Research on Comprehensive Evaluation of the Business Environment in Wuhan Based on Factor Analysis

Jianwen Zhan[1], Yuanning Hu[2]
[1]zhanjianwen1@outlook.com, [2]906709264@qq.com

School of management, Wuhan University of Technology, Wuhan, China

Abstract—The COVID-19 epidemic has seriously damaged the business environment in various regions. In order to study the current business environment situation, the article uses the domestic and international business environment evaluation index system for reference, and establishes a factor analysis model to analyze the business environment of 28 provincial capitals before and after the epidemic from the four dimensions of investment, trade, production and management, and talent development. The KMO test of statistical data is above 0.8, and the final interpretation rate of extracting three factors is above 0.8. Based on this, the scores and rankings of cities are calculated. The conclusion shows that the main factors of the business environment in each city are particularly affected by the epidemic situation, and the international trade environment has also undergone tremendous changes. In addition, the cities with the higher comprehensive scores have a stronger ability to resist the impact of the epidemic. Wuhan ranks forefront in the overall level of the business environment in China, but it still lags far behind Beijing, Shanghai, and other economically developed cities, and its shortcomings in the business relations are magnified. According to the research conclusions and the current situation, this article puts forward some suggestions on optimizing the business environment.

Keywords- Business environment; COVID-19 epidemic; Comprehensive competitiveness; Factor analysis

1 INTRODUCTION

Since the Fifth Plenary Session of the 18th CPC Central Committee put forward the requirement of "Perfecting the business environment with the rule of law, internationalization and convenience", governments at all levels have put forward many reform measures to optimize the business environment. In November 2018, the State Council issued "Notice on focusing on corporate concerns to further promote the implementation of the business environment optimization policies", so as to further expand the introduction of the foreign investment and promote facilitation of trade. In October 2019, the State Council issued "Regulations on Optimizing the Business Environment", which clarified the principles of improving the business environment and made corresponding provisions in four aspects from the perspective of improving the mechanism. At the regional level, the business environment

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among cities is still unbalanced, and the gap between regions is obvious, showing the best spatial distribution in the eastern region, the rapid development in the central and western region and the relatively backward spatial distribution in the northeast region[1]. Local governments have introduced corresponding optimization measures according to regional characteristics. Within five years, the Shanghai Government has launched four plans to optimize the business environment, aiming at four key points, namely, breakthrough in the key points, overall upgrading, institutional innovation and expanding coverage. In 2018, Hubei Provincial Government issued "Several Opinions on Further Optimizing Business Environment", which put forward specific implementation measures from the aspects of market opening, investment guarantee and property rights protection. However, the epidemic caused the change of economic structure, and the business environment of each city has been affected to varying degrees. The epidemic situation has led to the interruption of supply chain production, the rising price of demand chain, and the intensification of the enterprise chain competition. The resulting industrial chain effect has seriously affected economic development[2]. On the industrial level, the epidemic has the greatest impact on consumption-oriented and labor-intensive industries[3], the traditional consumption path shrinking and the Internet industry growing. At the level of enterprise scale, the small and medium-sized enterprises, which are the focus of the business environment, are most affected, the risk of financial fragility is more obvious, and problems such as the financing difficulties and the cash flow shortage are highlighted[4]. Taking Wuhan, which is most affected by the epidemic, as an example, Wuhan's GDP dropped by 4.7% year-on-year in 2020, which is the only city with the negative GDP growth among all provincial capitals. Therefore, how to restore the economy efficiently and improve the business environment is a major focus of urban development in the post-epidemic period. Combining with the current market economy situation and the influence of epidemic situation, this paper analyzes the opportunities and challenges of Wuhan's business environment development at the present stage, which has a strong practical guiding significance for serving the recovery of Wuhan's economic level and improving regional competitiveness.

2 LITERATURE REVIEW

2.1 Research on the scope of the business environment

The essence of the business environment is mainly reflected in the influencing factors related to the business environment. The research scope in this area is relatively wide, and the research results of different scholars are quite different. Civelek (2016)[5] focused on the analysis of the relationship between factors and the impact on the business environment, and held that the quality of the business environment is determined by the state, society and financial markets. Zhang (2017)[6] classified the business environment as an objective condition restricting the investment behavior, and combined with the investment situation, divided the composition of the business environment into seven aspects. Some studies focus on the impact of the business environment on taxation, transnational investment, science and technology, etc. Sun (2018)[7] pointed out that the modernization of tax service is an inevitable choice to optimize the tax business environment. Farok J(2020)[8] emphasized that countries with a stronger contract enforcement and more efficient international trade regulations attract more foreign direct

investment. Yishao(2020)[9] thought that the rise and development of the new business forms relying on the information technology depends on the innovation and optimization of the business environment.

