Chapter 2
Comprehensive Analysis of Existing Data: Chengdu in the World City Network

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In the fast-growing Chinese economy, Chengdu is currently developing into an important western center, playing a very similar role to Chicago in the 1800s. Both China and the US first developed their economies in eastern, coastal regions and then expanded inland, so Chicago and Chengdu both became transport and logistics centers of western development. But Chengdu today cannot hope only to become the "Chicago of China." Chicago is only a strong regional center, from which one must go through eastern coastal cities to connect internationally. But Chengdu today exists in the context of globalization. This means that having only regional advantages is insufficient. Current urban development is economically connected through the global space. As an emerging international city, a successful regional foundation is necessary for Chengdu, but not sufficient. Thus, we use global city analysis to make an empirical analysis of Chengdu.

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2.1 Analysis of Chengdu's External Linkage Effect

Conducting a world cities analysis is aimed at outlining the extension of the network from which Chengdu businesses can benefit. This extension is expressed in two linkage effects: the network connected by infrastructure and the network connected by business. The former makes practical business connections possible. The two are both vital to the successful growth of a city's economy. In this global cities analysis, the linkage of facilities is reflected in the flow of air passengers, and business linkage originates from the office network guiding advanced business services.

2.1.1 Measuring Chengdu's Infrastructure-Linked Network

2.1.1.1 Data Source

Flight coverage and traffic is an intuitive and accurate indicator reflecting of a region's exchange with the outside world. Through a partnership with Sabre Airline Solutions, a consultancy, we gathered relevant air passenger information for 2008 for flights with Chengdu as the origin or destination. These data are the true booking information of different airlines obtained from the airport marketing information data transmission system database. The flights from this database have three advantages. First, they cover global passenger traffic (domestic and international traffic), not just international passenger traffic. Second, they include real booking information, representing real passengers that can be compared with flight schedule data. Most, it provides the departure and destination of travel, which can rule out errors caused by transfers.

2.1.1.2 Research Result 1: Analysis of Air Passenger Linkage

Table 2.1 shows the top 50 air connections with Chengdu. The top four cities are to be expected, reflecting the economic status of Mainland China in the global economy. The highest-ranking cities are almost all in China, with foreign cities appearing after the 25th spot. To understand the significance of these rankings through further analysis, we will compare Chengdu's passenger connections with Beijing, Shanghai, and Guangzhou. The basic principle of this comparison is that for Chengdu to become an emerging global city, it must be an important interior (western) center forming a whole with the three eastern centers—Beijing (northern China), Shanghai (eastern China), and Guangzhou (southern China)—to integrate with the global economy together.

Table 2.1 Top 50 passenger connections with Chengdu for 2008

Rank	Connecting city	Rank	Connecting city
1	Beijing	26	Dalian
2	Shanghai	27	Fuzhou
3	Shenzhen	28	Singapore
4	Guangzhou	29	Tokyo
5	Kunming	30	Seoul
6	Hangzhou	31	Chongqing
7	Xi'an	32	Taipei
8	Nanjing	33	Bangkok
9	Wuhan	34	Yantai
10	Urumqi	35	Osaka
11	Jinan	36	Kuala Lumpur
12	Guiyang	37	Zhuhai
13	Changsha	38	Los Angeles
14	Xiamen	39	Shantou
15	Hong Kong	40	Frankfurt
16	Tianjin	41	Amsterdam
17	Wuxi	42	Paris
18	Qingdao	43	Nagoya
19	Wenzhou	44	Chicago
20	Zhengzhou	45	Sydney
21	Shenyang	46	Gaoxiong
22	Taiyuan	47	Munich
23	Lanzhou	48	Macau
24	Hefei	49	Manila
25	Ningbo	50	San Francisco

Table 2.2 lists the top 10 passenger connections of Chengdu, Beijing, and Shanghai, and Guangzhou, and comes to the following conclusions. First, Hong Kong ranks high in the lists of Beijing and Shanghai, but is squeezed out of the top 10 for Guangzhou and Chengdu (in Table 2.1 Hong Kong is only number 15). Second, Shanghai and Beijing both have foreign cities in their top ten (Tokyo and Seoul), but Guangzhou and Chengdu's top 10 are entirely domestic. Third, Chengdu and Guangzhou are each ranked fourth in the other city's list. But Beijing is ranked first in Chengdu's list, while Chengdu is only ranked fourth on Beijing's list. In Shanghai, the gap is even greater. These results indicate that in the air connections rankings, Chengdu and Guangzhou are equivalent, but are far behind Shanghai and Beijing.

Table 2.3 further compares foreign passenger connections. The table lists the international cities among the top 50 passenger connections from Chengdu, Beijing, Shanghai, and Guangzhou and comes to the following conclusions. Chengdu has the fewest foreign city connections. Four Asia-Pacific cities are ranked very high, but their ranking is further back on Chengdu's list. Leading global cities (London,

Table 2.2 Top 10 flight volumes (2008): Chengdu versus Shanghai versus Beijing versus Guangzhou

Rank	Arrival airport: Chengdu	Arrival airport: Shanghai	Arrival airport: Beijing	Arrival airport: Guangzhou
1	Beijing	Beijing	Shanghai	Beijing
2	Shanghai	Shenzhen	Shenzhen	Shanghai
3	Shenzhen	Hong Kong	Guangzhou	Hangzhou
4	Guangzhou	Tokyo	Chengdu	Chengdu
5	Kunming	Guangzhou	Xi'an	Nanjing
6	Hangzhou	Seoul	Hong Kong	Chongqing
7	Xi'an	Taipei	Seoul	Zhengzhou
8	Nanjing	Qingdao	Chongqing	Kunming
9	Wuhan	Chengdu	Tokyo	Xi'an
10	Urumqi	Xiamen	Kunming	Wuhan

Table 2.3 Comparison of international passenger connections: Chengdu versus Shanghai versus Beijing versus Guangzhou

	Chengdu		Shanghai		Beijing		Guangzhou
Rank	City connection	Rank	City connection	Rank	City connection	Rank	City connection
28	Singapore	4	Tokyo	7	Seoul	16	Tokyo
29	Tokyo	6	Seoul	9	Tokyo	25	Seoul
30	Seoul	14	Singapore	28	Singapore	28	Bangkok
33	Bangkok	25	Bangkok	33	Bangkok	29	Singapore
36	Kuala Lumpur	26	Nagoya	34	Moscow	32	Nagoya
38	Los Angeles	33	Paris	36	London	33	Nagoya
40	Frankfurt	34	London	37	Paris	34	Ho Chi Minh
41	Amsterdam	36	Busan	38	New York	37	Dubai
42	Paris	38	Frankfurt	39	Busan	38	Los Angeles
43	Nagoya	39	Sydney	42	Toronto	40	Jakarta
44	Chicago	40	Los Angeles	43	Los Angeles	41	Hanoi
45	Sydney	41	Kuala Lumpur	44	Frankfurt	42	Lagos
47	Munich	43	San Francisco	45	Los Angeles	43	Manila
49	Manila	45	New York	46	Sydney	44	Amsterdam
50	San Francisco	47	Melbourne	47	Vancouver	45	New York
		49	Moscow	48	Kuala Lumpur	46	Sydney
		50	Milan	49	Nagoya	47	Phnom Penh
				50	Amsterdam	48	New Deli
						49	Penang
						50	San Francisco

Table 2.4 Comparison of the global distribution of the cities of foreign air passengers: Chengdu versus Shanghai versus Beijing versus Guangzhou

World region	Chengdu	Shanghai	Beijing	Guangzhou
Asia-Pacific	7	7	7	12
Other Asian regions	0	0	0	1
Middle East/Northern Africa	0	0	0	1
Sub-Saharan Africa	0	0	0	1
Europe	4	5	5	1
North America[a]	3	3	5	3
Latin America	0	0	0	0
Australasia	1	2	1	1

[a]Denotes Canada and the US

New York, Paris) all appear on Shanghai and Beijing's lists, but not on Chengdu's. Guangzhou has only New York. These results indicate that Chengdu has few foreign passenger connections compared to the other cities.

Table 2.4 divides the foreign cities in Table 2.3 by major world region in order to illustrate the global passenger scope of the four cities. We can see that in the Asia-Pacific region, Chengdu has a similar number of foreign connections to Beijing and Shanghai, but this number is only half of Guangzhou's (this is mainly because in Table 2.3, Guangzhou has the most international city connections). Chengdu's connections to European and North American cities are equivalent to Shanghai and Beijing but in stark contrast with Guangzhou. These results suggest that the "global coverage rate" of Chengdu's passenger connections is on a similar level of Shanghai and Beijing, but the importance of its city linkages is still relatively low.

In summary, in terms of the infrastructure linkage effect reflected by air passenger connections, although there is still a large gap with Beijing and Shanghai, similar to Guangzhou, Chengdu has the potential to become an emerging world city.

