



# Impact of Disaster Risks on Regional Economic Resilience in China: A Case Study of Wenchuan Earthquake

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**Abstract:** The occurrence of disasters has a great impact on the sustainable development of cities and regions. This makes the ability of urban economic system to deal with disaster risk and its ability to recover development after being disturbed by disasters become two important indicators to measure the economic resilience. Unlike the study of economic shocks, we identify sectors of the economy that are sensitive to disaster disturbances in urban systems. It is of great significance to explore the structure of economic activity which is related to improve the stability and driving force of urban economy resilience. This paper establishes the premise hypothesis according to the Urban Economy Basic Theory. The object is the structure of urban Basic and Non-Basic economic activities. Taking the Location Quotient as the observation index, the economic resilience level of disaster risk area was explored through the empirical study of Wenchuan earthquake. The results show that the Investment, Finance, Government Finance, Transportation and Social Welfare sectors are the endogenous drivers of the post-disaster economy, which can quickly stimulate economic recovery in the short term but lack of sustainability. Besides, the development of Industry, Retail Trade, Construction, Education and Health Care need to be driven by external support. In the short term, the growth rate is not significant, but it is the main driving force of long-term economic development after the disaster. On the other hand, Government Finance, Social Finance Investment, Construction, Transportation and Social Welfare departments have undergone reverse changes between Basic and Non-basic economic activities after the earthquake, indicating that the earthquake disaster has a subversive effect on the turbulence of regional economic structure. Therefore, on the basis of extending the perspective of economic resilience researches, this paper discusses the method for assessing urban economic resilience, and puts forward some suggestions on how to improve resilience in the disaster risk areas.

**Keywords:** Resilience, Economic Activity Structure, Disaster Risk, Location Quotient, Wenchuan Earthquake

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## 1. Introduction

With the rapid development of China's economy, the coupling relationship between frequent natural disasters and regional economic chain is deepening day by day. And the economic losses caused by disasters increases exponentially. Since the Wenchuan Earthquake in 2008, the impact of disasters on regional economic structure and growth model has become the focus of attention of governments and economists. In a multi-disaster environment, "resilient city"

stands out in the concept of "smart city" and "sponge city", and becomes the core content of constructing sustainable development of modern society. From the perspective of urban construction, architectural engineering design, infrastructure planning, social order management, and the cultivation of safety culture should be the focal points of resilient cities. Besides, the adjustment of the economic structure and the reconstruction of the economic system are also the important contents to improve the resilience of cities.

Resilience describes the essential attributes of things, which are used to evaluate the internal structure of organizations and

systems. It can be described as “the ability of substance to bounce back to its original form” and “the ability to recover from a difficult situation” [1]. Because the concept of resilience has the connotation characteristics of dynamic, developmental and “better state of resilience” [2], it has been widely applied to the adaptive strategy of urban system in the face of the unpredictable future and frequent natural disasters and the study of human sustainable development [3]. Most of the scholars in some studies avoided the problem of detailed definition and started from the essential characteristics of resilient cities. Wildavsky proposes that resilient cities include six basic features, such as homeostasis, high flux, flatness, buffering and redundancy [4]. Existing researches are consistent with our definition of resilience and the goal of building resilient cities. In this paper, the two basic properties of resilient cities can be summarized as the stability of interference and the recovery after interference.

Economic resilience is used to describe the ability of a city or a regional's economic system to adapt to a changing environment. Economic resilience is the endogenous factor, and the improvement of regional economic resilience will inevitably lead to the improvement of urban resilience [5-7]. Reggiani introduced the concept of resilience into the field of economics and conducted a study on the ability of regional economy to cope with recession [8]. After that, the scholars began to pay attention to the problem of improving regional economic resilience. Using mathematical models and index system, they tried to evaluate the regional economy resilience and put forward corresponding strategies [9-11]. There is much debate about the financial crisis's disturbance to the economic system, which reflects the economic resilience of the system. And the differences among regionals are of great concern. Simmie J et. al discussed the growth pattern of regional economy after concussion [12]. Liangang Li et al. mentioned that regional economic resilience provides a new perspective for explaining regional differences in response to recession shocks. And analyzed the regional economic resilience of Liaoning Province in China in terms of its resistance and recoverability dimensions from 1990 to 2015 and explored the determinants of regional economic resilience [13]. Haichao Yu also referred to economic resilience is a critical indicator of the sustainable development of an urban economy. At the same time, their research found that the economic resilience opportunity index also varies spatially and increases over time amongst urban agglomerations in China [14]. Juntao Tan et al. quantitatively analyzed the economic resilience of resource-based cities in Northeast China in terms of resistance and recoverability during two economic crises: the Asian financial crisis and the global financial crisis. Moreover, they analyzed the main factors that affected regional resilience [15]. Other scholars specifically focus on important sectors of the economy, such as the relationship between the oil price and economic resilience carried out a detailed research [16].

