

The impact of regional integration on the economic resilience of cities—— Take the 108 cities along the Yangtze River Economic Belt as an example

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Abstract. In the process of steady progress towards high-quality development, facing the complex changes in the internal and external environment, it is increasingly important to enhance the resilience of urban economy. Taking the Yangtze River Economic Belt as an example, this paper uses the panel data of regional integration in 108 prefecture-level cities in the Yangtze River Economic Belt from 2005 to 2020 to explore the impact of urban economic resilience. The results show that regional integration has a significant role in promoting the resilience of urban economy, and mainly by optimizing the industrial structure and improving the ability of innovation, and the role of regional integration on the promotion of urban economic resilience is heterogeneity in the upper, middle and lower reaches of the Yangtze River Economic Belt.

Keywords: economic resilience; regional integration; the Yangtze River Economic Belt.

1. Introduction

In the face of the complex situation at home and abroad, China adheres to the new security pattern to ensure the new development pattern. On the basis of economic security, enhancing economic resilience has become an important strategic task for current development. In the Proposal of the Central Committee of the Communist Party of China on the 14th Five-Year Plan for National Economic and Social Development and the Second and Third Five Long-term Plan, the construction of “Resilient Cities” is proposed for the first time, believing that building resilient cities is conducive to strengthening their risk prevention and control capacity. Urban economic resilience is an important dimension in the construction of urban resilience. Urban economic resilience refers to the ability of urban economies to respond to external pressure and return to the pre-impact level

To further promote regional integration, China has put forward regional development strategies such as the Yangtze River Economic Belt and the Yangtze River Delta. In September 2014, the State Council issued the “About relying on the golden waterway to promote the development of the Yangtze river economic belt guidance”, the deployment of the Yangtze river economic belt construction will become a global influence of inland river economic belt, the interaction and cooperation, coastal border along the river comprehensively promote internal opening to the outside world and the first demonstration zone of the construction of ecological civilization.

Accelerating regional integration is an important path to achieve the strategic goal of jointly building a secure and resilient city in the 14th Five-Year Plan, and it is also crucial to improving the resilience of the urban economy. On the one hand, regional integration can eliminate market segmentation, promote the flow of factors, optimize resource allocation, drive industrial upgrading, and enhance the ability to resist risks. On the other hand, regional integration can reduce the information asymmetry between central cities and small and medium-sized cities, give full play to the spatial spillover effect of scientific and technological achievements, and jointly enhance the economic recovery power of cities in the region (Ye Tanglin et al., 2022).

Based on the above analysis, this paper takes the Yangtze River Economic Belt as an example to explore whether regional integration can improve economic resilience. The research will explore the influence of regional integration on urban economic resilience from both theoretical and empirical perspectives.

2. Literature References

The concept of resilience (Resilience) was first proposed by Holling(1973) from an ecological perspective, and since then, physics, engineering and other disciplines have begun to focus on resilience. In recent years, the research on resilience has been extended to the field of economics. Karen and William(2010) have designed the regional economic resilience evaluation index, and Martin(2012) defines the regional economic resilience from four dimensions: resistance, recovery, renewal and adaptation. Petach et al.(2021), using data from the composition of banks in US counties, found that community banks had a significant impact on regional economic resilience during the Great Recession. Schneiberg and Parmentier(2021) studied the impact of the banking structure on economic resilience and found that the increased density of branches of large derivatives holding banks in local economies was related to the sharp rise in unemployment, the weak employment recovery and the greater impact of the recession on unemployment.

Domestic scholars take the Pearl River Delta, Yangtze River Delta and other regions, which can be roughly divided into two categories: first, the sensitivity index based on a single index, and on the other hand, (Du Zhiwei et al., 2019; Du Wenxuan et al., 2022; Zhang Yuesheng et al., 2022). In addition, many scholars have explored the spatial differences and temporal and spatial evolution characteristics of economic resilience based on the measure of economic resilience, and carried out empirical analysis. Chen Congbo and Ye Azhong(2021) calculated the economic resilience of the Yangtze River Delta region based on the GDP growth rate, built a spatial Dubin model to test the promoting effect of digital economy development on the resilience of urban economy, and found that they strengthened the resilience of urban economy mainly by improving the innovation capacity of cities. Wang Huiling et al.(2022) constructed the evaluation index system of economic resilience from three dimensions of resistance and recovery ability, adaptation and adjustment ability and innovation and evolution ability, and tested the promoting effect of collaborative agglomeration of manufacturing and producer services on regional economic resilience with the help of fixed effect model.