2.2 Research on the Index System of the Business Environment

Since 1979, the World Economic Forum has published the Global Competitiveness Report every year, which is the earliest report on the business environment evaluation system. The report comprehensively evaluates and ranks countries with 12 competitiveness factors such as system, infrastructure and macroeconomic stability. Many scholars have targeted the evaluation system according to the characteristics of the study area. For example, Korner (2002)[10] proposed to measure the business environment of the incorruption index, the comprehensive governance index, the transparency index and the corporate governance risk index as the framework in measuring the business environment in Central Europe. In 2015, Guangdong Asia-Pacific Institute of Innovation and Economics built an index system with the internationalization, the rule of law and the marketization as the first-level indicators, and 48 second-level indicators such as the openness of foreign trade and economic cooperation as the quantitative standards.

Some scholars give their own views on the localization application of the business environment evaluation system in China. Li (2018)[11] thought that China lacks the quantitative empirical research on the evaluation system, and pointed out that the research on big cities should be taken as a sample of the business environment reform in other cities. Some scholars designed an index system that is more in line with China's national conditions in combination with policies. Zhang (2020)[12] took the market, government affairs, legal policies and humanities as the first-level indicators based on the outline of the 13th Five-Year Plan, and determines the second-level indicators and weights according to "the Regulations on Optimizing the Business Environment". Li (2021)[13] constructed an evaluation system of China's urban business environment from seven dimensions, including public service, market, rule of law, government affairs and innovation. It can be seen from the above research changes that the emphasis of the business environment evaluation system changes with the characteristics of different periods and regions, and the research on central cities can be used as a reference template for other cities.

2.3 Research on the Practice of the Business Environment

The foreign studies on the practical role of the business environment mainly focus on the related performance of enterprises. Sai S (2020)[14] thought that the ever-changing business environment will require enterprises to adopt different business evaluation driving methods. Liu (2021)[15] pointed out that the overall score of the business environment has a significant positive impact on the economic development. Mehdi (2021)[16] emphasized the positive relationship between the business environment, the competitiveness, the entrepreneurship and the financial performance.

The accumulated experience of policy exploration in improving the business environment in China provides a good practical basis for the related research. Dong (2012)[17] has studied the business environment experience in 30 cities, and found that the soft business environment still

has a significant impact on the economic development when the potential influencing factors are controlled. Song (2018)[18] analyzes the problems in the construction of the business environment in China, and puts forward improvement strategies for government affairs, rule of law, market and internationalization. Research by Hu (2021)[19] shows that China comprehensively applies three different business environment policy tools, among which environmental policy tools are the main means to optimize the business environment.

To sum up, scholars at home and abroad have made an in-depth research on the business environment from the different angles and established a relatively perfect evaluation system. However, the COVID-19 epidemic magnified the existing international contradictions, destroyed the living environment of domestic SMEs, and affected the economy in all directions[20], which led to significant changes in the business environment in various regions. The previous index system could not accurately evaluate the current situation, so adaptively changing the focus of the business environment evaluation will become a direction to expand the research system after the epidemic. In addition, the research on the business environment in central city will also point out the direction for further optimizing the business environment in various places.

3 MODEL ESTABLISHMENT

3.1 Evaluation system

3.1.1 Evaluating indicators

The selected indicators mainly refer to the "China‘s Urban Business Environment Index Report 2019 " of China Strategic Culture Promotion Association, and learn from the research of Tang (2020)[21] and Xu (2020)[22] on how the epidemic affects the economy, summarizing the four aspects that are seriously affected, and finally selecting 4 first-level indicators and 12 second-level indicators of investment environment, trade environment, production and operation environment and talent development environment.

