Resources Policy 82 (2023) 103522

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Economic resilience assessment and policy interaction of coal resource oriented cities for the low carbon economy based on AI

Yue Deng [a,b], Wanyi Jiang [a], Zeyu Wang [c,*]

[a] Institute of Quality Development Strategy, Wuhan University, Wuhan, Hubei, 430072, China
[b] Population and Health Research Center, Zhongnan University of Economics and Law, Wuhan, Hubei, 430073, PR China
[c] School of Public Administration, Guangzhou University, Guangzhou, Guangdong, 510006, China

ARTICLE INFO

Keywords:
Low-carbon economy
Coal-resource-oriented cities
Economic resilience
Economic architecture
AI

ABSTRACT

This study aims to evaluate the economic growth of coal-resource-oriented cities under Low-Carbon (LC) economic growth. The public participation mechanisms are promoted, and the vitality of the economic market of resource-oriented cities is enhanced by increasing the intervention of government policies. Firstly, the context of the coal-resource-oriented cities and LC economy are analysed. Secondly, an economic resilience assessment system for coal-resource-oriented cities is established, characterized by traditional and high-tech industries through the analysis of the condition of resource-oriented cities. Finally, in the process of optimizing and managing the economic structure, the assessment of the LC evolution path of resource-oriented cities is strengthened through the extensive participation of the general public. The results show that the economic resilience level of coal-resource-oriented and traditional cities fluctuates and increases from 2011 to 2021. In 2011, the economic resilience index of traditional cities and coal-resource-oriented cities was 0.11and 0.22. By 2021, traditional cities' and coal-resource-oriented cities' economic resilience assessment stability was 0.527 and 0.562. This study has pivotal reference value for promoting urban resource management and economic efficiency.

1. Introduction

Developing a Low-Carbon Economy (LCE) is necessary for both country and domestic resource-oriented cities (Andersen et al., 2018; Jing and Wang, 2020; Wang and Yu, 2021). With the gradual advancement of China's industrial modernization, more and more resources and energy will be required for growth, giving resource-oriented cities dominated by resource-oriented industries the opportunity to develop and prosper. However, with the massive extraction of resources, the increasing sophistication of the required extraction technologies, and the rapid rise in the cost of extraction, the prosperity of resource-oriented cities is necessarily unsustainable. The cost of its growth is irreversible, and the environmental damage is enormous. For resource-oriented city growth practice, the deep-seated contradiction between the continuous expansion of demand for high-carbon economic growth and the finite resources of cities has become increasingly apparent. Thus, the growth of the LCE has principal guiding significance for improving the economic vitality of resource-oriented cities.

With rapid urbanization, cities are undergoing significant changes in all aspects. Cities face shocks and disturbances such as economic crises, resource depletion, and extreme weather disasters (Brokalaki and Comunian, 2021; Batty, 2020). How to make cities resist and enhance their ability to cope with risks and disturbances so that they can adapt to disturbances and achieve better growth of learning absorption and innovation capabilities is more urgent. With the over-exploitation of coal, urban growth faces many contradictions and problems. Studying the economic resilience of coal-resource-oriented cities can lead to a new direction for sustainable urban growth. Additionally, the impact factors can be identified through qualitative and quantitative analysis of the economic resilience of coal-resource-oriented cities. The future economic growth prospects of cities can be predicted, and the existing urban growth problems can be further clarified. Therefore, targeted policy recommendations can be formulated to improve urban economic resilience (Deng et al., 2021).