The concept of integration was first proposed by the Dutch economist Dingbergen, who believed that integration would eliminate the human factors that hinder the most effective movement of the economy and create the most appropriate international economic structure through mutual cooperation. In the early stage, foreign scholars mostly discussed regional integration around the economic behavior and economic effects among countries. Estrada(2013) adopts the RIE method and evaluates the regional development and integration prospects of NAFTA, ASEAN, MERCOSUR and the European Union based on the four development levels of economic, political, social and technological development. Gong and Kim(2018) examined the impact of regional and global integration and trade and financial integration on regional business cycle synchronization in three regions including developing and emerging countries. Since the regional development strategies of the Pearl River Delta Economic Zone, Pan-Pearl River Delta Economic Zone, Pan-Pearl River Delta Cooperation Zone, Yangtze River Economic Belt, and Beijing-Tianjin-Hebei Coordination have been put forward successively, domestic scholars have explored the impact of regional integration in combination with practice. Regional integration can improve the efficiency of regional economic growth by promoting the free flow of factors, promoting the optimization of industrial structure and promoting regional cooperation (Li Xuesong et al., 2017; Zhang Chao, 2021). With the deepening of the integration level, the more open innovation environment and closer enterprise cooperation have injected new vitality into the urban innovation and development, and further improved the supply chain efficiency of the city (Yan Dongsheng et al., 2022; Yuan Yinghong and Wang Pearl, 2022; Zhang Zhidong and Hu Aiyuan, 2022).

Summarize the existing literature at home and abroad, few studies focus on the impact of regional integration on economic resilience, and there is also a lack of empirical studies on the economic resilience of the Yangtze River Economic Belt. Based on this, this paper discusses the theoretical mechanism of regional integration affecting the resilience of urban economy, and based on the fixed effect model, explores the 108 cities in the Yangtze River Economic Belt.

3. Theoretical mechanism

Since the implementation of the regional integration strategy, the high-quality development level of urban economy in the Yangtze River Economic Belt has been significantly improved, and regional integration can improve the growth efficiency by promoting factor flow, structural upgrading and strengthening regional cooperation (Huang Wen and Zhang Yuyao, 2019; Sun Bowen and Sun Jiuwen, 2019). In the face of internal and external economic risks, regional integration can give full play to the comparative advantages and scale effect between regions, strengthen regional cooperation, jointly realize economic recovery, and enhance the resilience of urban economy.

Based on the above analysis, the following hypotheses are proposed:

H1: Regional integration promotes the improvement of urban resilience.

The positive effect of regional integration on urban economic resilience is mainly reflected in two aspects. On the one hand, in the impact resistance period, optimizing the industrial structure can reduce the risk of economic development instability, alleviate the impact of external risks and reduce the overall economic loss; on the other hand, in the recovery transition period, improving the innovation ability can accelerate the transformation and upgrading of enterprises and broaden the path to realize economic benefits.

(1) Starting from the industrial structure, on the one hand, regional integration is conducive to optimize the industrial structure. According to the theory of industrial gradient transfer, across 11 provinces and cities, regional gap of the Yangtze river economic belt, through complementary advantages, industrial division of labor, can both for the middle and lower regions of industrial structure upgrading, and can create opportunities for upstream industry development, to enhance the industrial chain toughness, foster advantage industry cluster. On the other hand, optimizing the industrial structure is an important factor to enhance the resilience of the urban economy. First of all, the optimization of industrial structure is conducive to the formation of diversified industrial structure, a single industrial structure is more affected due to excessive reliance on a certain industry, when the external impact, and the diversified industrial structure has different demand elasticity, different export orientation, different orientation, and different external competition risk, more spatial structure adjustment and update, so as to more adapt to and bear, and then guide it to explore faster recovery and development path (Xu Yuan and Deng Hu Yan, 2020; Chen Yiwei and Wu Weiku, 2021). Secondly, the optimization of industrial structure is conducive to the integration of regional economic and social resources, expanding the space for economic development in each region, and improving the quality of economic development in each region (Li Xuesong et al., 2017).