2.1.2 Measuring Chengdu's Business Network

2.1.2.1 Model Construction

Currently, the authoritative way of measuring the degree of a city's commercial ties is analysis using the interlocking network model. The model is divided into three levels. The first level, the net level, is a blueprint of the "flows" of factors of production like capital, information, and human resources. The second level, the nodal level, is comprised of functional cities within the world city network. It is an intermediate perspective of the entire city network. The last micro level, the sub-nodal level, is the reflection of multiple advanced production services companies, which is an important

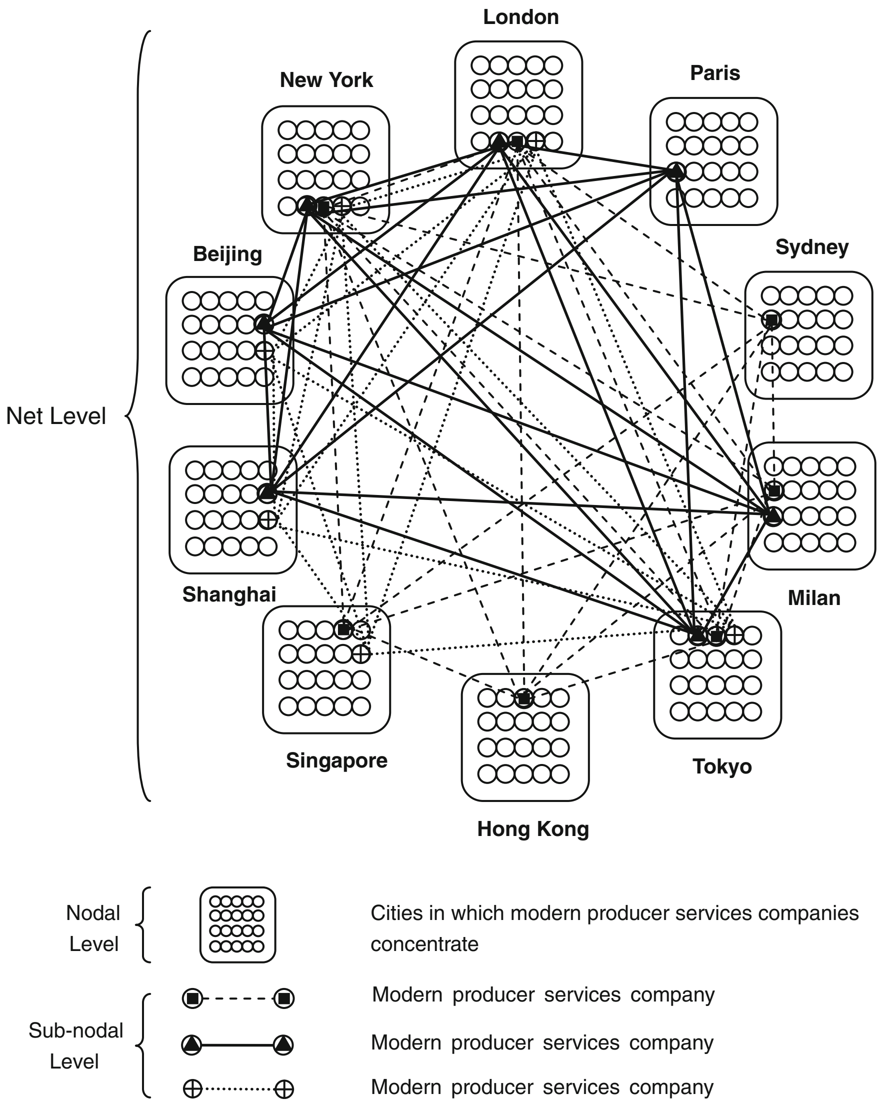

Fig. 2.1 The world city connection network formed by ten cities and three advanced producer services companies

source promoting the constant mutual exchange of production factors. Figure 2.1 shows the prior connections of ten cities through three different advanced production services companies and the partial interlocking network created. In the figure, the offices of companies in their respective cities form the most basic segment of the overall network connection, the sub-node. The external connections of the multiple sub-nodes within each city form the factor flows between cities, with each city becoming a factor node in the network. All factors will ultimately form a global city network through the linking of these nodes.

In the model, assuming within *n* cities there are *m* advanced producer services companies, the value of a company is measured by the importance of the company's office in its city in the global office system, expressed by the variable V_{ij}. The entire city network is the service value matrix *V* obtained by the permutation $n \times m$, wherein the constituent element of the matrix $V_{ij} = 0–5$. The criteria for judging their values are listed in Table 2.5. By grading the importance of company offices in the city and adding up the distribution of multinationals in the city, we obtain the service value of the city's industry, as shown in Table 2.6.

From service value matrix *V* we can obtain the basic points of connection between two cities through a company:

$$r_{abj} = v_{aj} v_{bj}$$

r_{abj} is a point of connection between city *a* and city *b* through company *j*, known as elemental interlock. Through the combination of the elemental interlocks of all companies, city *a* and city *b* obtain city interlock:

$$r_{ab} = \sum_j r_{abj}$$

Table 2.5 Judgment criteria for service value of sample multinationals

Distribution of sample multinationals in the city	Service value judgment criteria
No established agencies or network points	0
Established general agencies or network points, but on a small scale	1
Established general agencies or network points	2
Established general agencies or network points, but on a larger scale	3
Established regional headquarters	4
Established corporate headquarters	5

Table 2.6 Basic pattern of company service value determination

	Company 1	Company 2	……	Company j	$C_i = \sum_j V_{ij}$
City 1	1	1	……	V_{1j}	C1
City 2	2	3	……	V_{2j}	C2
City 3	1	5	……	V_{3j}	C3
……	……	……	……	……	
City i	V_{i1}	V_{i2}	……	V_{ij}	Ci
$F_j = \sum_i V_{ij}$	F1	F2		Fj	$S = \sum_i \sum_j V_{ij}$

Each city forms $n-1$ connections with $n-1$ other cities, so the sum of the city interlock of each city in the network is:

$$N_a = \sum_i r_{ai} \quad a \neq i$$

Here N_a is the number of links city a has with other cities in the world city network. The number of links of all cities in the network is:

$$T = \sum_i N_i$$

The number of links of a city in the world city network divide the total number of links is this city's degree of network connection.

$$L_a = (N_a/T)$$

Since the total number of links is enormous, the value of L_a tends to be small. To facilitate better comparison and measuring, we use the relative degree of connection approach, that is, measuring by the proportion of the number of links city a has to the city with the highest number of links. Here, the city with the highest number of links is New York, expressed by N_h, an New York's degree of connection is set at 1.00.

$$P_a = (N_a/N_h)$$

2.1.2.2 Sample Selection and Data Sources

According to the definition of producer services, we identified seven key service sectors—banking/finance, accounting, media, law, management consulting, business hotels, and exhibitions. From among the first five we selected 225 producer services multinationals as samples from among the Forbes 2000 (2010) according to the scale and global distribution of the multinationals in each industry (a multinational need only have offices in more than 15 cities, with at least one each in North America, Western Europe, and Asia for it to be identified as a global services company), and calculated their distribution in 621 global cities. Because the service value of business hotels and the exhibition industry is too broad to measure, considering the availability of this data, this study does not include those industries in the target scope, as shown in Table 2.7.

Table 2.8 lists the 20 Chinese cities with the best global network connectivity for 2010. In addition, it lists the world rankings of these 20 cities among the aforementioned 526 cities. The conclusions are as follows. The rankings are divided into two cut-off points (50 and 25 %), and China has three cities above 50 % and three above 25 %. Chengdu is 13.1 %, far behind the cut-off point. Chengdu is on the

Table 2.7 Data sources for the value of each urban service function

Indicator	Sample company	Remarks
Banking/finance, accounting, media, law, management consulting	Top 25 multinationals for each industry in the Forbes 2000 (2010)	Banking/finance is made up of the sum of the top 25 companies in finance, insurance, and banking (75 companies). If global distribution data for a company in the top 25 could not be found, we replaced it with a company ranked 25–30

Findings 2: Degree of connection for commercial services

Table 2.8 20 Chinese cities with best global network connectivity

Rank in China	World rank	City	Degree of connectivity in the city network[a]
1	3	Hong Kong	73.0
2	7	Shanghai	62.7
3	12	Beijing	58.4
4	43	Taipei	41.7
5	67	Guangzhou	34.1
6	106	Shenzhen	25.8
7	188	Tianjin	16.8
8	223	Kaohsiung	14.3
9	245	Nanjing	13.5
10	**252**	**Chengdu**	**13.1**
11	262	Hangzhou	12.5
12	267	Qingdao	12.3
13	275	Dalian	12.0
14	291	Macau	10.9
15	319	Chongqing	8.9
16	323	Xi'an	8.7
17	325	Suzhou	8.6
18	337	Wuhan	8.0
19	346	Xiamen	7.5
20	348	Ningbo	7.5

lower end of the global network connectivity scale, ranking only tenth in China and 252nd globally. These preliminary results suggest that in terms of commercial service linkages, Chengdu has a long way to go before becoming an emerging world city.

Table 2.9 comes from an early analysis in 2008. It shows the relative degree that "endocentric connection" occupies in business connections. This method is used to evaluate the relative depth of a city's relationships with other Chinese cities. Due to multifaceted relationships with cities abroad, we can predict that the degree of "endocentric connection" will be low for leading global cities. The conclusions are

Table 2.9 Endocentric connectivity of Chinese cities in 2008 (relative degree of relationship among Chinese cities domestically)

Rank	City	Endocentric connectivity	Rank	City	Endocentric connectivity
1	Xi'an	10.98	12	Qingdao	4.38
2	Chongqing	9.93	13	Dalian	3.81
3	Wuhan	9.46	14	Shenzhen	2.35
4	Fuzhou	8.73	15	Guangzhou	2.15
5	Shenyang	8.26	16	Macau	1.38
6	Xiamen	7.86	17	Beijing	1.10
7	Hangzhou	6.93	18	Kaohsiung	1.09
8	Nanjing	5.72	19	Shanghai	0.47
9	Suzhou	5.22	20	Hong Kong	0.20
10	Chengdu	5.18	21	Taipei	−0.14
11	Tianjin	4.86			

as follows. In terms of internal linkages, China's leading cities are ranked lowest, with the exception of particular cases like cities in Taiwan and municipalities directly under the central government. We can see from the table that Chengdu is ranked in the middle. The relative breadth of its network of business connections is more than two times that of many other cities in China, such as Guangzhou.