With LC economic growth, an assessment index system for the economic resilience of resource-oriented cities is constructed here. The relevant conceptual theories are organized, and the existing research results are referred to. The optimization of the LC economic growth path

* Corresponding author.
E-mail address: theowang@gzhu.edu.cn (Z. Wang).

https://doi.org/10.1016/j.resourpol.2023.103522
Received 16 December 2022; Received in revised form 22 February 2023; Accepted 26 March 2023

of resource-oriented cities is carried out by analyzing the growth prospects of resource-oriented cities. The theoretical meaning of LCE is to develop an economic model based on low energy consumption, low pollution, and low emission. The core connotation is the innovation of energy technology and emission reduction technology, industrial structure and system innovation, and the fundamental change of the concept of human survival and development. In the context of carbon neutrality, LCE has practical application value for the reform of urban development mode. The main innovation is to promote the continuous improvement of urban economic progress by reducing government policy intervention and deepening the reform of the state-owned enterprise system. This study has practical reference value for the future growth of the economic indexes of coal-resource-oriented cities.

2. Recent work

2.1. Research on the LCE and resource-oriented city growth

The growth and balanced management policies of the urban LCE are studied. For example, Yang et al. (2019) researched China's LC economic path and balanced management strategy. They summarized the path of China's LCE in terms of energy, industry, LC cities, circular economy, and LC technologies. Some policy suggestions were put forward to develop China's future LCE. These policy recommendations would enable a well-rounded LC transition in China through a rationally viable LC pathway. Research had practical application value for improving weather change and environmental problems. Zhang et al. (2019) evaluated the effectiveness of LC economies in sustainable growth. They measured the correlation between the efficiency of LC economies and the level of economic growth from a global perspective. From a dynamic perspective, global LC economic performance improved significantly during the survey, with an overall annual growth rate of 0.75%. Louche et al. (2019) investigated financial markets and transition strategies to an LCE. They helped financial markets perform a pivotal role in the transition to an LCE through a logic-based theory. The results showed that price efficiency and risk-adjusted return efficiency hindered the effective integration of the LCE in financial markets to some extent. Liu et al. (2020) studied the imbalance problem of LC growth in China and proposed a new comprehensive inequality index to measure this problem. The study extended the spatial decomposition model to explore factors of inequality. Ionescu (2021) conducted an empirical study on the correlation among green finance behavior, climate change mitigation, and environmental and energy sustainability. The results signified a significant correlation between the natural world and economic sustainability. Murshed et al. (2021) studied the role of the clean energy transition in achieving an LCE by assessing the impact between energy consumption and other key macroeconomic variables in Bangladesh. The results indicated that the clean energy transition could become a critical means of developing an LCE and solving environmental pollution.

In addition, LC economic policies are closely related to developing resource-oriented cities. Li and Zhang, 2021 examined the relationship among an LCE, food safety, and agricultural mechanization. They implemented a simultaneous equation model to explore the correlation among food security, agricultural automation, and agricultural carbon emissions in China. The method was validated using the ordinary least squares method. The results revealed that the organic combination of an LCE, food security, and agricultural mechanization could positively impact environmental protection. Yu et al. (2019) researched the identification and category of resource-oriented cities in China. They analysed the indexes and thresholds for identifying and categorizing resource-dependent cities using the theory and method of urban functional classification. They also explored the different connotations and features of the type of city. The results provided a basis for the scope and classification of resource-oriented cities. Xiao et al. (2021) studied the role of the coordinated growth of socio-economy and ecological environments in resource-oriented cities. A comprehensive assessment index system was constructed by coordinating the relationship between socioeconomic growth and the ecological environment. The results suggested that the sustainable growth of resource-oriented cities needed to promote high and new technologies to improve production efficiency. In summary, in the growth process of resource-oriented cities, the industry is the pillar of economic growth. The main focus of energy production and consumption is on the industry. Through the optimization of urban industrial growth policies, the coordinating role of the economic market can be effectively played, which can stimulate the economic vitality of the market and improve the utilization rate of resources in the city and the economic resilience of the urban system as a whole.

