**Table 1: Main sources of data studied in this paper**

|  |  |  |
| --- | --- | --- |
| **Data type** | **Data source** | **Value determination method and unit of data** |
| 1. Commuting time by highway | Checking the map of Gaode, which is expressed by the point-to-point traffic time of the city government office | Minutes |
| 1. commuting time by railway | Consulting the website of China Railway Customer Service Center | Minutes |
| 1. Commuting time by water | Checking the official website of Yangtze River Transportation | Minutes |
| 1. Economic, social, and demographic data of cities | The 2021 *China City Statistical Yearbook*, and the statistical yearbooks of the provinces or autonomous regions | GDP: RMB 100 million yuan; Population: 10 thousand people |
| 1. Transfer experience of mayors, deputy mayors, and secretaries of municipal CPC party committees among cities in the river basin\* | Information of officials from the official websites of China’s national and provincial governments, People’s Daily Online, Xinhua Net, and local chronicles of cities | With transfer experience = 1; Without transfer experience = 0 |

Note: \* Data for further analysis. The secretary of a municipal CPC party committee is the highest leader of the Communist Party of China in the city, and his/her power is generally greater than that of the mayor.

**Table 2: TOP 60 (ranked by F1) of inter-city connection intensity in the Yangtze River Economic Belt**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Direction of Connection** | **F1** | **F1 Ranking** | **Direction of Connection** | **F2** | **F2 Ranking** | **F1/F2** |
| Shanghai-Suzhou | 2.09% | 1 | Suzhou-Shanghai | 1.81% | 1 | 1.15 |
| Chongqing-Chengdu | 1.34% | 2 | Chengdu-Chongqing | 1.09% | 2 | 1.24 |
| Nanjing-Shanghai | 0.99% | 3 | Shanghai-Nanjing | 0.89% | 3 | 1.11 |
| Shanghai-Wuxi | 0.96% | 4 | Wuxi-Shanghai | 0.88% | 4 | 1.09 |
| Wuxi-Suzhou | 0.95% | 5 | Suzhou-Wuxi | 0.81% | 5 | 1.16 |
| Shanghai-Changzhou | 0.78% | 6 | Changzhou-Shanghai | 0.70% | 6 | 1.11 |
| Shanghai-Nantong | 0.62% | 7 | Nantong-Shanghai | 0.61% | 7 | 1.02 |
| Meishan-Chengdu | 0.58% | 8 | Chengdu-Meishan | 0.47% | 10 | 1.24 |
| Deyang-Chengdu | 0.57% | 9 | Chengdu-Deyang | 0.48% | 9 | 1.20 |
| Hefei-Shanghai | 0.55% | 10 | Shanghai-Hefei | 0.51% | 8 | 1.08 |
| Huanggang-Wuhan | 0.47% | 11 | Wuhan-Huanggang | 0.35% | 13 | 1.34 |
| Chengdu-Mianyang | 0.39% | 12 | Mianyang-Chengdu | 0.38% | 11 | 1.02 |
| Suzhou-Nantong | 0.37% | 13 | Nantong-Suzhou | 0.36% | 12 | 1.02 |
| Changzhou-Suzhou | 0.37% | 14 | Suzhou-Changzhou | 0.33% | 14 | 1.10 |
| Ziyang-Chengdu | 0.33% | 15 | Chengdu-Ziyang | 0.27% | 17 | 1.22 |
| Chongqing-Nanchong | 0.31% | 16 | Nanchong-Chongqing | 0.26% | 18 | 1.18 |
| Wuhan-Xiaogan | 0.31% | 17 | Xiaogan-Wuhan | 0.31% | 15 | 1.00 |
| Nanjing-Suzhou | 0.30% | 18 | Suzhou-Nanjing | 0.15% | 50 | 2.03 |