Among them, the investment environment measures the financing situation of enterprises from the perspective of the investment activities, selects the scale of fiscal revenue as the macro-economic environment of investment, and the accessibility of funds as the micro-market environment. The trade environment selects the number of state-level economic development zones and the actual use of foreign capital to analyze the degree of regional internationalization from the perspective of opening up to the outside world. The production and operation environment selects the industrial structure and the number of patent authorizations, aiming at analyzing the overall industrial development and innovation level of the region. Talent development environment mainly measures regional talent training and labor security from average salary, general talents, consumer price level, car ownership, contract completeness and infrastructure. Specific indicators are shown in TABLE 1.:

TABLE 1. EVALUATION SYSTEM IN PROVINCIAL CAPITAL CITIES

Primary index	Secondary index	Indicator description	
Investment environment	Scale of fiscal revenue	X1	1.Ratio of fiscal revenue to GDP in the same period (%)
	Availability of funds	X2	2.Local and foreign currency deposits of financial institutions (100 million yuan)
trade environment	State-level economic development zone	X3	3.Number of state-level economic development zones(single)
	Foreign investment in actual use	X4	4.The actual amount of foreign capital utilized in the whole year(USD 100 million)
Production and operation environment	Industrial structure	X5	5.The ratio of tertiary industry to industrial structures (%)
	Number of patents granted	X6	6.Annual number of patents granted in the region(single)
Talent development environment	Average salary	X7	7.Regional average annual salary (yuan)
	General talents	X8	8.Number of colleges and universities (single)
	Consumer price level	X9	9.Consumer Price Index (%)
	Car ownership	X10	10.Number of cars owned by the region (10,000 units)
	Completeness of contract	X11	11.Number of working people who purchasing medical insurance (10,000 people)
	Infrastructure	X12	12.Number of museums and public libraries(single)

3.1.2 Data sources and descriptions

Data mainly come from statistical yearbooks and statistical bulletins of provincial capitals, China regional economic database in EPS global statistical data, and China city database. The data used are 650 statistical data of 31 provincial capitals in 2019 and 2020. Due to the untimely publication of the statistical data of some cities and the unavailability of some attributes of some data, there are some missing values in the statistical data. The research mainly adopts the methods of mean interpolation, and excludes Xining, Nanning and Lhasa, which have too many missing data, and actually adopts the data of 28 provincial capitals.

3.2 Evaluation methods

3.2.1 Feasibility tests

Use SPSS25.0 to test the applicability of the factor analysis on statistical data. The results show that the KMO test values of two years are all greater than 0.8. Three factors were extracted

from 12 indicators in 2019 and 2020, and the cumulative variance interpretation rates were 80.114% and 81.770%. Specific indicators are shown in TABLE 2.:

TABLE 2. THE KMO TEST AND THE BARTLETT'S TEST OF SPHERICITY

Related parameters		2019	2020
KMO measure of sampling adequacy		0.835	0.83
Bartlett's test of sphericity	*Approximate chi-square*	332.557	332.557
	df	66	66
	Sig	0	0

3.2.2 Factor analysis and score calculation

It can be seen from TABLE 3that, the first principal component includes capital accessibility, the number of state-level economic development zones, the actual use of foreign capital, the number of patent grants, the general talents, the car ownership, the contract completeness and the infrastructure, covering four dimensions with high correlation with business operations in 2019, named as industrial management factor. The second component includes the industrial structure and the average salary, covering the production and the operation environment and talent development environment, measuring the relationship between enterprises and talents, named as business relationship factor. The third component includes the scale of fiscal revenue and the level of consumer price, which mainly reflects the macroeconomic situation, named as macroeconomic factor. Compared with 2019, the impact of the number of national economic development zones in the first principal component decreased in 2020. The second principal component includes the fiscal revenue scale, the consumer price level and the industrial structure, which is consistent with the connotation of the third principal component in 2019. The third principal component in 2020 is mainly influenced by the number of the national economic development zones, which is named as trade opening factor.

TABLE 3. FACTOR LOAD MATRIX AFTER ROTATION IN 2019 AND 2020

Evaluating indicators	2019			2020		
X1(%)	F1	F2	F3	F1	F2	F3
X2(100 million yuan)	0.306	0.462	0.653	0.163	0.853	0.145
X3(single)	0.748	0.59	0.202	0.882	0.396	0.031
X4(USD 100 million)	0.619	-0.18	0.47	0.382	0.174	0.835
X5(%)	0.853	0.304	-0.014	0.847	0.195	0.284
X6(single)	0.071	0.897	0.06	0.422	0.637	-0.405
X7(yuan)	0.829	0.419	0.039	0.919	0.136	0.103
X8(single)	0.615	0.674	0.126	0.785	0.463	-0.115
X9(%)	0.864	0.113	-0.245	0.856	-0.275	0.145

X10(10000 units)	0.156	-0.05	-0.795	0.189	-0.808	-0.121
X11(10000 people)	0.897	0.101	-0.019	0.808	-0.125	0.166
X12(single)	0.809	0.502	0.201	0.906	0.327	0.148