Table 2.10 is also derived from earlier analysis from 2008, showing the relative depth of business service relationships between Chinese cities and the leading world cities of New York and London. The conclusions are as follows. Like Table 2.5, the ranked cities are divided into two groups. China has three cities reaching 0.75 and above and three between 0.5 and 0.59. The last three cities are quite interesting because they are different from the three cities above the second cut-off point in Table 2.5, that is, Guangzhou and Shenzhen are not present. But this allows Chongqing to rise to fourth place, not Chengdu. Although its rank improved slightly (to ninth), Chengdu is still in a middle position. This is further evidence that Chengdu's business services connectivity is nothing special. Moreover, this is also related to the fact that London and New York were not present in Table 2.3 illustrating Chengdu's air passenger connections. In addition, this shows that nearby Chongqing is developing these important connections, while Chengdu is not.

In Table 2.11, we turn to analyze the relationship between two cities, showing the business services relationship between Chengdu and other cities. We analyze this in two ways: absolute, or the total number of cities connected to Chengdu; and relative, which adds a city's total relationships to the consideration. The table has two lists of cities, each going from one to fifty. The conclusions are as follows. In the absolute relationship column, London and New York are ranked first and second, respectively (in view of their importance in the world city network, this is to be expected), while Beijing, Shanghai, and Hong Kong follow close behind.

Table 2.10 Worldwide centralization of Chinese cities for 2008 (relative degree of connection with New York and London)

Rank	City	Connectivity with New York and London	Rank	City	Connectivity with New York and London
1	Hong Kong	0.87	12	Tianjin	0.01
2	Beijing	0.82	13	Xiamen	−0.06
3	Shanghai	0.76	14	Hangzhou	−0.07
4	Chongqing	0.59	15	Shenzhen	−0.12
5	Shenyang	0.52	16	Xi'an	−0.19
6	Taipei	0.50	17	Kaohsiung	−0.26
7	Wuhan	0.36	18	Suzhou	−0.26
8	Fuzhou	0.25	19	Dalian	−0.40
9	Chengdu	0.15	20	Qingdao	−0.51
10	Nanjing	0.11	21	Macau	−0.62
11	Guangzhou	0.10			

However, these three Chinese cities are in the reverse order of Table 2.5 in terms of global network connectivity. In the relative connectivity column Chinese cities occupy the top nine spots, and the "localization trend" is quite apparent. New York and London's business services relationship with Chengdu are in middle positions. This table shows that Chengdu is in the early stages of being an emerging world city.

In Table 2.12, we return to a direct comparison of Chengdu, Shanghai, Beijing, and Guangzhou. Table 2.12 references only the leading cities of the second list of Table 2.8 (see the note for Table 2.12). We selected 20 cities to list in the Chengdu column. Listed on the right is the equivalent relevant relationship ranking for the other three cities. The conclusions are as follows. The global rankings of Chengdu's partnership cities are generally lower than the other three cities, especially Shanghai. London, New York, and Paris are important business services partners of Beijing and Shanghai, but only New York appears in the Chengdu column (none of these three cities appear in Guangzhou's column). This once again shows the relatively small service relationship between Chengdu and other cities.

Table 2.13 shows the worldwide regional distribution of the cities from the previous tables. This is similar to the airline passenger destination distribution of Table 2.4. The conclusions are as follows. Unlike Table 2.4, in this table, Chengdu and Guangzhou have similar distributions the cities with which they have the most business services relationships rather than Shanghai and Beijing. Half of Chengdu's partnership cities are from the Asia-Pacific region, while only four are from Europe and North America. Shanghai and Beijing have 12 and 10, respectively (Guangzhou has only 3). This table also confirms that there is a difference between the distribution of air passenger flows and business services connections.

To summarize the business services connectivity findings, made an assessment of the "global relevance" of Chengdu's business services connections through its

Table 2.11 Top 50 cities with cooperative relationships with Chengdu

Rank	Absolute connection	Relative connection	Rank	Absolute connection	Relative connection
1	London	Shenzhen	26	Toronto	Singapore
2	New York	Qingdao	27	Frankfurt	London
3	Beijing	Nanjing	28	New Delhi	New Delhi
4	Shanghai	Tianjin	29	Johannesburg	Bangalore
5	Hong Kong	Dalian	30	Dublin	Paris
6	Tokyo	Hangzhou	31	Barcelona	Perth
7	Singapore	Guangzhou	32	Bangkok	Buenos Aires
8	Paris	Beijing	33	Taipei	Hanoi
9	Dubai	Shanghai	34	Melbourne	Barcelona
10	Sydney	Tokyo	35	Dusseldorf	Bangkok
11	Seoul	Osaka	36	San Francisco	Ho Chi Minh
12	Shenzhen	Seoul	37	Bangalore	Los Angeles
13	Guangzhou	Hong Kong	38	Washington DC	Taipei
14	Kuala Lumpur	Kuala Lumpur	39	Tianjin	Dusseldorf
15	Chicago	Johannesburg	40	Brussels	Dublin
16	Los Angeles	Nicosia	41	Istanbul	Cairo
17	Milan	Karachi	42	Karachi	Montevideo
18	Jakarta	Lahore	43	San Diego	Amsterdam
19	Buenos Aires	Birmingham (UK)	44	Cairo	Beirut
20	San Paolo	New York	45	Dallas	Caracas
21	Moscow	Sydney	46	Lisbon	Monterrey
22	Amsterdam	Manchester	47	Vienna	Moscow
23	Madrid	Dubai	48	Ho Chi Minh	Port Louis
24	Mexico City	Rio de Janeiro	49	Manchester	Baghdad
25	Mumbai	Jakarta	50	Milan	Milan

relationship with more important cities rather than a relatively few randomly selected partner cities. From Table 2.12 we derived two measurements that are presented in Table 2.14.

The average ranking of world city connectivity of these four cities confirms an earlier conclusion: Chengdu's average ranking is far lower than the other three cities, especially compared with Beijing and Shanghai. By comparing the rankings of their partner cities and the rankings of their urban connectivity, we find that Chengdu and Guangzhou's global relevance is low, but Beijing and Shanghai are positively correlated. This especially true for Shanghai. This section clearly shows that Chengdu (and Guangzhou) has not achieved the global connectivity of Beijing and Shanghai and is still at the edge of the world city network.

Table 2.12 Comparing the top 20 cooperation cities: Chengdu versus Shanghai versus Beijing versus Guangzhou

Partner city rank	Chengdu	Connectivity rank	Shanghai	Connectivity rank	Beijing	Connectivity rank	Guangzhou	Connectivity rank
1	Shenzhen	106	Hong Kong	3	Shanghai	7	Shenzhen	106
2	Guangzhou	67	Beijing	12	Hong Kong	3	Beijing	12
3	Beijing	12	New York	2	Singapore	5	New Delhi	33
4	Shanghai	7	London	1	Frankfurt	19	Shanghai	7
5	Tokyo	6	Singapore	5	Guangzhou	67	Ho Chi Minh	70
6	Osaka	111	Tokyo	6	Tokyo	6	Bangkok	42
7	Seoul	24	Paris	4	London	1	Bangalore	59
8	Hong Kong	3	Frankfurt	19	New York	2	Seoul	24
9	Kuala Lumpur	23	Guangzhou	67	Bangkok	42	Hong Kong	3
10	Johannesburg	47	Bangkok	42	Paris	4	Manila	54
11	Nicosia	84	Los Angeles	17	Los Angeles	17	Singapore	5
12	Karachi	77	San Paolo	14	Seoul	24	Montreal	51
13	Lahore	120	Madrid	15	Washington DC	28	Tokyo	6
14	Birmingham	85	Milan	11	Moscow	18	Kuala Lumpur	23
15	New York	2	Chicago	8	Ho Chi Minh	70	Sofia	98

(continued)

Table 2.12 (continued)

Partner city rank	Chengdu	Connectivity rank	Shanghai	Connectivity rank	Beijing	Connectivity rank	Guangzhou	Connectivity rank
16	Sydney	10	Sydney	10	Brussels	25	Toronto	13
17	Manchester	76	Munich	34	Chicago	8	Taipei	43
18	Dubai	9	Moscow	18	Sydney	10	Sydney	10
19	Rio de Janeiro	86	Brussels	25	Dubai	9	Osaka	111
20	Jakarta	26	San Francisco	27	San Francisco	27	Jakarta	26

Note The Chengdu column is based on the second list of Table 2.11 but does not include the small cities

Table 2.13 Comparison of the global distribution of the Top 20 partner cities: Chengdu versus Shanghai versus Beijing versus Guangzhou

Region	Chengdu	Shanghai	Beijing	Guangzhou
Asia-Pacific	10	6	8	14
Other Asian regions	2	0	0	2
Middle East/North Africa	1	0	1	0
Sub-Saharan Africa	1	0	0	0
Europe	3	8	5	2
North America[a]	1	4	5	1
Latin America	1	1	0	0
Australasia	1	1	1	1