(2) From the perspective of innovation ability, on the one hand, regional integration helps to improve the innovation ability. With the deepening of regional integration, knowledge exchange among various industries is closer, which is conducive to reducing the cost of information and knowledge dissemination, promoting the sharing of industrial resources, and enhancing the possibility of interdisciplinary and cross-industry innovation (Liu Chengkun and Li Xinran, 2021). Has a high level, on the other hand, innovation city resource utilization rate is higher, and high innovation level city often competitive, enterprises face the impact from the market and constantly take measures to improve their toughness, so the higher innovation level of the city before the impact, its toughness compared to other cities higher (Wang Peng and Zhong Min, 2021). After the impact of urban crisis, cities with higher innovation level can more quickly through technical support to resume production and expand market, so as to solve the problem of industrial chain and sales chain collapse, and further use knowledge, find new development opportunities and ability to adapt to the external environment when facing crisis, is more likely to achieve transformation and upgrading, and even produce new externalities, new industries, drive the overall development of other industries, make the whole region shows stronger economic resilience (Xu Yuan and Zhang Linling, 2019; Guo Jiang and Xu Zeqing, 2019).

Based on the above analysis, the following hypotheses are proposed:

H2: Regional integration has enhanced the urban resilience by optimizing the industrial structure.

H3: Regional integration has enhanced urban resilience by improving innovation capacity.

4. Variable description

(1) Interpreted variable: urban economic resilience (UER). Referring to the research of Zhang Zhen et al.(2020), considering the definition of urban economic resilience, and considering the two dimensions of resistance and resilience, 10 related indicators are selected to build an evaluation index system of economic resilience to measure the level of urban economic resilience.

Before calculation, first of all, because each index has different dimensions, it cannot be compared, so the data of the index system is standardized. The calculation formula is as follows:

$$\text{For the forward indicators: } X_s = \frac{X - X_{min}}{X_{max} - X_{min}}$$

$$\text{For the negative indicators: } X_s = \frac{X_{max} - X}{X_{max} - X_{min}}$$

X_s is the standardized value of the index, X is the actual value of the index, X_{max} is the maximum value of the index, and X_{min} is the minimum value of the index.

Then, the entropy method will be used to calculate the weight. The principle of the entropy method is to use the entropy value to judge the dispersion degree of the index. The smaller the entropy value, the greater the dispersion degree of the index, the more information it can provide, and the greater the weight will be. The calculation formula is as follows:

$$p_{im} = \frac{X_{im}}{\sum_{i=1}^n X_{im}}$$

$$e_m = -k \sum_{i=1}^n p_{im} \cdot \ln p_{im}$$

$$w_m = \frac{1 - e_m}{\sum_{m=1}^{10} (1 - e_m)}$$

In this equation, X_{im} is the standardized value of the m index in the i city item, and p_{im} is the proportion of the i sample value in the index under the m th index item. $k=1/\ln(n)$, w_m is the weight of the m th index.

Finally, the score of urban economic resilience level is obtained by multiplying the standardized index data with its corresponding weights. The higher the score, the higher the resilience level of the city. The calculation formula is as follows:

$$UER_i = \sum_{m=1}^{10} X_{im} \cdot w_m$$

UER_i is the resilience level of the i city, X_{ij} is the standardized value of item m in the i city, and w_m is the weight of the m th index.

Table 1. Evaluation index system of economic resilience

Level 1 indicators	Level 2 indicators	Index interpretation	Indicator nature	Weight
Urban economic resilience	resistance	Registered urban unemployment rate	-	0.02%
		Dependency of foreign capital	-	0.31%
		Regional total factor productivity	+	7.86%
		Per capita expenditure on social security	+	21.34%
	restoring force	Per capita savings balance	+	16.69%
		gdp rate of rise	+	0.69%
		per capita gdp	+	12.23%

Loan-to-deposit ratio of financial institutions	-	0.05%
local financial expenditure	+	22.87%
Total retail sales per capita	+	17.94%

