take the advantage of provincial capital, strengthen the function of higher-level element gathering, scientific and technological innovation, culture leading and comprehensive service; Shenzhen keeps focusing on building high-technology industrial base and regional financial center, information center and trade center; Zhuhai develops to be an important tourist city and pivotal ports linking with Hongkong and Macau, the rest cities become the tourism extended bead, modern industry and modern agriculture base.

Form unique structure and property industrial circle. The industry homogenization will be greatly reducing the general economic efficiency, so each city should coordinated develop chemical industry, appliance, electronic information, textile, ocean industry and modern agriculture; build supporting service set around internal industry. The opening of Hongkong-Zhuhai-Macau Bridge and Hengqin free-trade area will make for patches marketing among Hongkong, Macau and Guangdong Province, and intensify the inner economic relation.

Form modernized transportation and communication net at home and abroad. The highway density in PRD is already top of the league tables by the end of 2013, and have high density multi-airports group and multilevel port cluster, while railway network is relatively lagging behind with unbalanced development in directions especially between each bank of the Pearl River. Just because of this it is extremely urgent to strengthen regional plan and integration in transportation network. The opening of Hongkong-Zhuhai-Macau Bridge, Zhongshan-Nansha-Humen intercity railway and Shenzhen-Zhuhai intercity railway will improve present conditions and establish convenient transportation and communication facilities to form an one-hour economic circle, to promote the elements float efficiently.

It should be said that, after the first round development, Pearl River East has already faced with problem like cost increasing, land deficit, water and population constrains, unfavorable situation of foreign capital loss and slow growth are showing up. Meanwhile, radiation effect from Hongkong becomes more and more weak. At the same time, transportation improvement in Pearl River West and Development of Hengqin will provide more capital and human resource, element will highly promote the tourist industry and bring the new opportunity of industry transfer. It should be focused that, therefore, city function and industry structure will have a brand-new layout among Pearl River Delta cities in this process. Disordered competition and repeated construction that caused by administrative barriers should be avoided, or they will influence the improvement of whole regional competitiveness. Only in this way, PRD will truly grow into one of the world-class metropolitan area, and anticipate in international cooperation and competition in high level.

Reference
[4] Li Xuexin, differences comparison between Central Plains city circle and Yangtze River delta city circle, Statistics and Decision, 2013(11).