[a]Canada and the United States

Table 2.14 Global relevance of cities' external relationships: Chengdu versus Shanghai versus Beijing versus Guangzhou

City	Global relevance[a]	
	Average connectivity ranking	Relevance of connectivity ranking
Chengdu	82.20	−0.01
Shanghai	17.00	0.35
Beijing	19.60	0.16
Guangzhou	39.80	−0.01

[a]Based on the top 20 cities with the most partner cities

2.2 Analysis of Chengdu's Agglomeration Effect

Chengdu is a product of agglomeration. The rapid development of a city must inevitably be manifested in the continuous gathering of various factors and outputs. The differences in the degree of agglomeration of factors and outputs among each city decide the differences in the position and role of each city in the economic system. For Chengdu to become the western center of the Chinese economy and be listed alongside Beijing, Shanghai, and Guangzhou in the Chinese economic system, for it to move toward becoming a world city, it must constantly increase its own agglomeration of factors and outputs. Meanwhile, in the context of economic globalization, no national center city can be closed in its development or limited to the development of the economy of its own country. Rather, it must be open and develop facing the world economy. Thus, the position and role of a city in the economic system of its own country cannot be limited to analysis and comparison within the economy of its own country. Rather, it must be further analyzed and understood in the context of the global city system. Therefore, in this chapter, we will select several globally representative cities in order to understand the rules of the agglomeration of factors and outputs in the urban development process by way an analysis and comparison of the history and current situation of agglomeration in these cities, thereby better understanding the current situation and trends of the agglomeration of factors and outputs in Chengdu and other Chinese cities. The following describe the research methods.

2.2.1 Model Building

Two basic aspects of urban economic development are the constant growth of factors and outputs. From the perspective of agglomeration, this means the continuously increasing level of agglomeration of factors and outputs in the city. According to basic macroeconomic theory, factors and outputs in economic growth can be expressed with this basic equation:

$$\mathrm{Y} = \mathrm{Af}(\mathrm{K}, \mathrm{L})$$

where Y represents outputs, A represents technology, K represents capital, and L represents Labor. From this we can conclude that the degree of a city's factor and output agglomeration can be measured from these four aspects. That is, we must analyze and compare the degree of output agglomeration, technology agglomeration, capital agglomeration, and labor agglomeration in each city.

In terms of output agglomeration, as a city's output is generally measured by the city's GDP, and GDP itself is based on a certain area, we use GDP per unit of land to measure output agglomeration. We can measure technology agglomeration using a city's level of scientific and technological innovation. In this case, we use a city's international patents to measure the degree of technology agglomeration. We can use population concentration and population density to measure the degree of labor agglomeration. For capital agglomeration, because capital overall is mainly used for research and development or production, and the agglomeration of R&D capital is closely tied to the agglomeration of technology, while the agglomeration of production capital is closely tied to the agglomeration of labor, we can use the agglomeration of technology and labor to measure the agglomeration of capital. Thus, we select sixteen representative cities from around the world and study the history and current situation of urban agglomeration from the three aspects of GDP, international patents, and population density and from the two dimensions of history and current reality. This allows us to have an understanding of the development of Chengdu and other Chinese cities from a global agglomeration perspective.

GDP per unit of land and population density data are obtained through the official websites and databases of city governments, research organizations, and official statistical organization. International patent data comes from the website database of the World Intellectual Property Organization (WIPO).

2.2.2 Selection of Representative Cities

Among global cities, from the two dimensions of time and space, we select sixteen representative cities for analysis. From the time perspective, modern economic prosperity first appeared in the main cities in Europe and America. After the industrial revolution of the mid-19th century, with the gradual spreading of the impact of the industrial revolution, London, Stockholm, Zurich, New York, and Chicago each experienced rapid economic growth, and output and factors rapidly concentrated in these cities. After World War II, Japan was the first to achieve economic prosperity in Asia, and the economies of Japan's major cities such as Tokyo began to grow first among major Asian cities. Hong Kong and Singapore followed closely thereafter, also achieving economic takeoff. By the 1990s, China and India were showing signs of economic booms, and today, Beijing, Shanghai, Guangzhou, Chengdu, Chongqing, Xi'an, Mumbai, and Bangalore are all in the rapid development stage. From a spatial perspective, a city's geographic location has a huge impact on its development. Here, we mainly consider three cases: first, coastal; second, inland; and third, on an inland sea or river. Based on these criteria, we select the following cities:

Start of economic prosperity	Coastal	Inland	Inland sea or river
Mid-19th century	London, New York, Tokyo	Zurich, Chicago	Stockholm
1980s	Hong Kong, Singapore		
1990s	Shanghai, Guangzhou, Mumbai	Beijing, Chengdu, Xi'an, Bangalore	Chongqing

2.2.3 Historical Agglomeration in Representative Cities

2.2.3.1 History of Agglomeration in Representative European and American Cities

The first world cities in the modern sense first appeared in Europe and America in the mid-19th century with the completion of the industrial revolution. Through the second World War, the first rapid agglomeration in modern urban history occurred in London, Zurich, and Stockholm in Europe and New York and Chicago in America. We can see this in the population concentrations of each country, as Fig. 2.2 shows. In England, the source of the industrial revolution, London's population grew rapidly beginning in 1840, with growth slowing around 1900 and the population reaching a peak around 1940. Zurich and Stockholm's populations began growing rapidly around 1900, peaking around 1960.

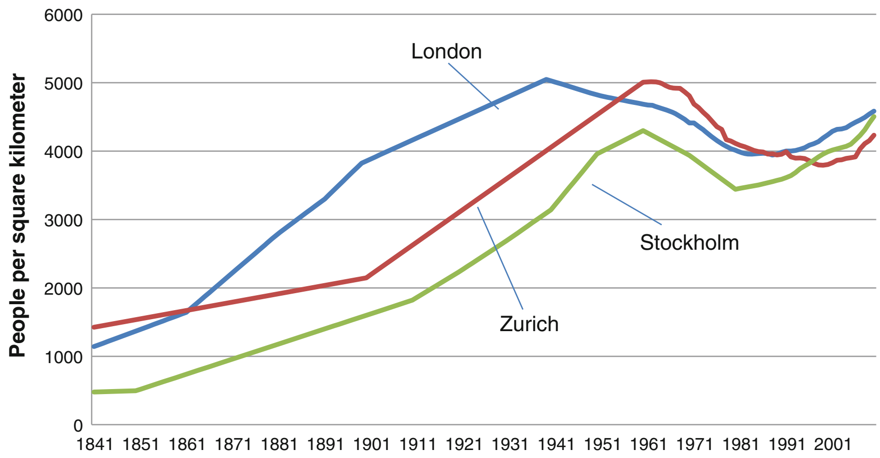

Fig. 2.2 Urban population density (Europe)

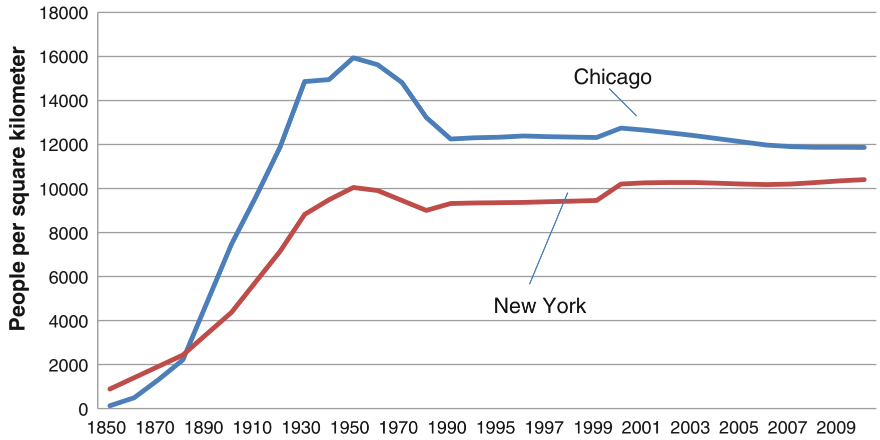

Fig. 2.3 Urban population density (America)

From Fig. 2.3 we can see that the population concentrations of New York and Chicago began accelerating in 1850, peaking around 1950.