(2) Explanatory variable: the level of regional integration. In this paper, we refer to the research of Li Ge and Gao Da(2022) and measure the regional integration level with the help of gravity model. The calculation formula is as follows:

$$RI_{it} = \sum_{j=1}^{107} RI_{ijt}$$

$$RI_{ijt} = W_{ijt} \times \frac{\sqrt{P_{it} \times GDP_{it}} \times \sqrt{P_{jt} \times GDP_{jt}}}{D_{ij}^2}$$

$$W_{ijt} = \frac{GDP_{it}}{(GDP_{it} + GDP_{jt})}$$

RI_{it} is the city i in the t year and the remaining 107 cities economic belt economy, RI_{ijt} is economic ties strength between city i and city j , and P_{it} is the population of the city i and city j in t year, GDP_{it} GDP_{jt} are the GDP of the city i and city j in t year, D_{ij} is the distance between city i and city j , W_{ijt} is the weight of GDP.

(3) Control variables: Referring to the existing research results on economic resilience (Guo and Xu, 2019; Chen Yiwei and Wu, 2021), the following six control variables were selected in this paper.

① Degree of opening to the outside world (OPEN): The degree of external impact is highly likely to be affected by the fluctuations of the international market, so the higher the dependence on foreign countries, the worse the ability to resist the external impact, as measured by the ratio of the actual use of foreign capital to GDP.② Human capital (HUM): Urban human capital adaptation and adjustment stage after the impact helps to carry out innovative activities and innovative enterprise development, and constantly improve the resilience of urban economy. It is measured by the proportion of college students per 10000 people in the total population.③ Degree of government intervention (GOV): After the external impact, the government's regulation and intervention in the urban macro-economy is conducive to the reintegration of urban internal resources, accelerating the adjustment of its own structure and adaptability, and helping the recovery of the crisis industry, measured by the ratio of the government's general public budget fiscal expenditure to GDP.④ Financial development level (FIN): Efficient capital flow is an important factor to support enterprises to survive the recession period and quickly resume production after the impact. It is measured by the ratio of the total deposit and loan at the end of the city to the urban GDP at the end of the year.⑤ Entrepreneurial vitality (ENT), the higher the entrepreneurial vitality of the city, the more inclusive of new ideas, the more conducive to improve the activity of urban innovation activities, enhance the economic resilience, measured by the proportion of urban individual commercial operations in the total urban population.⑥ Transportation development level (ROAD), with the gradual deepening of economic network connection, the development of transportation infrastructure construction level, regional communication is more convenient and efficient, can unite with adjacent areas to jointly resist the impact, measured by the per capita road freight volume.

(4) Data sources

The data are mainly from China Urban Statistical Yearbook, Statistical Yearbook of China Urban Construction, China Statistical Yearbook and statistical Yearbook of various provinces and cities. Some missing data will be supplemented by interpolation method. The study selected 108 prefecture-

level cities along the Yangtze River Economic Belt from 2005 to 2020. Due to changes in chaohu City, Bijie City and Tongren City, many missing values were eliminated.

Table 2. Descriptive statistical results of the variables

Variable	Obs	Mean	Variance	Min	Max
Economic resilience UER	1728	0.125	0.067	0.03	0.689
regional election system RI	1728	0.001	0.001	0	0.015
Degree of openness to the outside world OPEN	1728	0.023	0.02	0	0.107
human capital HUM	1728	167.139	219.236	0.576	1270.424
Degree of government intervention, the GOV	1728	0.18	0.091	0.055	1.485
Financial development level FIN	1728	2.234	0.943	0.764	6.928
Entrepreneurial vitality ENT	1728	0.127	0.113	0.003	0.754
Traffic development level: ROAD	1728	0.002	0.003	0	0.063

5. The spatiotemporal evolution characteristics of economic resilience in the Yangtze River Economic Belt

Based on the basis of calculating the economic resilience of 108 cities in the Yangtze River Economic Belt from 2005 to 2020, this paper analyzes the spatial and temporal evolution characteristics of urban resilience in the Yangtze River Economic Belt with the help of ArcGIS software, as shown in Figure 1. From the perspective of spatial distribution pattern, from 2008 to 2020, the economic resilience of cities in the lower reaches of the Yangtze River Economic Belt has remained high, the economic resilience of cities in the middle reaches of the Yangtze River Economic Belt has shown an upward trend, and the economic resilience gap among cities in the Yangtze River Economic Belt has narrowed. Regional integration of the Yangtze river economic belt pay attention to the coordinated development of the upper reaches and reaches of the Yangtze river, especially in the lower reaches of the Yangtze river delta region as the Yangtze river economic belt, the radiation driving common development of the Yangtze river region, realize the free flow of capital, talent, technology, so as to promote the Yangtze river economic belt.