In disaster environment, economic resilience is used to describe the stability of urban economic system against disaster disturbance and the driving force of recovery and

development. Some Chinese scholars evaluate the impact of earthquake on the economy from the perspective of input and output [17], and estimate the economic growth of the disaster area and the whole country. Other research summarizes the dynamic change model of regional economy after the impact, and calculates the resilience index of different regions [18]. In recent years, study of the global economic structure on regional economic resilience empirical has been deepened gradually. Brown and Greenbaum using the change of employment data at the county level in 35 years, research the relationship between industry diversity and the economic resilience. He found that the industry diversification county has a better performance in dealing with the external shocks, and the high concentration of industrial county has poor economic resilience [19]. Davies studied the influence of sector structure on the economic resilience of European countries, and the results showed that regions with high proportion of financial industry were more resilient, while regions with a large proportion of manufacturing industry were less resilient [20]. And Xu and Warner [21] also got similar results in the study on the United States.

On the basis of previous studies, this paper extends the concept of economic resilience to measure disaster situations, and explores the differences in resistance and recovery of regional economies in response to disaster shocks. Faced with the threat of disasters, the economic development of some areas can recover rapidly and return to the track of growth, while in some areas, the economy is depressed for a long time or even gradually declining. It can be seen from the research results of many scholars that the urban economic structure is an important factor affecting the regional economic resilience, and the concordant development of various economic sectors is the key to reducing the disaster impact risk and enhancing the regional economic resilience.

Therefore, the improvement of regional economic resilience needs to consider, adjust and reform the economic structure of the disaster city in the region itself. As a classical theory in urban geography, the urban economic base theory was put forward by H. Hoyt in 1939 on the basis of predecessors [22]. This theory explains the source of urban economic growth based on the viewpoint of comparative benefits of external input, indicating that urban economic growth realized by promoting the flow of funds into the region through services of outside the region [23]. The core view of the theory is to divide the economic activity structure of a city into two parts: basic activity and non-basic activity. Basic activities refer to activities that provide services to areas outside the city, while non-basic activities refer to economic activities carried out to meet the needs of the city itself. The two parts depend on each other, and a certain proportion should be maintained to promote the coordinated development of regional economy [24-25]. The practical application of this theory is widely used in communities and rural areas. According to these theories, a large number of economic activities have been studied, including the analysis of industrial characteristics and development, the study on urban relations and classifications, and the research on regional

centrality and external service capacity.

Scholars have conducted many studies on the division methods of urban economic activities, such as Location Quotient, Normal City, Industrial Separation, Minimum Demand and so on. The Location Quotient is a major measurement used to distinguish the basic and non-essential components of urban economic activity. P. Haggett [26] proposed and applied it in location analysis. It is a very meaningful indicator to measure the spatial distribution of regional elements and reflect the degree of specialization of an industrial sector. Therefore, as the main measure method to distinguish the basic and non-basic parts of urban economic activity, the basic activity part with higher specialization level in regional production can be determined by using the location quotient index [27-31]. In this way, the basic activity sectors which obtain income from outside the area are investigated, and the driving force sectors of economic development are also analyzed. At the same time, the non-basic activities which can provide stable energy for the city interior are divided.

To sum up, under the perspective of disaster risk management, the improvement of economic resilience makes the urban economic system keep stable and sustainable development, which is especially important for the construction of resilient city. There are many studies on economic activities under normal conditions, but little attention is paid to the economic resilience of disaster-resistant stability and post-disaster recovery. That is to say, the relevant research on the construction of resilient cities has not focused on the impact and disturbance of disasters on regional economy, nor has there been an analysis of the difference of economic resilience in disaster risk areas. At the same time, there is little mention to identify the key points of economic resilience augment.

Therefore, this paper will start an empirical study from the division of basic/non-basic economic activity sectors, and compare the changes of economic activity structure in Wenchuan area before and after the “5.12 Earthquake”. We will dig into the economic sectors most affected by disasters and analyze their changing and developing characteristics. Furthermore, the direction of structural adjustment is discussed to effectively enhance the economic resilience. Finally, it provides some suggestions for sustainable development of resilient cities.

## 2. Data Sources and Analytical Methods

### 2.1. Data Sources

The 5, 12 Wenchuan Earthquake, occurred at 14:28:04 on May 12, 2008. The epicenter was in Wenchuan county of Aba Tibetan Autonomous Prefecture in Sichuan Province of China. The magnitude of the earthquake is 11, affecting more than half of China and several Asian countries. As a result of the great harmfulness of the Wenchuan earthquake, and the profound fluctuating impact on the Sichuan region and the Chinese economy, this paper selects Wenchuan as the research object and collects data of various economic activities departments in Sichuan Province.

The data are mainly from the Statistical Yearbook. Taking the occurrence time of Wenchuan earthquake as the intermediate node, the data of the main economic activity sectors in Wenchuan County were statistically analyzed, including five years before the earthquake, from 2003 to 2007, and five years after the earthquake, from 2008 to 2012. An overview of each county and city was sorted out, and the samples included 18 prefecture-level cities and 3 autonomous prefectures (21 prefecture-level units in total). There are 43 municipal districts, 14 county-level cities, 120 counties and 4 autonomous counties (181 county-level units in total). It included administrative area land from the whole province and various counties (city, area), the employees, the rural economy conditions, trade, foreign capital and finance of all state-owned and non-state-owned industrial enterprises above designated size, labor wages and savings, investment in fixed assets, construction, transportation and postal services, education, health care and social welfare.