Other cities rose along with post-war global economic prosperity. After peaking, the population densities of these representative cities fell gradually until stabilizing around 1980, after which London, Zurich, and Stockholm began to rise again, and New York and Chicago remained stable. With this falling population concentration in the context of global economic prosperity, the output agglomeration of these cities remained stable or grew slowly. As Figs. 2.4 and 2.5 shows, London, Zurich, and Stockholm's GDP per unit of land rose slowly from 1960 to 1984, but have

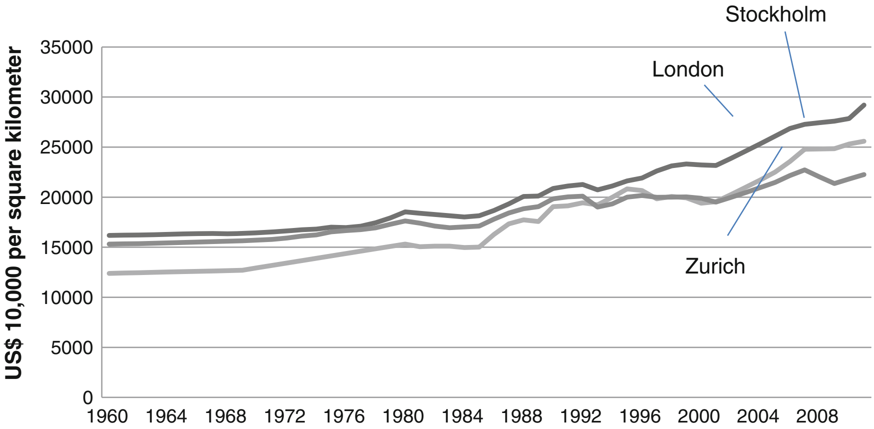

Fig. 2.4 Growth of urban GDP per unit of land (Europe)

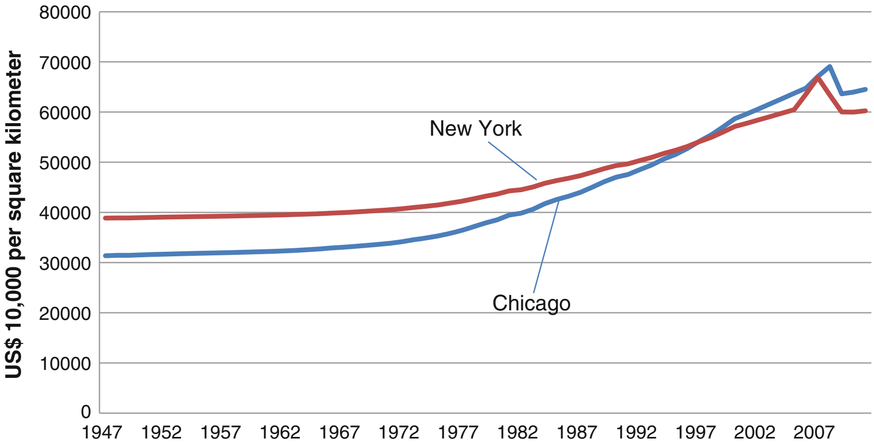

Fig. 2.5 Growth of urban GDP per unit of land (America)

risen quicker from 1984 to date. GDP per unit of land in New York and Chicago grew slowly from around 1950 to 1977, after which it began growing more rapidly.

Clearly, population concentration is not the main reason these cities began a phase of rapid economic growth around 1980. Rather, it is another agglomeration, investment agglomeration. Figures 2.6 and 2.7 shows that beginning in 1980, the number of international patents in these cities began to grow rapidly. The increasing concentration of technology pushed forward the rapid growth in GDP per unit of land, i.e. output agglomeration, in these cities.

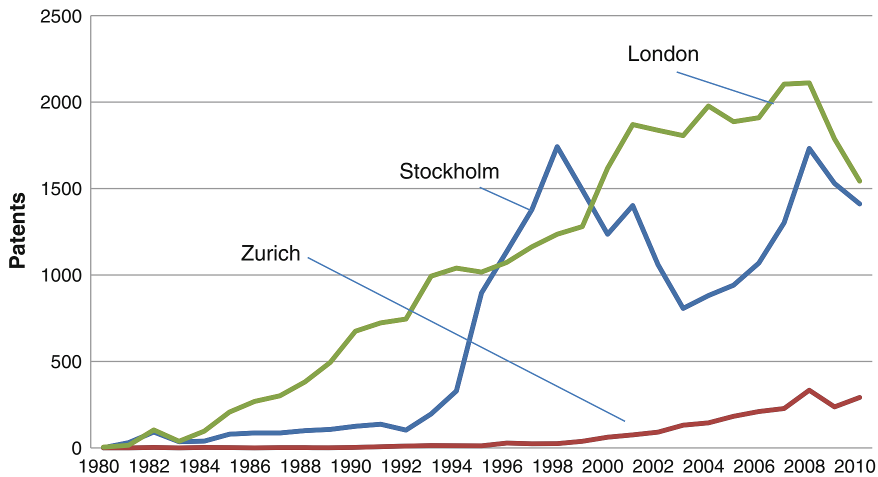

Fig. 2.6 International patents by city (Europe)

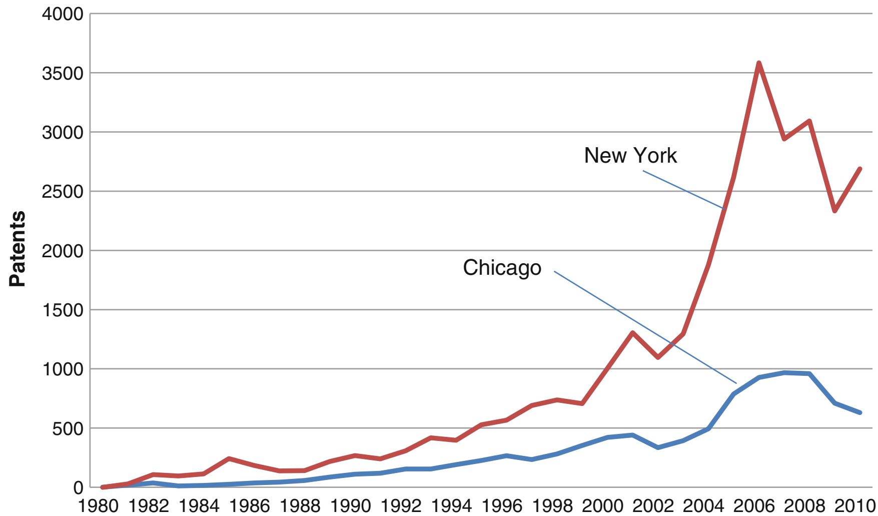

Fig. 2.7 International patents by city (America)

2.2.3.2 History of Agglomeration in Representative Asian Cities

The rapid economic growth of representative cities in Asia began after World War II. As Fig. 2.8 shows, Tokyo began its rapid economic growth around 1960, a state that lasted until around 1990, after which the economy stagnated. As Fig. 2.9 shows, Tokyo's population concentration fell to a low after World War II, grew rapidly thereafter, and stabilized around 1980. As shown in Fig. 2.10, Tokyo's

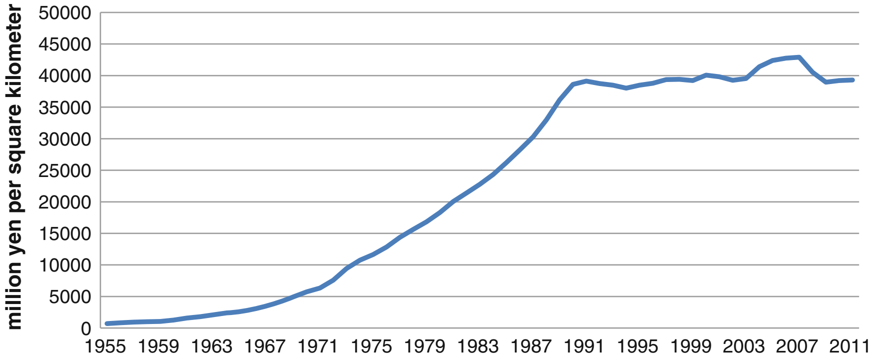

Fig. 2.8 Growth in GDP per square kilometer (Tokyo)

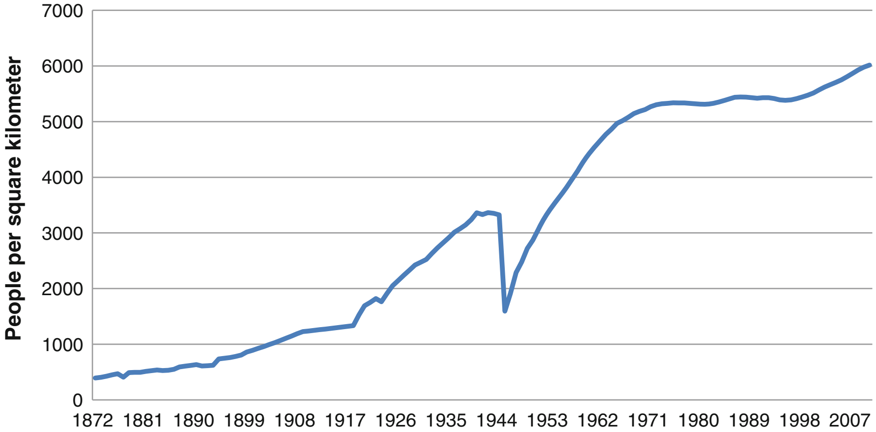

Fig. 2.9 Urban population density (Tokyo)

international patents began growing rapidly after 1980. Considering the aging Japanese population, the ability of Tokyo to maintain its output agglomeration between 1980 and 1990 owes mainly to the rapid increase in the degree of technology agglomeration.

Hong Kong and Singapore achieved rapid economic growth immediately after Tokyo. As shown in Figs. 2.11 and 2.12, Hong Kong and Singapore's GDP per kilometer began growing rapidly in 1980. With the exception of the Asian financial crisis in 1998, from 1998 to 2004, growth stagnated or declined slightly. Overall, Hong Kong and Singapore's degree of output agglomeration has maintained rapid growth.

Correspondingly, population density in Hong Kong and Singapore began to rise in 1980. As Figs. 2.13 and 2.14 shows, population density in both cities has been growing constantly.