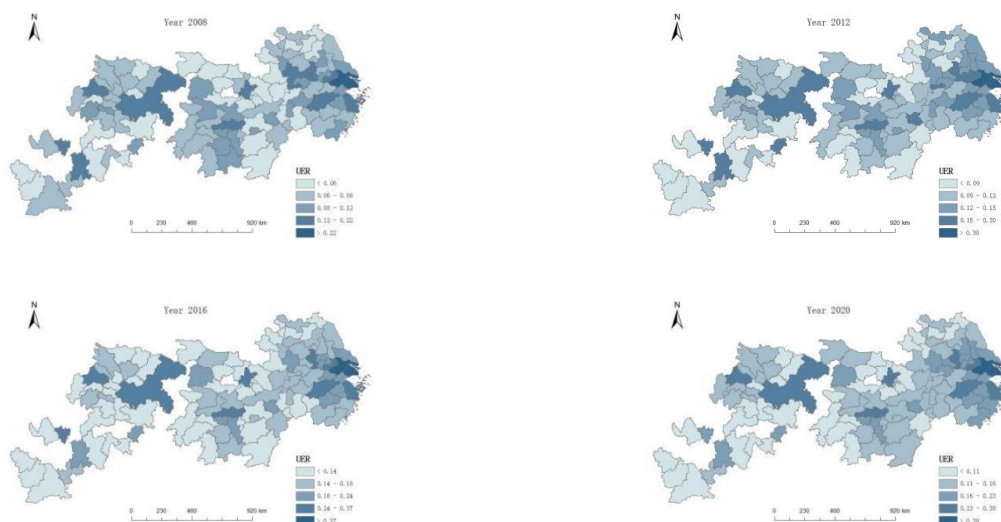


Fig. 1 Evolution of economic resilience along the Yangtze River Economic Belt (2008-2020)

Table 3. Economic resilience level of the 108 cities along the Yangtze River Economic Belt in 2020

City	Economic resilience	City	Economic resilience	City	Economic resilience
Shanghai Municipality	0.6845	the City of Suzhou	0.0842	Yiyang City	0.1165
Nanjing City	0.2931	Lu'an City	0.1134	Chenzhou City	0.1110
Wuxi City	0.2684	Bozhou city	0.0867	the City of Yongzhou	0.1089
Xuzhou Citey	0.1445	Chizhou city	0.1284	Huaihua city	0.1017
Changzhou City	0.2226	Xuancheng City	0.1339	Loudi city	0.0949
Suzhou City	0.3834	Nanchang City	0.2081	Chongqing City	0.2900
Nantong City	0.2052	Jingdezhen City	0.1549	Chengdu City	0.2350
Lianyungang City	0.1019	Pingxiang City	0.1202	Zigong City	0.1405
Huai'an City	0.1285	Jiujiang City	0.1292	Panzhuhua city	0.2028
Yancheng	0.1550	Xinyu city	0.1314	Luzhou City	0.1095
Yangzhou City	0.1603	Yingtang city	0.1400	Deyang city	0.1254
Zhenjiang City	0.1819	Ganzhou City	0.1285	Mianyang City	0.1442
Taizhou City	0.1660	Ji'an City	0.1218	Guangyuan city	0.1154
Suqian city	0.1019	Yichun City	0.1154	Suining city	0.1201
Hangzhou City	0.2918	Fuzhou City	0.1038	Neijiang City	0.1204
Ningbo City	0.2970	Shangrao City	0.1126	Leshan City	0.1226
Wenzhou City	0.1639	Wuhan City	0.2705	Nanchong City	0.1216
Jiaxing city	0.1819	Huangshi City	0.1015	Meishan city	0.1113
Huzhou city	0.1778	Shiyan City	0.1294	Yibin City	0.1082
Shaoxing city	0.1797	Yichang City	0.1708	Guang'an city	0.0994
Jinhua City	0.1830	Xiangyang city	0.1417	Dazhou city	0.1060
Quzhou City	0.1257	Ezhou city	0.1266	Ya'an city	0.1132
Zhoushan city	0.2109	Jingmen City	0.1015	Bazhong city	0.0889
Taizhou	0.1644	Xiaogan City	0.0985	Ziyang city	0.0926
Lishui city	0.1352	Jingzhou city	0.1072	Guiyang City	0.1988
Hefei City	0.2115	Huanggang	0.0919	Liupanshui city	0.0895
Wuhu City	0.1633	Xianning city	0.1021	Zunyi City	0.0999
Bengbu City	0.1403	Suizhou city	0.1000	Anshun City	0.0838
Huainan City	0.1042	Changsha City	0.2471	Kunming City	0.2141
Ma'anshan City	0.1882	Zhuzhou	0.1661	Qujing city	0.0925
Huaibei City	0.1256	Xiangtan City	0.1664	Yuxi city	0.1358
Tongling city	0.1454	Hengyang City	0.1159	Baoshan city	0.0812
Anqing City	0.1374	Shaoyang City	0.1017	Zhaotong city	0.0782
Huangshan city	0.1568	Yueyang City	0.1453	Lijiang city	0.1007
Chuzhou	0.1266	Changde City	0.1593	Pu'er city	0.0717
Fuyang city	0.0932	Zhangjiajie City	0.0869	Lincang city	0.0805