The most representative sector of regional economic level is selected as the sample index to study the regional economic activity. Factor dimensionality reduction by SPSS2.0 software, on the premise of ensuring that the results of KMO and Bartlett data test passed, 10 indicators sufficient to cover more than 90% of the region's economic situation were identified, including Industry, Investment, Government Financial Revenue and Expenditure, Finance, Transportation, Education, Construction, Retail Trade, Health Care and Social welfare. Due to the lack of data of mileage representing the traffic development status of individual years, the mean value of the years before and after the missing value was taken on the premise that the experimental results did not affect the final results, and finally constituted the basic data source.

### 2.2. Analytical Methods

#### 2.2.1. Theoretical Foundation

Based on the basic theory of urban economy, a two-dimensional structure of regional economic activities is constructed by dividing urban basic or non-basic economic sectors. It is applied to the evaluation of regional economic system's “disaster resistance stability” and “disaster recovery driving force”. “Stability” indicates that the economic department in the area is damaged by the disaster-causing factors, but its structure overcomes the failure and collapse to maintain stability. The evaluation of regional economic stability is generally based on the severity of direct economic losses which are closely related to the internal economy in the disaster-stricken areas. Stability accords with the connotation of non-basic economic activities. “Driving force” refers to the hematopoiesis ability which can drive the sustainable development after the disaster. Such as the regional ability to attract investment, the level of import and export trade and regional external economic exchanges. This is consistent with the theoretical connotation of basic economic activities.

#### 2.2.2. Premise Hypothesis

According to the theory, this paper puts forward the basic assumptions. The assumption is divided into two parts:

Firstly, it is assumed that the basic economic activity of the city serves as the main indicator to measure the economic driving force. That is to say, this part generates income for the city from outside region. Basic sectors of economic activity have externalities. It has a high degree of specialization in the regional scope, and is regarded as the dominant industrial sector. The more frequent the basic economic activities, the stronger the productive capacity of the regional economy. After the disaster, the medium and long term regional economic recovery and development drive will be stronger.

In addition, the assumption is that the non-basic economic activities provide the needs meeting regional internal economic activity. As the main indicators of economic structure stability, frequency of the basic non-economic activity means the complex of regional internal economic system function and the large internal supply. In these circumstances, the economic system have strong anti-interference ability to disasters. The correspondence between theory and hypothesis is shown in the figure 1.

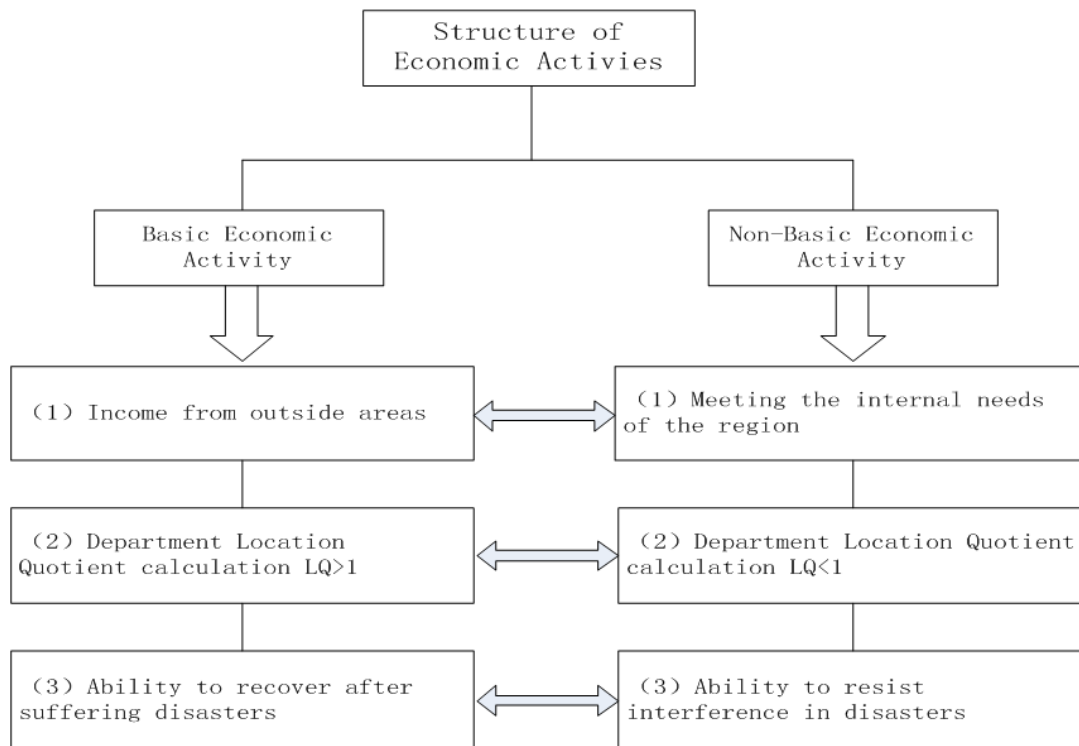


Figure 1. The correspondence diagram between the basic theory of urban economy and the basic hypothesis.