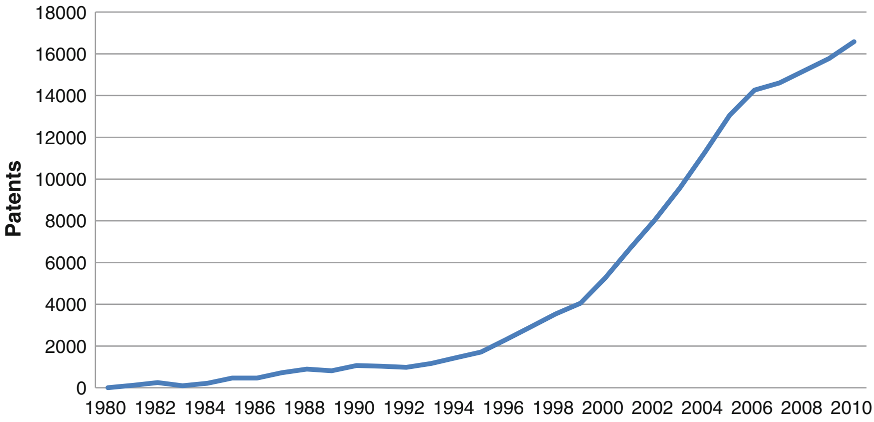

Fig. 2.10 International patents (Tokyo)

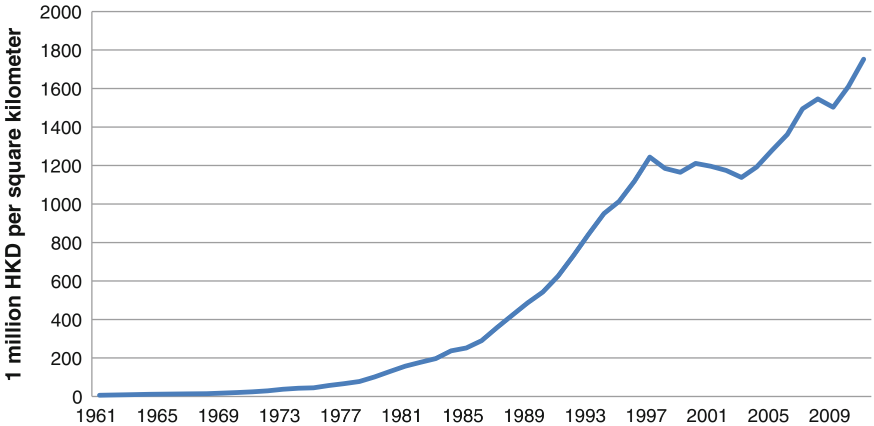

Fig. 2.11 Growth in GDP per square kilometer (Hong Kong)

Meanwhile, as Figs. 2.15 and 2.16 shows, from around 1995 onwards, Hong Kong and Singapore's international patents began to grow rapidly. The joint increasing of technology agglomeration and labor agglomeration supported the increasing degree of GDP per kilometer, that is, output agglomeration.

Mumbai and Bangalore's rapid economic growth began around 1993, as shown in Fig. 2.17. Mumbai's growth has been significantly faster. One can see from Fig. 2.18 that Mumbai's population concentration is much higher than Bangalore's, as is the speed of increase. In terms of technology agglomeration, Fig. 2.19 shows that Bangalore's patents began increasing rapidly after 1998, while Mumbai's patent growth proceeded slowly. One can see that compared to Bangalore,

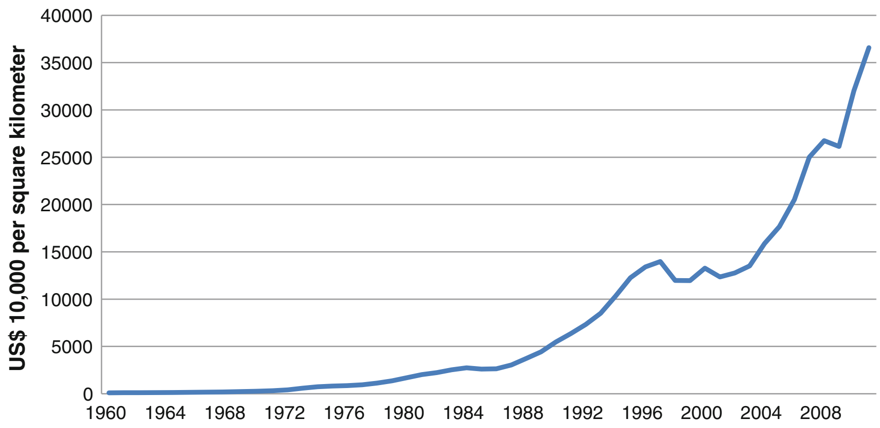

Fig. 2.12 Growth in GDP per square kilometer (Singapore)

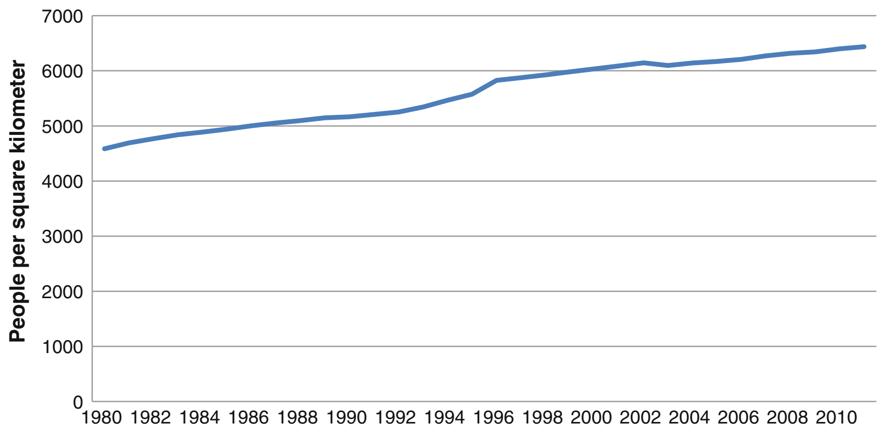

Fig. 2.13 Population density (Hong Kong)

Mumbai's economic agglomeration is basically an agglomeration of labor and production capital rather than agglomeration of technology and R&D capital.

2.2.3.3 History of Agglomeration in Representative Chinese Cities

As Fig. 2.20 shows, rapid economic growth in China began around 1992 and continues to this day. Figure 2.21 shows that population concentration during the same period has also increased rapidly, but different cities have seen different degrees of technology clustering. As Fig. 2.22 shows, international patents have grown rapidly in Beijing and Shanghai since 1992, with growth also significant in

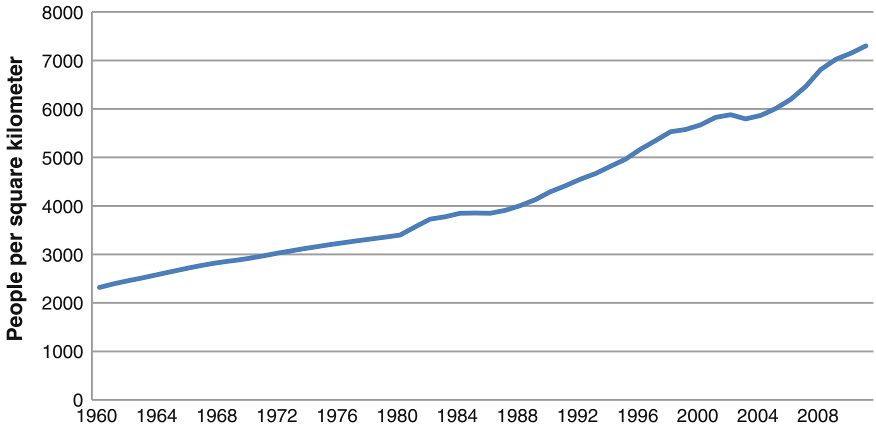

Fig. 2.14 Population density (Singapore)

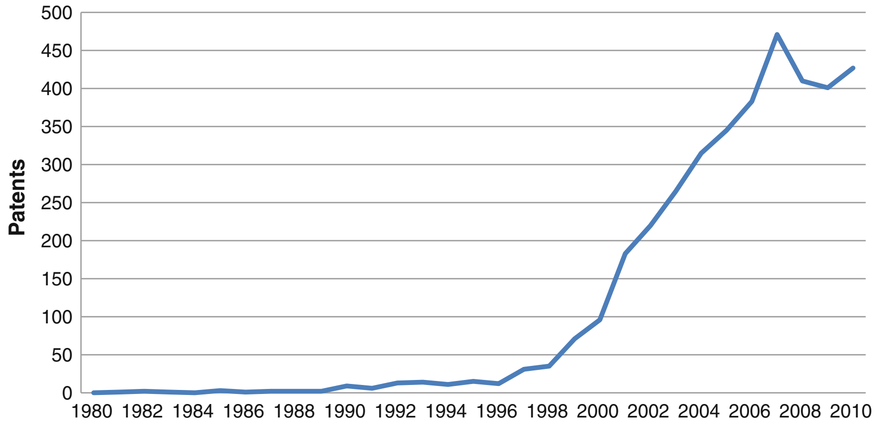

Fig. 2.15 International patents (Hong Kong)

Guangzhou. But patent growth has proceeded slowly in Chengdu, Xi'an, and Chongqing.