6. Empirical analysis of regional integration on urban economic resilience

6.1 Direct effect analysis

In this paper, the two-way fixed-effect model is first used to explore, and the specific model is constructed as follows:

$$UER_{it} = \beta_0 + \beta_1 INTE_{it} + \beta_2 X_{it} + \alpha_{it} + \delta_{it} + \varepsilon_{it} \quad (1)$$

In the model, the UER_{it} is the economic resilience of the explained variable, $INTE_{it}$ is the regional integration of the explained variable, i represents the city, t represents the time, X_{it} is the control variable, the α_{it} is the individual fixed effect, δ_{it} is the time-fixed effect, and ε_{it} is the random interference term.

As shown in Table 4, control variables were added for regression, and the coefficient before regional integration variables was always significantly positive at the level of 1%, indicating that regional integration has a significant effect on urban economic resilience, assuming H1 was verified. Then observe the results of the control variables, the degree of openness to the outside world (OPEN) has a significant negative impact on urban economic resilience, human capital (HUM) and entrepreneurial vitality (ENT) has a significant positive impact on urban economic resilience, and the degree of government intervention (GOV), financial development level (FIN) and transportation development level (ROAD) effect is not significant.

Table 4. The Promoting effect of regional integration on urban economic resilience

Variable	UER					
Regional Integration of the INTE	20.299*** (6.27)	19.566*** (5.86)	19.656*** (5.89)	19.478*** (5.82)	17.380*** (5.13)	17.319*** (5.12)
Degree of openness to the outside world OPEN		-0.180** (-2.47)	-0.186*** (-2.63)	-0.189*** (-2.65)	-0.102 (-1.62)	-0.098 (-1.59)
human capital HUM		0.000*** (4.91)	0.000*** (4.93)	0.000*** (4.66)	0.000*** (4.75)	0.000*** (4.73)
Degree of government intervention, the GOV			0.013 (0.77)	0.002 (0.10)	0.004 (0.27)	0.005 (0.28)
Financial development level FIN				0.003 (1.45)	0.002 (1.08)	0.002 (1.07)
Entrepreneurial vitality ENT					0.073*** (4.46)	0.074*** (4.91)
Traffic development level: ROAD						-0.134 (-0.49)
Individual fixed	yes	yes	yes	yes	yes	yes
Time fixed	yes	yes	yes	yes	yes	yes
Obs	1728	1728	1728	1728	1728	1728
Number of citycode	108	108	108	108	108	108
R-squared	0.879	0.892	0.892	0.893	0.902	0.902