### 2.2.3. Model Construction

Based on the basic theory of urban economy, the structural model of urban economic activity is established. Here are mathematical model formulas.

$$T = B + NB \quad (1)$$

In Formula (1), T is the total economic activity of the city, B is the basic economic activity, and NB is the non-basic economic activity. Based on the assumption of urban economic base theory, the above selected variables are divided into basic economic activities and non-basic economic activities, so as to distinguish the driving force of the economic system and which department affect the stability of the disaster areas.

In order to distinguish which component variable belongs to the basic economy and the non-basic, the calculation formula of urban economic activity structure is constructed.

$$LQ = \frac{D_i / P_i}{D_T / P_T} \quad (2)$$

LQ is the Location Quotient of an Economic sector in Wenchuan.  $D_i$  is the output value or the number of employees in an economic sector of Wenchuan.  $P_i$  is the total output value or number of employees in Wenchuan.  $D_T$  is the output value or number of employees of this economic department in Sichuan province, and  $P_T$  is the total output value or number of employees in Sichuan province.

In order to ensure that the final result of LQ value is not affected, the corresponding dimension of each department of city and region is uniform. The value selection also depends on the availability and accuracy of the economic sector data. Specifically, it includes two aspects:

(1) Calculate the ratio of the number of employed persons in a certain sector to the total number of employed persons in the city. The result divides the ratio of the employee number in the

sector to the total employee number in the area in which the city is located. The final result of division is the value of Location Quotient.

(2) Calculate the proportion of the output value of specific sectors of the city to the total output of the city. At the same time, calculate the output value of this sector in the region as a proportion of the gross national product. Their quotient value is the result of location quotient.

The sector with a LQ greater than 1 is the basic economic activity sector, indicating that the sector has surplus products, which can be used for export and generate income from areas outside the city. When LQ less than 1, it means that the sector is a non-basic economic activity sector whose products are mainly supplied locally.

### 3. Empirical Results

#### 3.1. Seismic Disturbance Is Significant for the Structure of Urban Economic Activity

In terms of Finance, Investment, Retail Trade, Government Revenue and Expenditure, Industry, Social Welfare and Gross

Domestic Product changes in economic output (Figure 2), the overall economy rose steadily before the earthquake and declined significantly in the year of the earthquake (2008).

The Financial sector and Fixed Asset Investment are obviously disturbed by the earthquake. The output value of the Finance and the Fixed Asset Investment increased sharply during the period of 1 ~ 3 years (2008 ~ 2010) after the earthquake, but then dropped distinctly. It can be seen that the sector vulnerable to the impact of capital is vulnerable to earthquakes alike, but strong resilience.

Retail Trade Finance, and Industry are slowly picking up at a steady pace. But after the reconstruction of the disaster area, its growth rate and development momentum are still stable. For these sectors, disaster recovery is hard to see in the short term. Those sectors affected by earthquakes require a longer period of time to recover.

In addition to the above sectors, the Education, Health Care, Transportation and Construction are tardy to respond to the effects of earthquake disasters. There are no significant changes before and after the earthquake.

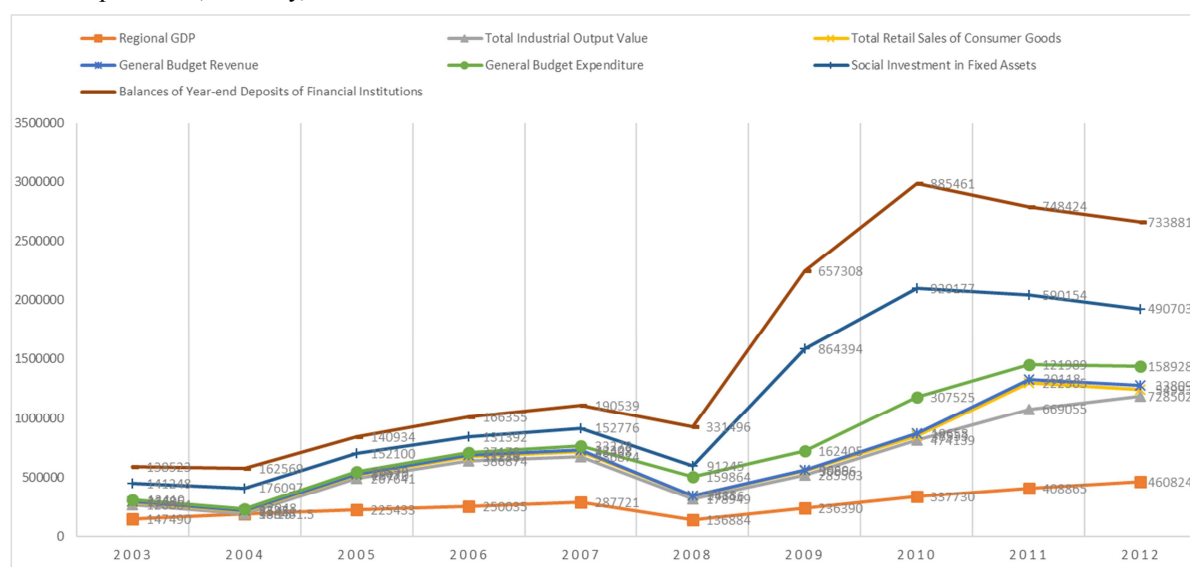


Figure 2. Changes of major economic indicators in Wenchuan from 2003 to 2012.