3.2.3 Comprehensive evaluation results

According to the results in Table 3, the scores of provincial capitals in 2019 and 2020 are calculated, and the factors weights directly adopt the ratio of each factor to the cumulative variance contribution rate of all factors. The results are as follows:

TABLE 4. THE BUSINESS ENVIRONMENT FACTOR SCORES AND COMPREHENSIVE SCORES OF 28 PROVINCIAL CAPITAL

City	2019					2020				
	Industrial management	***Business relationship***	***Macroeconomic***	***Score***	***Rank***	***Industrial management***	***Macro economic***	***Trade opening***	***Score***	***Rank***
Beijing	1.93	3.10	0.47	2.00	1	2.74	2.35	-1.51	2.08	1
Shanghai	1.97	1.21	2.09	1.80	2	1.32	2.22	2.77	1.75	2
Chongqing	1.92	-1.81	0.14	0.70	3	1.09	-1.35	1.19	0.45	4
Tianjin	0.95	-0.96	2.00	0.63	4	-0.21	0.22	2.79	0.30	7
Guangzhou	0.93	0.64	-1.29	0.51	5	2.19	-0.88	-0.75	0.99	3
Chengdu	0.64	0.32	-0.83	0.33	6	1.21	-0.63	-0.87	0.45	5
Hangzhou	0.20	0.76	-0.23	0.27	7	0.12	0.98	0.07	0.34	6
Xian	0.82	-1.00	-0.06	0.23	8	0.41	-0.65	0.47	0.14	10
Wuhan	0.82	-0.23	-1.50	0.20	9	0.64	-0.81	0.23	0.20	8
Nanjing	0.38	0.17	-0.50	0.19	10	0.29	0.02	0.04	0.19	9
Zhengzhou	0.39	-0.41	-0.98	-0.03	11	0.23	-0.57	-0.13	-0.03	11
Changsha	0.14	-0.40	-0.91	-0.16	12	-0.10	-0.14	0.10	-0.09	12
Shenyang	-0.32	-0.57	0.86	-0.20	13	-0.52	-0.28	0.44	-0.33	17
Kunming	-0.42	-0.25	0.50	-0.24	14	0.08	-0.98	-0.77	-0.31	16
Hefei	-0.12	-0.21	-0.86	-0.26	15	-0.05	-0.55	-0.53	-0.25	14
Harbin	-0.28	-0.51	0.02	-0.29	16	-0.62	0.03	-0.06	-0.37	19
Jinan	-0.21	0.06	-1.28	-0.31	17	-0.12	-0.36	-0.50	-0.24	13

Shijiazhuang	-0.38	-0.33	-0.12	-0.32	18	-0.38	-0.12	-0.32	-0.30	15
Taiyuan	-0.57	-0.03	-0.08	-0.36	19	-0.27	-0.36	-0.65	-0.35	18
Urumqi	-1.59	1.19	1.68	-0.39	20	-1.43	1.99	-0.40	-0.38	20
Nanchang	-0.62	0.25	-0.64	-0.41	21	-0.40	-1.05	0.23	-0.49	24
Fuzhou	-0.44	-0.80	0.18	-0.43	22	-0.31	-0.72	-0.47	-0.44	21
Guiyang	-0.71	-0.16	0.06	-0.45	23	-0.57	-0.26	-0.31	-0.45	22
Changchun	-0.15	-1.44	-0.28	-0.50	24	-0.77	-0.82	0.71	-0.59	27
Yinchuan	-1.15	-0.70	1.78	-0.58	25	-1.48	0.48	0.60	-0.68	28
Lanzhou	-1.23	0.16	0.70	-0.58	26	-0.90	0.30	-0.62	-0.54	25
Huhehot	-1.05	0.07	0.20	-0.58	27	-1.02	0.26	-0.16	-0.56	26
Haikou	-1.84	1.91	-1.11	-0.78	28	-1.18	1.67	-1.60	-0.48	23

3.3 Results and analysis

3.3.1 The comprehensive analysis

It can be seen from TABLE 4. that, on the whole, Beijing and Shanghai lead other cities in comprehensive scores, while Beijing, Shanghai, Guangzhou, Tianjin, Chongqing, Chengdu, Hangzhou, Xi'an, Wuhan and Nanjing rank among the top ten in comprehensive scores for two consecutive years. As can be seen from Figure 1, most of the cities with the top scores do not change by more than one place, while most of the cities with the lower scores change greatly. On the one hand, it shows that the overall business environment in economically developed areas is better, on the other hand, it shows that cities with a good business environment have a stronger resistance to the impact of the epidemic and have obvious advantages in adapting to environmental changes and stable development.