| Leshan-Chengdu | 0.30% | 19 | Chengdu-Leshan | 0.24% | 20 | 1.22 |
| Chongqing-Guangan | 0.28% | 20 | Guangan-Chongqing | 0.27% | 16 | 1.02 |
| Chongqing-Luzhou | 0.27% | 21 | Luzhou-Chongqing | 0.26% | 19 | 1.06 |
| Nanjing-Hefei | 0.27% | 22 | Hefei-Nanjing | 0.18% | 32 | 1.49 |
| Shanghai-Zhenjiang | 0.26% | 23 | Zhenjiang-Shanghai | 0.22% | 23 | 1.17 |
| Shanghai-Wuhan | 0.25% | 24 | Wuhan-Shanghai | 0.24% | 21 | 1.05 |
| Wuxi-Changzhou | 0.25% | 25 | Changzhou-Wuxi | 0.22% | 24 | 1.13 |
| Wuxi-Nantong | 0.24% | 26 | Nantong-Wuxi | 0.21% | 25 | 1.11 |
| Wuhan-Hefei | 0.24% | 27 | Hefei-Wuhan | 0.22% | 22 | 1.07 |
| Changzhou-Nanjing | 0.22% | 28 | Nanjing-Changzhou | 0.20% | 27 | 1.10 |
| Shanghai-Chuzhou | 0.22% | 29 | Chuzhou-Shanghai | 0.21% | 26 | 1.04 |
| Chengdu-Neijiang | 0.21% | 30 | Neijiang-Chengdu | 0.17% | 37 | 1.22 |
| Chongqing-Dazhou | 0.21% | 31 | Dazhou-Chongqing | 0.20% | 29 | 1.08 |
| Yuxi-Kunming | 0.21% | 32 | Kunming-Yuxi | 0.20% | 28 | 1.03 |
| Shanghai-Taizhou | 0.20% | 33 | Taizhou-Shanghai | 0.16% | 45 | 1.28 |
| Chengdu-Yibin | 0.20% | 34 | Yibin-Chengdu | 0.18% | 33 | 1.09 |
| Chongqing-Suining | 0.19% | 35 | Suining-Chongqing | 0.17% | 38 | 1.13 |
| Nanjing-Wuhu | 0.19% | 36 | Wuhu-Nanjing | 0.19% | 31 | 1.02 |
| Liuan-Hefei | 0.19% | 37 | Hefei-Liuan | 0.12% | 55 | 1.56 |
| Yancheng-Shanghai | 0.19% | 38 | Shanghai-Yancheng | 0.19% | 30 | 1.00 |
| Chongqing-Neijiang | 0.19% | 39 | Neijiang-Chongqing | 0.16% | 40 | 1.15 |
| Mianyang-Deyang | 0.18% | 40 | Deyang-Mianyang | 0.15% | 49 | 1.22 |
| Wuhu-Hefei | 0.18% | 41 | Hefei-Wuhu | 0.18% | 34 | 1.04 |
| Qujing-Kunming | 0.18% | 42 | Kunming-Qujing | 0.18% | 35 | 1.02 |
| Shanghai-Xuzhou | 0.18% | 43 | Xuzhou-Shanghai | 0.16% | 44 | 1.12 |
| Zhenjiang-Yangzhou | 0.18% | 44 | Yangzhou-Zhenjiang | 0.15% | 48 | 1.16 |
| Chengdu-Nanchong | 0.17% | 45 | Nanchong-Chengdu | 0.17% | 36 | 1.00 |
| Shanghai-Yangzhou | 0.17% | 46 | Yangzhou-Shanghai | 0.17% | 39 | 1.03 |
| Nanjing-Wuxi | 0.17% | 47 | Wuxi-Nanjing | 0.15% | 46 | 1.10 |
| Shanghai-Wuhu | 0.16% | 48 | Wuhu-Shanghai | 0.11% | 57 | 1.56 |
| Nanjing-Chuzhou | 0.16% | 49 | Chuzhou-Nanjing' | 0.09% | 58 | 1.86 |
| Wuhan-Huangshi | 0.16% | 50 | Huangshi-Wuhan | 0.16% | 42 | 1.02 |
| Yangzhou-Nanjing | 0.16% | 51 | Yangzhou-Nanjing | 0.16% | 43 | 1.02 |
| Ezhou-Huanggang | 0.16% | 52 | Huanggang-Ezhou | 0.16% | 41 | 1.00 |
| Suzhou-Hefei | 0.16% | 53 | Hefei-Suzhou | 0.15% | 51 | 1.08 |
| Shanghai-Bengbu | 0.16% | 54 | Bengbu-Shanghai | 0.12% | 56 | 1.35 |
| Chongqing-Yibin | 0.15% | 55 | Yibin-Chongqing | 0.14% | 53 | 1.12 |
| Hefei-Huainan | 0.15% | 56 | Huainan-Hefei | 0.15% | 47 | 1.00 |
| Chuzhou-Hefei | 0.15% | 57 | Hefei-Chuzhou | 0.14% | 52 | 1.05 |
| Nanchang-Shanghai | 0.15% | 58 | Shanghai-Nanchang | 0.05% | 59 | 3.17 |
| Wuhan-Xianning | 0.15% | 59 | Xianning-Wuhan | 0.02% | 60 | 9.66 |
| Suining-Chengdu | 0.14% | 60 | Chengdu-Suining | 0.14% | 54 | 1.07 |