#### 3.2. Location Quotient Better Reflects the Characteristics of Economic Changes in Disaster Areas

In this paper, the basic/non-basic economic activities of 10 main economic sectors in Wenchuan County are divided by using Location Quotient. The results shown in Table 1 (4 decimal points retained).

Table 1. The results of Location Quotient of various economic activity sectors from 2003 to 2013.

LQ	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Industry	1.3200	0.0004	1.4192	1.6844	1.2787	1.1160	0.9439	1.0423	1.1287	1.2161
Retail Trade	0.4015	0.3330	0.3095	0.3759	0.3950	0.4759	0.3209	0.2881	1.4228	0.3074
Government	0.6269	0.6515	0.6531	0.6968	0.6907	4.9907	2.7076	3.6751	1.3420	1.5104
Investment	2.4212	2.2748	1.4328	1.0038	0.9527	1.1049	4.3060	3.4475	2.0067	1.4092
Construction	1.0335	1.5140	1.4297	1.2516	1.0143	0.5188	0.6819	0.4377	0.6134	0.4015
Education	1.8474	1.7935	1.6265	1.5462	1.4858	1.5936	1.4268	1.4512	1.6435	1.6248
Health Care	1.1982	1.2659	0.8595	0.8848	0.8243	0.7930	0.4516	0.5071	0.4874	0.4801
Finance	0.3039	0.2893	0.2162	0.2436	0.2538	1.0595	1.1310	1.1053	1.1135	0.9530
Transport	0.9763	0.8629	0.7777	0.3392	0.9370	1.2288	0.6299	0.9622	1.1249	1.1775
Social Welfare	0.0229	0.0209	0.0191	0.0434	0.0205	0.4149	1.1722	1.0421	1.0591	0.7414

Divided by  $LQ=1$ . Before the earthquake, the basic economic activities of Wenchuan County were: Industry, Investment, Construction and Education. Non-basic sectors of economic activity are Retail Trade, Finance, Government Financial, Transportation, Health Care and Social Welfare. The structure of economic activity before the earthquake is as follows:

$$T_{\text{before}} = \sum (B_I + B_{\text{Inv}} + B_C + B_E) + \sum (NB_R + NB_F + NB_G + NB_T + NB_H + NB_S)$$

The change of Location Quotient before and after the earthquake is basically consistent with the growth trend of the actual economy, as shown in figure 3. The Government Finance, Social Finance, Transportation and Social Welfare sectors' Location Quotient value changed from the non-basic economic sector of  $LQ < 1$  to the basic economic activity sector of  $LQ > 1$  after the earthquake. Investment has always been the dominant sector in Wenchuan region to support the development of regional economy, especially in the second

year after the earthquake. The location quotient of the Construction sector changed from  $LQ > 1$  to  $LQ < 1$ , that is from the basic economic activity to the non-basic economic activity. The two basic sectors of economic activity, Industry and Education, and the non-basic sectors, Retail Trade and Health Care, were relatively stable and did not change significantly. After the earthquake, the formula of economic activity structure becomes as follows:

$$T_{\text{after}} = \sum (B_I + B_E + B_F + B_G + B_T + B_S + B_{\text{Inv}}) + \sum (NB_R + NB_H + NB_C)$$