2.2.3.4 Historical Laws of Urban Agglomeration

We can see from the history of agglomeration in the world's most advanced cities, that the process of urban development is historically reflected as the continuous agglomeration of factors and outputs. In addition, according to the different factors promoting further agglomeration of output, this process can be divided into two phases. The first phase is mainly the agglomeration of labor and production capital,

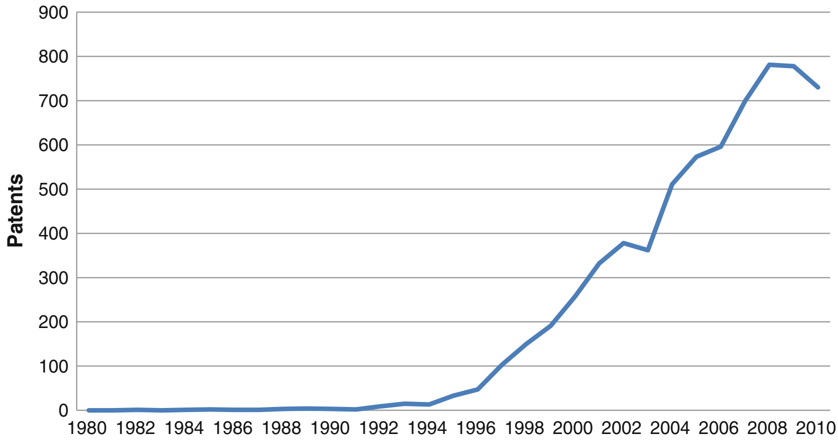

Fig. 2.16 International patents (Singapore)

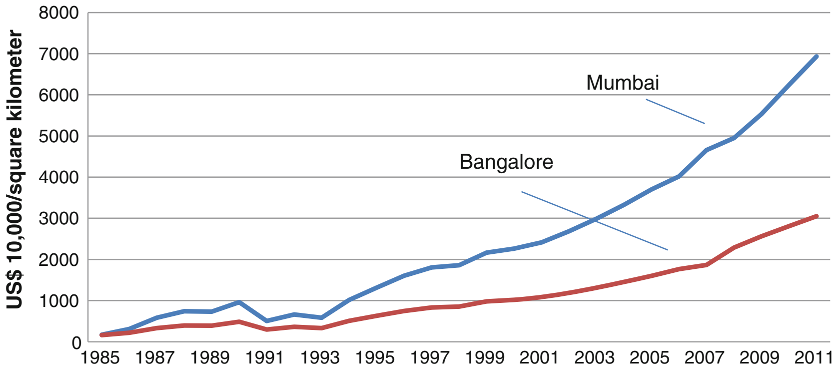

Fig. 2.17 Growth in GDP per square kilometer (India)

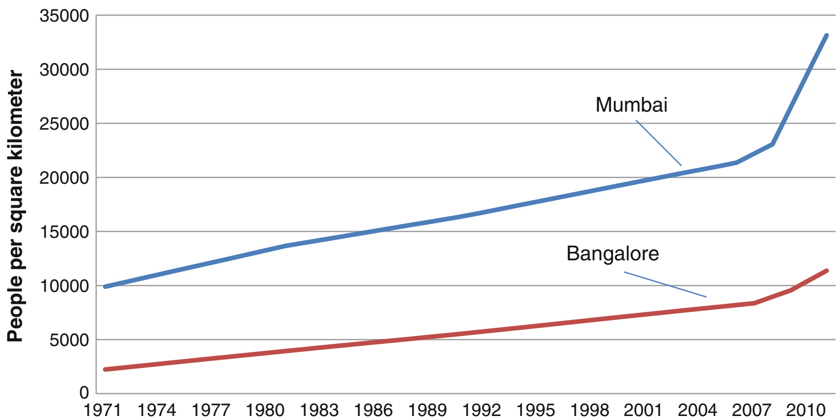

Fig. 2.18 Urban population density (India)

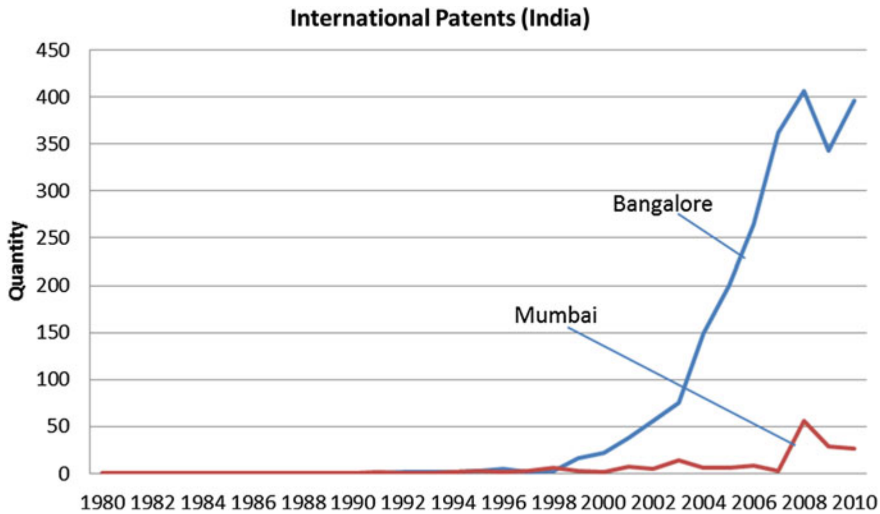

Fig. 2.19 International patents (India)

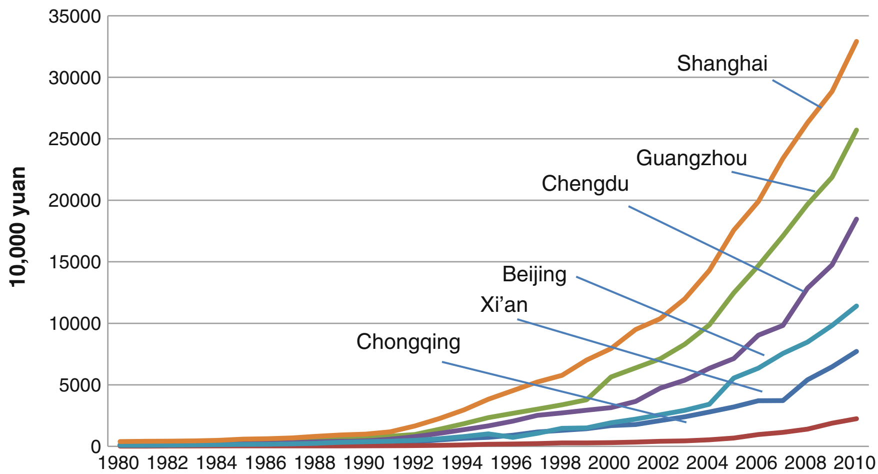

Fig. 2.20 Growth in GDP per kilometer (China)

while the second is the agglomeration of technology and R&D capital. From the historical agglomeration of European and American cities and Tokyo, we can see the successive appearance of these two stages. But when we consider Hong Kong, Singapore, and cities in India, and China, we discover that urban development has not shown significant characteristics of stages. For example, in Hong Kong and Singapore, labor and production capital as well as technology and R&D capital basically jointly pushed forward the agglomeration of output, reflected in rapid

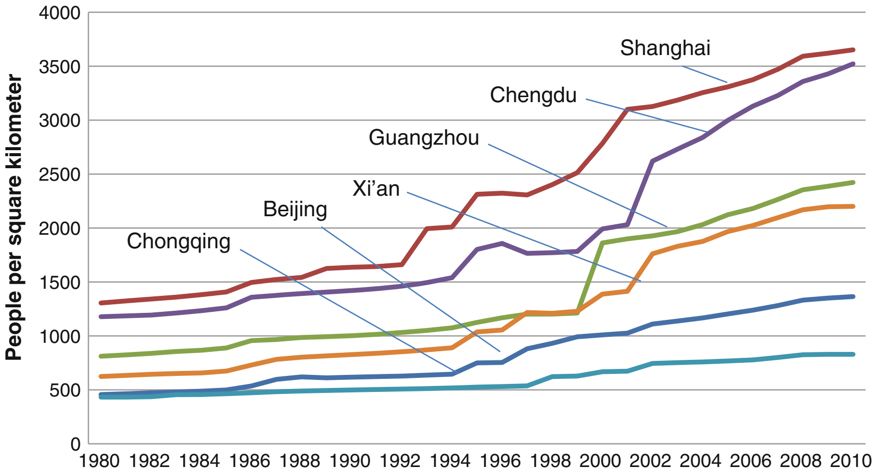

Fig. 2.21 Urban population density (China)

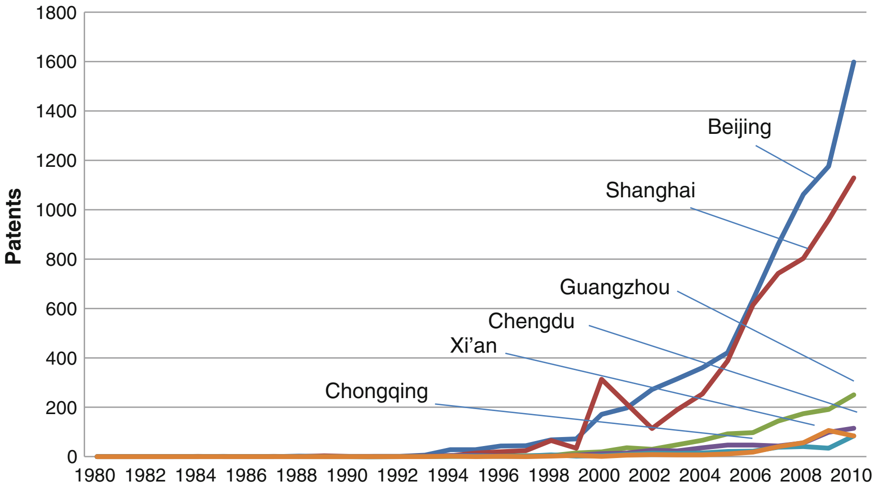

Fig. 2.22 International patents (China)

increases to population density and international patents. Mumbai and Bangalore in India have had rapid increases in patent volume, but the agglomeration of output has been relatively slow. This at first seems to be an exception, but if we analyze the Indian reality, we see that the problem is that India's population agglomeration and capital agglomeration are disjointed. Although large numbers of people have gathered in cities, because there has been a lack of corresponding agglomeration of production capital, there has been no effective agglomeration of labor, and thus no agglomeration of output. Among the six Chinese cities in our survey, the situation in Beijing and Shanghai is similar to that in Hong Kong and Singapore. But Beijing does relatively poorly in agglomeration of labor and production capital, and therefore produces less corresponding agglomeration of output than Shanghai. The other four cities including Chengdu are very much in the first historical stage of agglomeration, that is, mainly relying on the agglomeration of labor and production capital to promote the agglomeration of output.