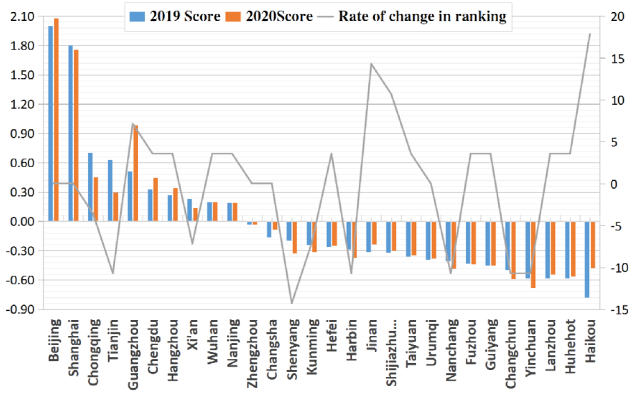

FIGURE 1. COMPREHENSIVE SCORE AND RANKING CHANGE RATE IN 2019 AND 2020

According to Figure 2, from the perspective of the industrial management factor, the comprehensive scores are basically consistent with the changes in the scores of the industrial management factor. The cities with the higher comprehensive scores have higher scores in the industrial management factor, and the industrial management factor are the most important factor for two consecutive years, indicating that this item is the key indicator affecting the business environment.

According to the change of the factor composition in TABLE 3, the third factor in 2019 changed into a secondary factor in 2020. There are two main reasons for this change. The enterprise is mainly reflected in the fact that the low rate of resumption of work leads to the decline of the commodity output, and the failure of the upstream and downstream industrial chains to resume work simultaneously enlarges the risk of cash flow break. In terms of employees, the demand for talents in small and medium-sized enterprises is reduced, and it is difficult for talents to find jobs matching them in the job market, and the problems faced by incumbents, such as being unable to arrive in time, changing income and being laid off, aggravate the change of business relationship. In addition, the epidemic situation hinders the communication between enterprises and employees, and the online communication is inefficient. The above reasons lead to a decrease in the impact of the relationship between enterprise management and talent development on the business environment.

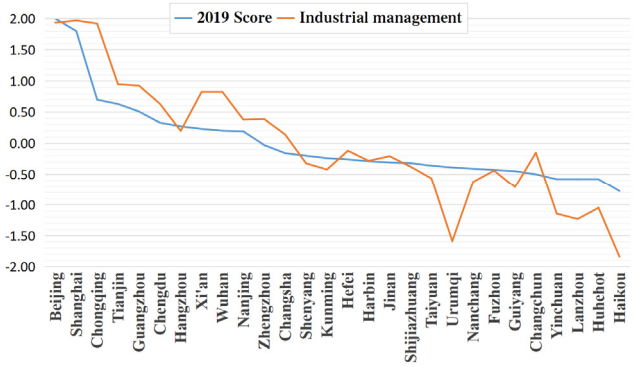

FIGURE 2. THE FIRST FACTOR SCORE AND COMPREHENSIVE SCORE IN 2019

The trade opening factor has become the main factor in 2020, which indicates that the international trade environment has changed greatly, and the degree of opening has increased the impact on the business environment, which is also in line with the situation that the world trade environment has been severely impacted under the influence of the epidemic.

3.3.2 Analysis of the Business Environment Level in Wuhan

According to TABLE 4, Wuhan's overall ranking of the business environment level has increased by one place, but its comprehensive score has not changed much, and there is still a big gap between Wuhan and other cities such as Beijing and Shanghai, and it is still in the second step of the ranking of the business environment in all cities.

TABLE 5. SCORES AND RANKINGS OF THE BUSINESS ENVIRONMENT FACTORS IN WUHAN IN 2019 AND 2020

Age	Factor	Score	Rank
2019	Industrial management	0.82	7
	Business relationship	-0.23	16
	Macroeconomic	-1.50	28
	Score	0.20	9
2020	Industrial management	0.64	6
	Macroeconomic	-0.81	23
	trade opening	0.23	8
	Score	0.20	8

According to TABLE 5, the decline of the industrial operation score indicates that many dimensions of the enterprise's direct operation environment are affected by the epidemic situation, which shows that the downward pressure on the economy increases and the attraction of talents decreases. The rising ranking shows that Wuhan has more advantages than other places after the epidemic. In addition, although the ranking of Wuhan is higher than the comprehensive ranking, there is a big gap between Wuhan and Beijing, Shanghai. As a key factor affecting the business environment, Wuhan is in the urgent need of recovery and developing steadily with reference to experience.