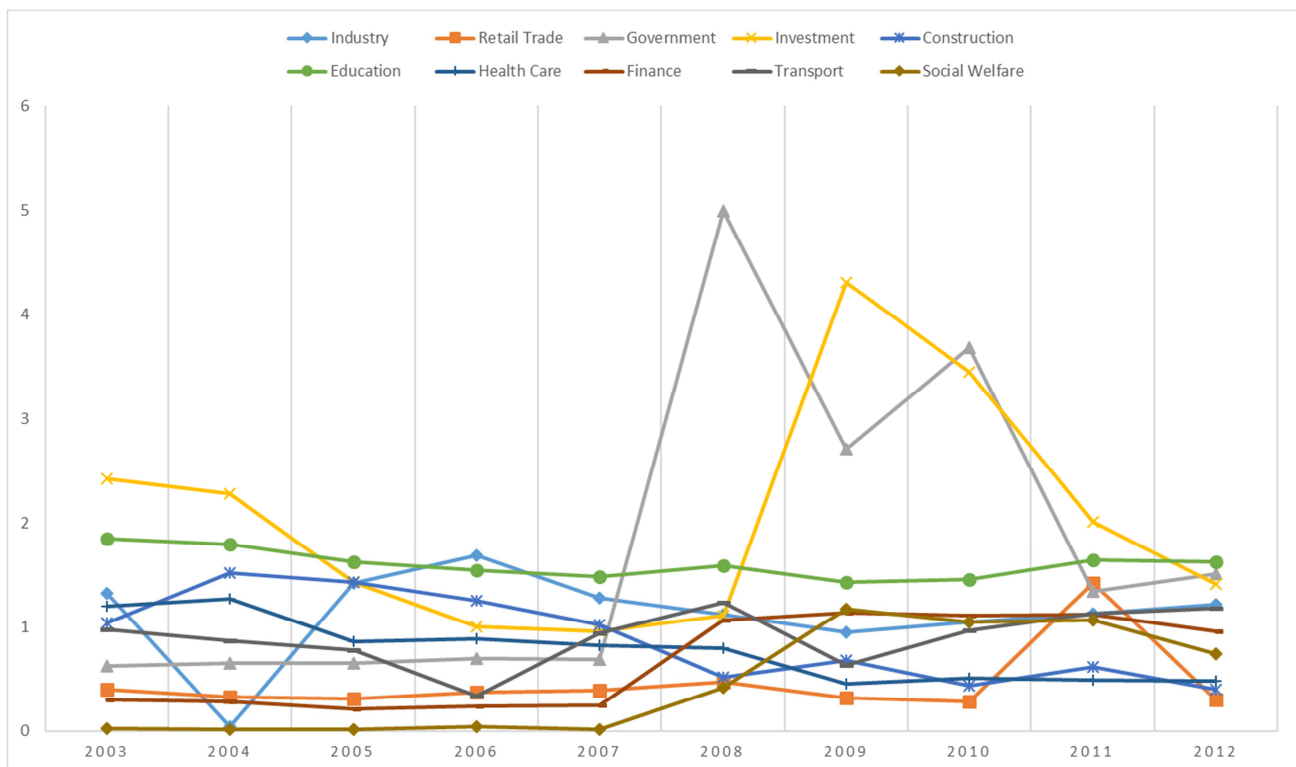


Figure 3. Earthquake impact on various sectors of economic activity.

### 3.3. Sensitive Economic Sectors Are the Main Drivers of Disaster Recovery

This paper analyzes the driving forces of economic growth in Wenchuan by combining the characteristics of post-disaster economic changes with the characteristics of Location Quotient changes.

For the sections with remarkable economic growth after the disaster, if the Location Quotient increases or remains constant, it is a sector that depends on itself to drive the economic development, and if the Location Quotient decreases, it means that the sector needs external introduction to drive the development.

For the sections with slow economic growth after the disaster, the Location Quotient increases shows that it is the export sector, which can be used as the driving force of the regional economy. If the location quotient is reduced or unchanged, that is the sector needs to rely on outside aid-driven.

Through the analysis of the data results, the sectors including Investment, Finance, Government Finance, Social Welfare, and Transportation are the main development driving forces of the local economy. They belong to the dominant sectors which export products and services to other areas. Besides, Industry, Retail Trade, as well as Construction, Education, and Health Care need to bring in state and social



resources to help build them. As is shown in figure 4.

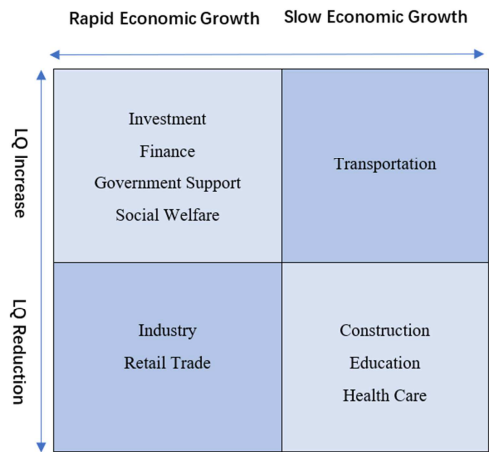


Figure 4. Interaction Matrix between Economic Growth and Location Quotient.

3.4. Location Quotient in Most Sectors Presents a Reverse Change After the Disaster

In order to compare the change degree of Location Quotient before and after the earthquake more intuitively, so as to analyze the stability of regional economic activity structure, we normalize the regional quotient (Figure 5). The Location Quotient of the non-basic economic activity sector is represented by cyan blue, as shown in figure 5. The darker the color, the lower the location quotient, which means that the department is more dependent on input. Use red color to indicate the Location Quotient of the basic economic activity department. The stronger the color is, the higher the Location Quotient is, which indicates that the output dependence of the department is stronger.