2.2. Research on urban economic resilience assessment and policy intervention

Regarding the assessment of urban economic growth and resilience indexes, Faggian et al. (2018) provided a preliminary assessment of regional economic resilience in the Italian region by analyzing the Italian local labor system. The findings expressed that regional economies were sensitive to recessionary shocks in the local labor system. Di Pietro et al. (2021) studied the resilience factors of regional economic growth in the European Union by measuring regional vulnerability, resistance, and resilience indexes in each region. The results indicated that the region's response to external disturbances varied depending on the nature of the impact. Regions highly resilient to supply-side recessionary shocks might be less resilient to demand-side shocks. Pretorius et al. (2021) explored policy pathways to regional economic resilience in developing countries by investigating economic resilience policies in the Southern African region. The results suggested that economic openness, export market dynamics, and sectoral composition might affect the economic resilience of urban growth. Saputro and Suwito (2022) studied the factors of economic resilience in asymmetric warfare by analyzing urban economic life and dynamic conditions. The results manifested that in the growth of resource-oriented cities, the economic resilience of the digital economy, digital bureaucracy, and banking industry needs to be further enhanced through national policies.

In addition to the regulating role of the economic market itself, it can be seen through empirical analysis that the level of urban growth is closely related to the government's policy intervention. Wang et al. (2018) evaluated indexes of urban circular economy growth through an empirical study in 40 cities in China. They proposed an assessment index system for developing urban consumer electronics, using an improved entropy method combining expert weighting and entropy weighting. The results implied that the urban circular economy had improved significantly in recent years. Jiang et al. (2019) explored the application of the resistance model in urban ecological land use efficiency assessment. The land cover type, distance from roads, and distance from residential areas were used as important indexes to protect the regional ecosystem structure. The findings denoted a significant correlation between the level of urban economic growth and the efficiency of urban ecological land use. Surya et al. (2021) examined renewable energy use and sustainable urban growth. The results demonstrated that the use of energy resources needed to be optimized to support economic growth and the growth of urban areas. The efficiency of energy management and the effectiveness of the distribution process were required to be improved. Liu et al. (2021) studied the coupling and coordination of urban economic growth and ecological environment in the Yellow River basin. They used coupled coordination model and geographically weighted regression analysis to construct an assessment index system for economic growth and ecological environment. Madaleno et al. (2022) researched the correlation among incubators, accelerators, and urban economic growth. They combined theory and evidence on incubator and accelerator programs and their impact on urban economic growth. The findings suggested that government policy intervention was momentous in promoting urban economic resilience. Wang et al. (2022) investigated enterprise resource optimization based on an artificial intelligence (AI) algorithm and modeled project features, user behaviors, and content features with neural network algorithm. Ultimately, a neural network algorithm-based recommendation and resource optimization model for cultural and creative industry venture projects is constructed. The results denoted that with the increase in training time, the recognition accuracy of the model reached 81.64%. Wang et al. (2022) explored network public opinion (NPO) risk prediction and credibility detection by using blockchain technology and regulated by blockchain technology and NPO. They pointed out that the designed experimental scheme can reasonably predict the risk and test the credibility of non-profit organizations. Wang et al. (2022) studied edge computing technology in enterprise performance and venture capital management, and the supplier performance evaluation results manifested that the partnership between venture capital enterprises and suppliers was affected by various factors.

To sum up, the main problem encountered in this study is that there are too many factors affecting regional economic fluctuations, and urban economic resilience has an important reference value for the economic transformation of the whole city. Thereupon, the study addresses the "old" problem of LC urban regional economic development by assessing urban economic systems and adopting an innovative approach such as AI and economic resilience assessment.

3. Economic resilience assessment and growth path optimization of coal-resource-oriented cities

3.1. Analysis of LCE and resource-oriented city growth prospects

In the face of resource and environmental pressures, the economic growth mode characterized by high carbon in the past is difficult to sustain. A new economic form characterized by low carbon is taking shape (Sarker et al., 2018). From industrial structure, some traditional industries characterized by high emissions have gradually adjusted and withdrawn. LC industries, represented by high-tech industries, have progressively become strong. From the perspective of enterprise production, LC production links are required to promote upgrading technical equipment. Moreover, there is a trend of cross-border formation of ecological industrial chains to realize the application of resource cycle reduction. Thereby, the LCE of resource-oriented cities has broad growth prospects. The structural framework of resource-oriented urban growth is analysed. Fig. 1 presents the structure.