Analyzing these data and comparing Hong Kong, Singapore, Beijing, and Shanghai, we can see that if Chengdu is to become world city, it can no longer follow the two-stage path of American and European cities. It must transform the two stages into two aspects, allowing the agglomeration of labor and production capital and technology and R&D capital to jointly promote the agglomeration of urban output in order to continuously enhance the city's competitiveness.

2.2.4 Analyzing Current Agglomeration in Representative Cities

The current agglomeration of each representative city is shown in Fig. 2.23. The output agglomeration of Indian and Chinese representative cities is still far lower than European and American representative cities and advanced Asian cities. In terms of labor concentration, as Fig. 2.24 shows, Mumbai and Bangalore's population densities are higher or equivalent to various advanced cities, but considering the special situation of lower concentrations of production capital in Indian cities,

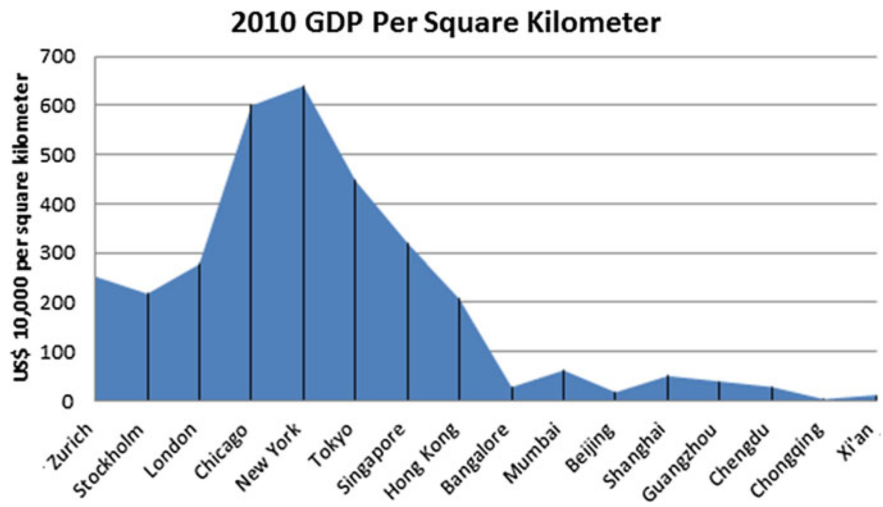

Fig. 2.23 2010 GDP per square kilometer in various cities [Zurich, Stockholm, London, Chicago, New York, Tokyo, Singapore, Hong Kong, Bangalore, Mumbai, Beijing, Shanghai, Guangzhou, Chengdu, Chongqing, Xi'an]

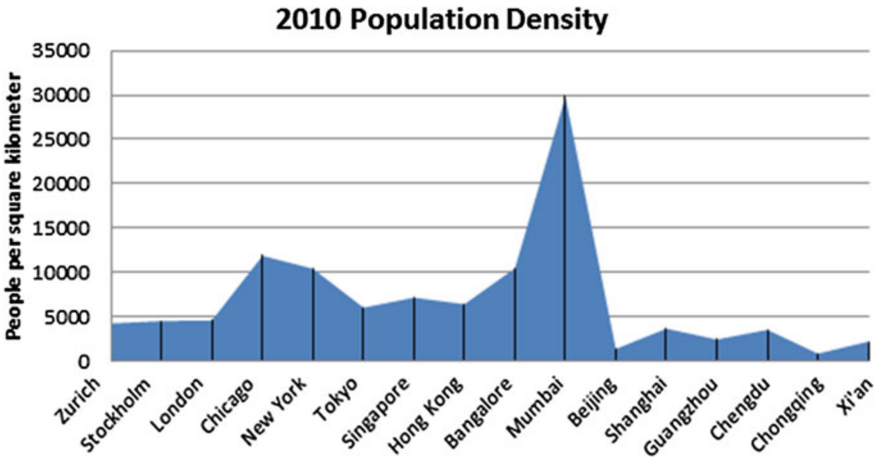

Fig. 2.24 2010 population density [Zurich, Stockholm, London, Chicago, New York, Tokyo, Singapore, Hong Kong, Bangalore, Mumbai, Beijing, Shanghai, Guangzhou, Chengdu, Chongqing, Xi'an]

Mumbai and Bangalore's effective labor concentrations are actually far lower than their population concentrations. The population density of Chinese cities is far lower. As Fig. 2.25 shows, with the exception of slightly higher international patent volumes in Beijing and Shanghai, Mumbai, Bangalore, Guangzhou, Chengdu, Chongqing, and Xi'an are significantly lower than other advanced cities. We can see that labor and technology agglomeration in representative cities of emerging still lags well behind those of advanced countries overall. Further improving all aspects of agglomeration is still the fundamental approach for these cities to develop further and move toward becoming world cities.

2.2.5 Comprehensive Analysis: A Horizontal Comparison of Chengdu's Agglomeration

In summary, through a study of the past and present agglomeration situations of sixteen representative cities around the world, we found that from a historical point of view, European and American cities and Tokyo have moved in two successive stages toward becoming world cities, with the first stage being driven by agglomeration of labor and capital and the second stage being driven mainly be technology and R&D agglomeration. However, Hong Kong, Singapore, Beijing, and Shanghai's agglomeration processes have mainly been jointly driven by these two types of forces. We can see that in the current context, a city can no longer take the old successive-stage road toward becoming a world city, but must carry out the two stages simultaneously, focusing on improving the concentration of labor,

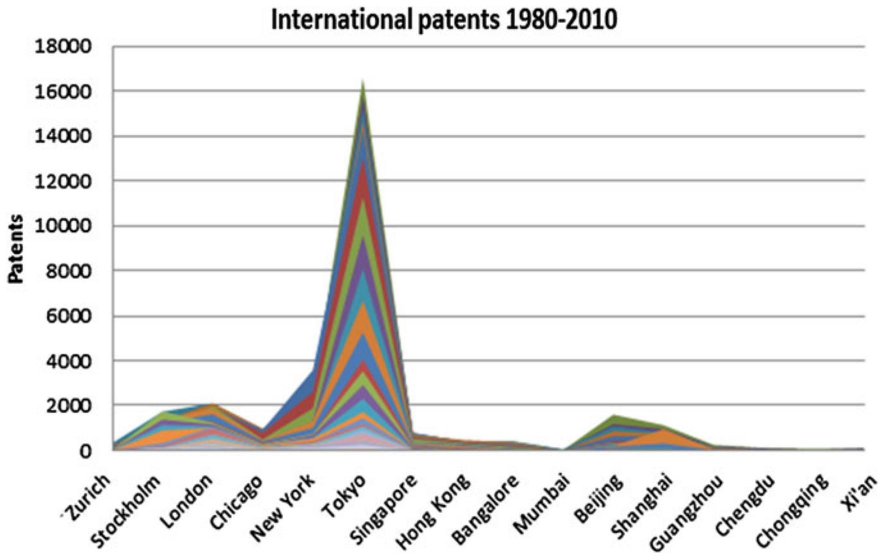

Fig. 2.25 International patent volumes 1980-2010 [Zurich, Stockholm, London, Chicago, New York, Tokyo, Singapore, Hong Kong, Bangalore, Mumbai, Beijing, Shanghai, Guangzhou, Chengdu, Chongqing, Xi'an]

production capital, technology, and R&D capital. Looking at the present situation, Chinese cities are far behind the world's advanced cities in terms of both output agglomeration and factor agglomeration and need to further enhance both.

Based on the above analysis, considering Chengdu from the perspective of agglomeration, we can find that from a historical perspective, among the six Chinese cities, Chengdu's rate of output agglomeration has been behind only Shanghai and Guangzhou. In terms of agglomeration of labor and production capital, it has been second only to Shanghai. In terms of agglomeration of technology and R&D capital, it has been slower than Beijing, Shanghai, and Guangzhou but quicker than Chongqing and Xi'an. Looking at the current situation, Chengdu's degree of output agglomeration is behind only Shanghai and Guangzhou. In terms of agglomeration of labor and production capital, it is second only to Shanghai. In terms of agglomeration of technology and R&D capital, it is behind Beijing, Shanghai, and Guangzhou, but ahead of Chongqing and Xi'an. Thus, combining both space and time, Chengdu has the power to become a center city for western China. Especially in terms of agglomeration of labor and production capital, the city exhibits a high degree of competitiveness. But to become a world city, Chengdu's achievements in time and space must both be higher. Although the city is doing well in existing output agglomeration and other aspects, there is still a large gap with Tier I cities in terms of the volume of increase in higher-level agglomeration of technology and R&D capital. Thus, Chengdu still has a long way to go on the road to becoming a world city.

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