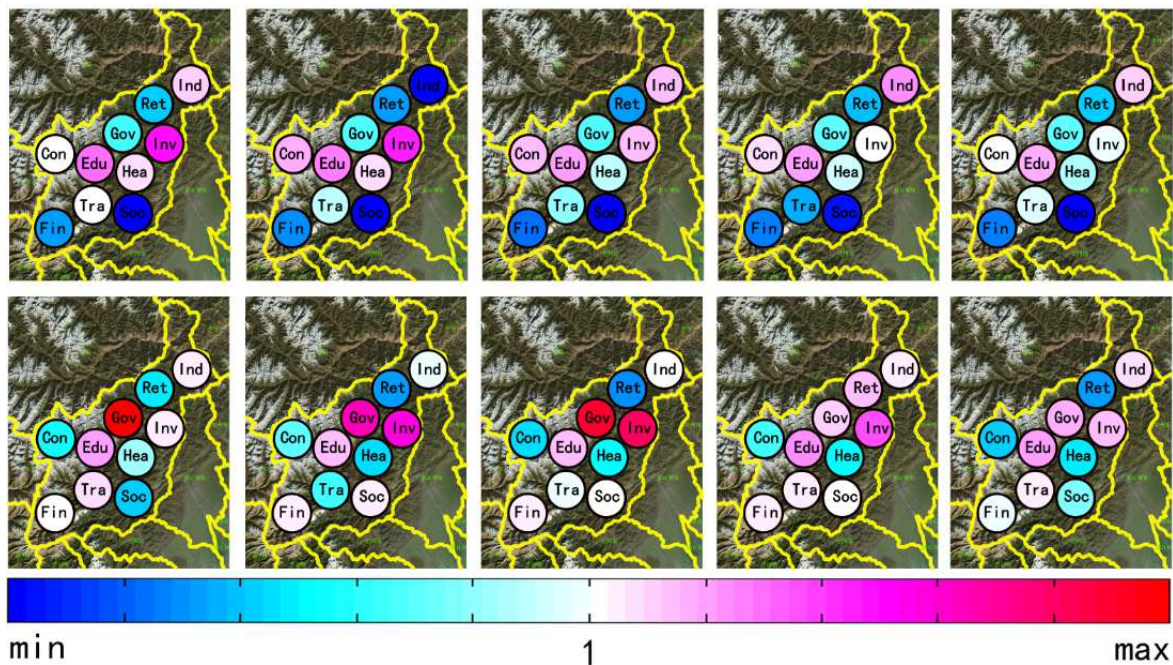


Figure 5. Location Quotient Change Degree.

According to the results of the Location Quotient, there is no significant change in four non-basic economic activity sectors: Industry, Education, Retail Trade and Health Care. It can be seen that the long-term impact of the earthquake on the Industry, Retail Trade, and Education is weak because these sectors are labor-intensive or basic service sectors. It is important to note, however, that the stability shown by the Health Care does not conform to conventional perceptions. The rapid increase in the number of injuries following the earthquake should have led to a sharp increase in demand for health care. However, the value of its Location Quotient has not changed significantly. This reflects the important role of outside medical assistance, making Wenchuan County's Health Care still as a non-basic economic sector after the earthquake.

On the other hand, social fixed asset investment has always been the dominant sector in Wenchuan area ( $LQ > 1$ ), which drives the development of regional economy. The results of Quotient value in the two years after the earthquake are also far greater than 1. It is not only higher than other sectors, but also higher than its own average before and after the earthquake. The stability of the Investment sector also shows that the transfer payment is less in China. Post-disaster relief funds are mainly invested in infrastructure construction and social welfare for people's livelihood.

Perhaps as a result of post-disaster state aid funding and support, the Government Finance, Transportation, Social Finance and Welfare sectors have shifted from non-basic economic activities to basic economic activities.

Only the Construction has changed from the basic

economic activity to the non-basic economic activity. This is due to the large increase in the demand for the construction industry in the post-disaster reconstruction process, and the advantages of the construction industry in this region cannot meet the demand for recovery and disaster relief, so there is an import phenomenon in the construction industry. This shows that the central government and Sichuan Province's aid capacity is far stronger than the capacity of the original regional economic structure. At the same time, it should also be noted that the absence of a follow-up transitional adjustment policy may undermine Wenchuan's original dominant economic sectors.

## 4. Analysis and Discussion

According to the calculated results and basic assumptions, the resilience of economic activities structure in Wenchuan area is analyzed. The location quotient value of a certain sector represents the level of specialization in the economic structure, so as to identify the basic economic activities of a city. Furthermore, the change of economic sectors after the disaster disturbance is excavated, and the economic resilience of Wenchuan area is discussed.

### 4.1. Resilience Assessment of Stability and Driving Forces

(1) Sensitive sectors are key to the rapid recovery of the economy in the short term

Affected by the earthquake, the Government Finance, Social Finance, Transportation and Social Welfare sectors changed from non-basic economic activity before the earthquake to basic economic activity after the earthquake. That is to say, they change from products and services that can only meet the internal needs of the region to products and services that can be exported out of the region, and to generate revenue from outside. The empirical results show that more than half of the sectors are greatly disturbed by earthquakes, and the above four sectors are particularly sensitive to the effects of earthquake disasters. These sectors have shown strong resilience within 1 to 3 years after the disaster, which plays a very important role in short-term economic recovery.

Fixed asset investment has turned the local construction industry into a non-basic economic activity sector, and promoted the development of the financial to become a basic economic activity sector. But there is a need to be wary of the sharp fall in these sensitive sectors after a brief surge. In the urban resilient economy, the scale of sensitive sectors should be controlled within a certain range, and the sensitive sectors should not become the "single core" of regional economy as far as possible.

If the regional economy has strong dependence on sensitive sectors, it is necessary to arrange a dual-core or multi-core structure as far as possible so as to avoid the destruction of the original economic system due to the excessive disturbance after the disaster.