6.2 Mediation effect analysis

In order to identify the action mechanism of regional integration affecting the resilience of urban economy, the intermediary model is used for empirical testing:

$$M = \theta_0 + \theta_1 INTE_{it} + \theta_2 X_{it} + \alpha_{it} + \delta_{it} + \varepsilon_{it} \quad (2)$$

$$UER_{it} = \gamma_0 + \gamma_1 INTE_{it} + \gamma_2 M + \gamma_3 X_{it} + \alpha_{it} + \delta_{it} + \varepsilon_{it} \quad (3)$$

In the model, M is the intermediary variable, and the agent variables of industrial institution (IS) and innovation ability (INNO) are selected as the intermediary variable. In the process of verifying the mediation mechanism, first, determine the influence of the explanatory variable on the mediation variable, if θ_1 Significant, the mediation variable M is included in the benchmark regression model (1) for the regression analysis of the model (3), if γ_2 Significant, then indicates a significant mediation effect, and conduct the next test, if γ_1 Not significant, indicating the presence of a complete mediation effect, comparing $\theta_1 \times \gamma_2$ and γ_1 , if they are consistent, indicate presenting a partial mediation effect.

6.2.1 Optimization of industrial structure

This paper adopts the proportion of the output value of tertiary industry and the output value of secondary industry (IS) to measure the upgrading of urban industrial structure. According to table 5 (2), it can be seen that regional integration has significant effect to advanced industrial structure, combined with (3), the independent variable regional integration and the intermediary industrial structure in the same model, contrast (1) column, found to join the intermediary variables, the regional integration of urban economic resilience is not changed, but the influence coefficient fell, it shows that the influence of regional integration on urban economic toughness part through industrial structure optimization, assuming H2 to verify.

Table 5. The action mechanism of regional integration affecting the resilience of urban economy through industrial structure

Variable	(1) <i>UER</i>	(2) <i>IS</i>	(3) <i>UER</i>
Industrial structure of advanced IS			0.010** (2.07)
Regional Integration of the INTE	17.319*** (5.12)	67.164*** (3.13)	16.631*** (5.31)
Degree of openness to the outside world OPEN	-0.098 (-1.59)	-0.600 (-0.88)	-0.092 (-1.49)
human capital HUM	0.000*** (4.73)	0.000* (1.66)	0.000*** (4.39)
Degree of government intervention, the GOV	0.005 (0.28)	-0.490*** (-2.64)	0.010 (0.59)
Financial development level FIN	0.002 (1.07)	0.111*** (3.28)	0.001 (0.49)
Entrepreneurial vitality ENT	0.074*** (4.91)	0.122 (0.94)	0.073*** (4.84)
Traffic development level: ROAD	-0.134 (-0.49)	-3.764** (-2.08)	-0.096 (-0.36)
Individual fixed	yes	yes	yes
Time fixed	yes	yes	yes
Obs	1728	1728	1728
Number of citycode	108	108	108
R-squared	0.902	0.622	0.904

6.2.2 Improvement of innovation ability

This paper uses the number of patent applications (INNO) to measure the urban innovation ability of cities. According to table 6 (2), it can be seen that regional integration has significant positive impact on innovation ability, combined with (3), the independent variable regional integration and intermediary variable innovation ability in the same model, contrast (1) column, found to join the intermediary variables, the influence of regional integration on urban economic resilience is not changed, but the influence coefficient decreased, it shows that the influence of regional integration on urban economic toughness partly through innovation ability, assuming H3 to verify.

Table 6. The action mechanism of regional integration affecting the resilience of urban economy through innovation capacity

variable	(1) UER	(2) INNO	(3) UER
Innovation capability: INNO			0.007*** (3.24)
Regional Integration of the INTE	17.319*** (5.12)	727.545*** (10.72)	12.382*** (3.15)
Degree of openness to the outside world OPEN	-0.098 (-1.59)	-7.141*** (-3.84)	-0.050 (-0.86)
human capital HUM	0.000*** (4.73)	0.000 (0.75)	0.000*** (4.72)
Degree of government intervention, the GOV	0.005 (0.28)	-1.111*** (-3.16)	0.012 (0.72)
Financial development level FIN	0.002 (1.07)	0.355*** (4.10)	-0.000 (-0.12)
Entrepreneurial vitality ENT	0.074*** (4.91)	1.988*** (4.25)	0.061*** (5.27)
Traffic development level: ROAD	-0.134 (-0.49)	-4.287 (-0.87)	-0.105 (-0.43)
Individual fixed	yes	yes	yes
Time fixed	yes	yes	yes
Obs	1728	1728	1728
Number of citycode	108	108	108
R-squared	0.902	0.755	0.907