**Table 3: Average values of city network indexes and city development indexes of the Yangtze River Economic Belt and its sub-regions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Subregion** | **Network density（%）** | **Outward Degree Centrality（%）** | **Inward Degree Centrality（%）** | **Outward Closeness Centrality（%）** | **Inward Closeness Centrality（%）** | **Betweenness Centrality（%）** | **2021**  **Urbanization rate（%）** | **2021**  **Average GDP (100 million yuan RMB)** |
| **Overall Yangtze River Economic Belt** | **70.67** | **20.8** | **31.3** | **36.7** | **37.6** | **9.78** | **69.78** | **4459.84** |
| Chengdu basin | 75.5 | 90 | 94 | 14.27 | 14.27 | 168.52 | 72.37 | 6075.33 |
| Chongqing urban Agglomeration | 74.5 | 95 | 95 | 14.29 | 14.29 | 262.52 | 73.49 | 6321.62 |
| Wuhan Urban Agglomeration | 75.3 | 93 | 93 | 14.25 | 14.25 | 53.44 | 71.25 | 6435.59 |
| Hefei Urban Agglomeration | 76.5 | 92 | 92 | 14.23 | 14.23 | 38.90 | 73.21 | 4450.27 |
| Nanjing Urban Agglomeration | 80.5 | 89 | 88 | 14.15 | 14.17 | 15.13 | 77.16 | 6457.49 |
| Shanghai Urban Agglomeration | 82.6 | 93 | 93 | 14.25 | 14.25 | 74.27 | 86.54 | 8897.55 |
| Kunming Urban Agglomeration | 66.6 | 93 | 93 | 14.25 | 14.25 | 53.43 | 69.29 | 2832.24 |
| Changsha Urban Agglomeration | 68.8 | 93 | 92 | 14.23 | 14.23 | 45.65 | 70.23 | 3043.13 |
| Nanchang Urban Agglomeration | 65.4 | 93 | 91 | 14.21 | 14.25 | 40.12 | 71.39 | 2714.93 |

**Table 4: Analysis of cohesive subgroups of city networks in the Yangtze River Economic Belt**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Region** | **The 2nd Class Subgroup** | | **The 3rd Class Subgroup** | |
| **Location of Region** | **Provinces Involved** | **Area Name** | **Cities Involved** |
| The Yangtze River Basin | Northwest bank of middle reaches | Upstream Yangtze River Delta Urban Agglomerations | Sichuan,Xizang,Qinghai Adjoining District Urban Agglomeration | Xining, Luzhou, Ali, Huaihua, Zhangjiajie, Linzhi, Guangan, Dazhou, Nanchong; |
| Sichuan,Chongqing,and Eastern Xizang Urban Agglomeration | Zhaotong, Ziyang, Zigong, Leshan, Meishan, Deyang, Changdu, Suining, Neijiang, Panzhihua, Bazhong ,Yibin, Guangyuan, Mianyang, Yaan, Chengdu, Chongqing; |
| Middle and upper reaches | Yunnan, Western Xizang, and part of Qinghai | Western Xizang-Qinghai Urban Agglomeration | Rikaze, Shannan, Haidong, Naqu, Lasa; |
| Yunnan Urban Agglomeration | Qujing, Puer, Baoshan, Lincang, Yuxi, Kunming, Lijiang; |
| East bank of middle reaches | Part of Triangle of Central China | Hubei Adjoining District Urban Agglomeration | Xiangyang, Jingzhou, Yichang, Shiyan, Xiaogan, Huangshi, Ezhou, Huanggang, Xianning, Suizhou, Wuhan, Jingmen, Jiujiang, Yueyang; |
| Hunan- Southwest Jiangxi Urban Agglomeration | Hengyang, Shaoyang, Changde, Zhuzhou, Yiyang, Loudi, Yongzhou, Changsha, Nanchang, Xiangtan, Pingxiang, Fuzhou, Yichun, Jian, Ganzhou, Xinyu; |
| Lower reaches | Part of Yangtze River Delta Urban Agglomerations | Anhui- Northeast Jiangxi Urban Agglomeration | Jingdezhen, Shangrao, Yingtan, Hefei, Wuhu, Bengbu, Huainan, Maanshan, Huaibei, Tongling, Anqing, Huangshan, Fuyang, Suzhou, Chuzhou, Liuan, Xuancheng, Chizhou, Haozhou; |
| Jiangsu-Shanghai Urban Agglomeration | Nanjing, Wuxi, Xuzhou, Changzhou, Suzhou, Nantong, Lianyungang, Huaian, Yancheng, Yangzhou, Zhenjiang, Taizhou, Suqian, Shanghai; |