(2) Stable sectors are critical to long-term post-disaster economic growth

The stabilization sector did not show strong resilience in the

early stages of disaster recovery. However, as the recovery and reconstruction efforts proceed, they can gradually transform into a reserve of regional follow-up driving forces. The earthquake keeps the output capacity of finance and investment at a higher level, and the investment pull and financial support together become the largest active sector driving the economic development. The earthquake brought strong financial support, and the preferential policy led to a sharp increase in investment. Government finance and investment became the two dominant sectors after the earthquake. In addition, the social welfare sector also produced surplus output under the influence of financial support and investment injection.

The aid efficiency was seriously affected by the air drop during the rescue period because of the poor traffic hindering the main road of rescue. The development of the transportation sector after the earthquake is the result of the financial department giving special support to the weak sector under the guidance of the rescue experience. These deeper points to the existence of mutual influence between the sectors, and jointly drive the development of the region's economic transformation.

### 4.2. Strategies for Improving Economic Resilience in Disaster Risk Areas

Based on the analysis of the impact of previous disasters, the economic resilience of the city is evaluated scientifically. Finding out the key factors that affect the stability and recovery of economic system and further adjusting the structure are the strategic connotation of improving the economic resilience of disaster risk areas.

(1) Take history data as a mirror, comparing economic structural changes in disaster-affected areas

The government departments in disaster risk areas should pay attention to the archiving and backup of economic data, and compare the changes of economic activity structure in time. It is the premise and foundation of evaluating and improving the regional economic resilience to fully understand the changing rules and characteristics of structure. It could supply the basis to list the impact of disasters on the regional economy.

(2) Focus on sensitive sectors, stabilizing the non-basic economic activity components of the area

In the face of disasters, a stable and dynamic internal economic system is needed to support the sustainable development. Identify the sensitive sectors in which "basic/non-basic" variations occur from the measurements. Among them, the non-basic activity part, as the main index to measure the disaster response stability of the economic structure, reflects the complexity of the functional structure and the level of internal supply. The better the stability of disaster response is, the stronger the anti-jamming ability of economic system is. Non-basic economic sectors, in particular, need to be imported to advance development. Therefore, stabilize non-basic sectors of economic activity, enhancing the resilience of regional economic stability.

(3) Optimize recessive sectors, driving the basic economic



activity components of the area

The trauma to the regional economy caused by disasters requires the continuous operation of the sectors to drive the recovery and development. The basic economic activity sector is committed to external exports and generates local income, representing a high level of specialization within the region.

Therefore, the basic economic activity cannot be the department that fully relies on the aid of the government and the outside to develop. The region should be optimized to consolidate its own anti-disaster initiative, so as to avoid excessive external assistance to undermine the independent development of the dominant industries. It is the internal core of regional economic resilience to focus on weak sectors and maintain their ability to drive post-disaster economic recovery.

(4) Integrate economic structure, matching the basic/non-basic economic activities in the area

Disasters have some disturbance and damage to the regional economy. The regional basic/non-basic economic sectors determine the resilience from the two aspects of driving force and stability. Therefore, the promotion of regional economic resilience should focus on the driving force and the internal stability of the system. Reasonable adjustment of the proportion of “basic-non-basic” economic sectors in the whole economic system will weave a solid internal economic system for the construction of sustainable resilience cities.

According to the requirement of resilience improvement, combined with the actual situation of regional economic level and government support ability, the guidance and utilization of new funds and resources after the disaster, the available human, material and financial resources will be invested in the corresponding departments in a certain proportion. Through the allocation of resources, the regional basic / non-basic economic activities can be promoted to different degrees, and the integration of regional economic activity structure can be realized.

## 5. Conclusions

The promotion of economic resilience is an important part of building a sustainable development city. The structure of urban economic activity is related to the regional ability to resist disaster risk and the recovery level after the disaster disturbance. The stability and the recovery driving force of economic structure are two important aspects to measure the regional economy resilience. In this paper, the influence of Wenchuan earthquake on regional economic activity is studied, and the economic resilience of Wenchuan area is further analyzed. The results show that:

(1) The disturbance of earthquake disaster to the economic development of Wenchuan area is obvious. In terms of recovery drivers, the Investment, Government Finance, Social Finance, Transportation and Social Welfare become the internal drivers of the post-disaster economy, while Industry, Retail Trade, Construction, Education and HealthCare also need external support for development.

(2) In the economic activity structure, the sectors of finance, investment, construction, transportation and social welfare

have undergone “basic-non-basic” reverse changes after the earthquake. This reflects that they are most sensitive to disaster disturbance, but also reflects the city lack of disaster response stability.

(3) In Wenchuan area, sensitive sectors are the key to the short-term rapid recovery of economic system. And stable economic sectors are crucial to long-term post-disaster economic growth. On the basis of this, the strategy of improving economic resilience is put forward, such as “taking history as mirror”, “focusing on sensitive sectors”, “recessive sectors optimization” and “economic structural integration”.

By identifying the sensitive departments to the disturbance of disasters, the variation of economic activity structure before and after the earthquake is analyzed. And some suggestions for improving the resilience are given. We hope to provide valuable measurement methods, identifying the sectors that should be supported in the aftermath of disasters and provide decision-making basis for economic restructuring and industrial upgrading in disaster-risk areas. Finally, the goal of improving economic resilience and building sustainable development economic system will be achieved.

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