The increase of macroeconomic score indicates that with the support of policies and the injection of funds, Wuhan recovered well in finance, industry and people's life. However, in the past two years, Wuhan's rank of this index is lower than the average ranking of provincial capitals, and the impact of the epidemic intensified the industrial differentiation, and the service industries such as the tourism, the passenger transport and the catering were hit hard. The digital economy represented by the online distribution, the internet finance and the online education flourished during this period. Therefore, promoting the transformation of the industrial structure and improving the consumption level of residents are the potential sectors to further improve the business environment and enhance the comprehensive competitiveness.

In 2019, the ranking of business relationship factors in Wuhan is lower than the average ranking of cities, and Wuhan resumed work later than other cities, which leads to higher communication costs between enterprises and talents. Wuhan has many high-quality educational resources in colleges and universities, and the number of college students ranks in the forefront of all cities. This talent advantage has not been brought into full play due to the epidemic situation. Therefore, improving the business relationship between the enterprises and the talents is an important part of Wuhan to make up its shortcomings. Wuhan's rank of the trade factor is consistent with the comprehensive ranking, but there is a wide gap between Wuhan and the cities with the higher index, which indicates that Wuhan should attach the importance to inter-regional cooperation and promote coordinated economic development.

4 CONCLUSIONS

The epidemic has not only highlighted the advantages of development, but also exposed the shortcomings of Wuhan. The main shortcomings are the imperfect industrial structure, the weak ability of enterprises to resist risks, and the wide gap in economic openness with the leading cities. The key advantages of Wuhan in restoring economy, further improving the business environment and coordinating development in all aspects are talents, labor security and transportation. In the post-epidemic era, the global economic situation is becoming more and more changeable. Wuhan needs to make good use of this strategic opportunity, give full play to its own advantages and further improve the business environment. Specifically, we should focus on the following aspects:

4.1 Optimize the talent training system and improve the talent evaluation system

First, strengthen personnel training, improve the quality of teaching connotation in local colleges and universities, improve the basic guarantee of education, further reduce the cost of the talent team construction, establish a talent value incentive system, and improve the employment policy for the graduates. Secondly, we should carry out the classified evaluation, highlight moral evaluation based on peer evaluation, pay attention to introducing the market evaluation and the social evaluation, and give full play to the main role of multiple evaluations.

4.2 Promote industrial innovation and development and build a modern industrial system

Enterprises are the active factor in innovation and development. Accelerating the transformation and upgrading of the industrial structure and improving the efficiency of industrial system have positive effects on innovation and development. The first step of innovation and development is to improve the efficiency of government affairs to lower the market entry threshold, establish a multi-level industrial investment and financing system, and trigger market vitality and creativity. Second, taking manufacturing as the cornerstone of the industry, we will improve the independent innovation capability in the key areas, promote the integration of advanced manufacturing and service industries, and promote the innovative application of the new generation information technologies such as big data, Internet of Things and artificial intelligence in various fields.

4.3 Adhere to all-round open development and promote regional coordinated development

First, relying on the geographical advantages of the central transportation hub to strengthen the construction of shipping and regional aviation, restore and improve the international aviation network, and strengthen cooperation with border ports and coastal areas such as Inner Mongolia, Guangxi and Yunnan. Second, strengthen cooperation with the Yangtze River Economic Belt, Beijing-Tianjin-Hebei, Yangtze River Delta and other regions, enhance the level of interconnection with major ports along the "the belt and road initiative", and improve the internationalization of the business environment.

4.4 Resist the overall impact of the epidemic and scientifically judge the economic situation

On the macro level, Wuhan's demand and production level plummeted, investment, consumption and export were significantly impacted, and short-term unemployment rose and prices rose. On the micro level, enterprises are an important part of the allocation of social and economic resources, and the small and medium-sized enterprises in Wuhan are particularly affected by the epidemic. Therefore, in view of the impact of the epidemic, the first is to reduce interest rates at the macro level, increase the investment and promote the upgrading of industrial structure. Second, give financial and tax supports to enterprises, strengthen employment security, explore flexible office mechanism, and develop online and intelligent office.

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