6.3 Heterogeneity analysis

The impact of regional integration on urban economic resilience is expounded from the above two perspectives, and regional integration plays a significant role in promoting the enhancement of the economic resilience of the cities along the whole Yangtze River Economic Belt. However, the Yangtze River Economic Belt spans three regions, the east and west of China, and is the largest inland river industrial belt in the world. Subject to administrative division, will the influence of regional integration strategy show some differences on different regions to some extent? To test this conjecture, this paper divides the experimental group into three regions: upstream, midstream and downstream, and performs groups to test the benchmark model. According to the regression results in Table 7, the INTE coefficient in the upstream, middle and downstream, and the INTE coefficient in the middle region regression model was significantly higher than that in the other two regions. This result fully demonstrates that compared with the upstream and downstream regions, the regional integration of the Yangtze River Economic Belt has a better role in promoting the urban economic resilience in the middle regions.

Table 7. Heterogeneity analysis of regional integration affecting the resilience of urban economies

variable	lower reaches	middle reaches	head waters
	UER	UER	UER
Regional Integration of the INTE	18.730*** (4.51)	26.112*** (13.30)	12.294*** (3.45)
Degree of openness to the outside world OPEN	-0.149 (-1.68)	-0.082 (-0.76)	0.210*** (2.95)
human capital HUM	0.000*** (3.34)	0.000*** (3.31)	0.000*** (5.10)
Degree of government intervention, the GOV	0.034* (1.98)	-0.065* (-1.80)	-0.021* (-1.71)
Financial development level FIN	0.001 (0.22)	-0.003 (-0.65)	0.001 (0.49)
Entrepreneurial vitality ENT	0.068*** (3.15)	0.028** (2.61)	0.038** (2.19)
Traffic development level: ROAD	0.465 (0.44)	0.502 (1.45)	-0.104 (-0.54)
Individual fixed	yes	yes	yes
Time fixed	yes	yes	yes
Obs	656	576	496
Number of citycode	41	36	31
R-squared	0.910	0.928	0.905

7. Research conclusions and policy implications

7.1 Study Conclusion

This paper studies the impact of regional integration on the resilience of urban economy by combining qualitative and quantitative analysis. Based on the relevant data of 108 cities in the Yangtze River Economic Belt from 2005 to 2020, the influence effect on the urban economic resilience; then, the mechanism of regional integration on urban economic resilience; finally, the heterogeneity analysis based on the spatial geographical location. The specific conclusions are as follows: (1) the regional integration of the Yangtze River economic belt has a significant role in promoting the urban economic resilience.(2) Regional integration mainly improves the resilience level of urban economy by optimizing the industrial structure and improving the innovation capacity.(3) Under different spatial and geographical locations, the impact of regional integration on urban economic resilience is different, which specifically shows that the impact of regional integration on the level of urban economic resilience is more obvious in the middle reaches of the Yangtze River Economic Belt.

7.2 Countermeasures and suggestions

Based on the conclusions obtained in this paper, the following three countermeasures and suggestions can be drawn:

(1) Regional integration should be continuously promoted to promote the resilience of urban economies. We need to give full play to the advantages of the Yangtze Economic Belt, a major region for national strategic development, implement the new development concept, promote high-quality development of the Yangtze Economic Belt, and set a new model for coordinated development among regions.

(2) We should give full play to the role of regional integration in optimizing industrial structure and improving innovation ability. We should give full play to the role of industry associations, city chambers of commerce and other platform carriers, encourage regional enterprises to exchange and

share experience, realize complementary industrial chains, and jointly promote continuous innovation of enterprises and resist risks.

(3) We should continue to give full play to the leading role of cities in the middle and lower reaches of the Yangtze River Economic Belt, achieve spillover effects, and boost the economic resilience of cities in the upper reaches of the Yangtze River Economic Belt. Each administrative region should reduce the administrative boundary constraint of the flow of elements, and realize the diffusion of the potential energy in the middle and downstream development to the upstream.

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