3.2. Assessment and analysis of economic resilience of coal-resource-oriented cities

Coal-resource-oriented cities refer to economic, geographical areas with common economic characteristics, social functions, and environmental attributes formed by coal mining and processing. The resilience of urban economic systems is complex (Bulut et al., 2019). The level of economic resilience is affected by a combination of factors. Hence, a single analysis of the resilience index of the overall urban economic resilience system and a comparative analysis of the economic resilience of various subsystems cannot explain the reasons for the change. Further research is needed on the main factors affecting urban economic resilience. On the one hand, it can clarify the main reasons for the change in urban economic resilience. On the other hand, it can propose targeted countermeasures and suggestions according to the characteristics of the city and formulate relevant policies to enhance the city’s economic resilience. The economic resilience assessment system of resource-oriented cities is studied, and the structure is exhibited in Fig. 2.

3.3. Optimization of LC economic growth path and policy intervention

Implementing LCE strategies can enhance cities’ stable growth and innovation capabilities in the face of unknown risks and disturbances (Fagerberg, 2018; Mensah, 2019; Gazzola et al., 2020) to achieve further growth in the city. It is vital to improve the scientific nature of LC assessment of resource-oriented cities and promote the understanding and participation of all stakeholders in the LC growth path. It is significant to strengthen the LC growth of resource-oriented cities. However, the LC growth of resource-oriented cities is inseparable from the extensive participation of governments at all levels, entrepreneurs, scientific research institutes, intermediary institutions, and the general public. Strengthening the assessment of the LC growth path of

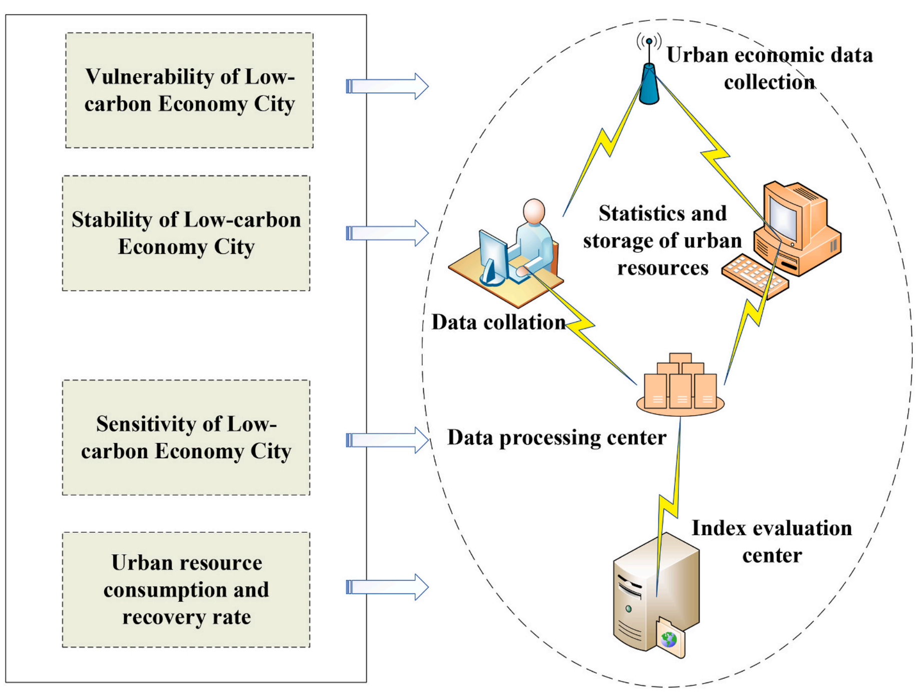

Fig. 1. Structural framework diagram of resource-oriented urban growth.

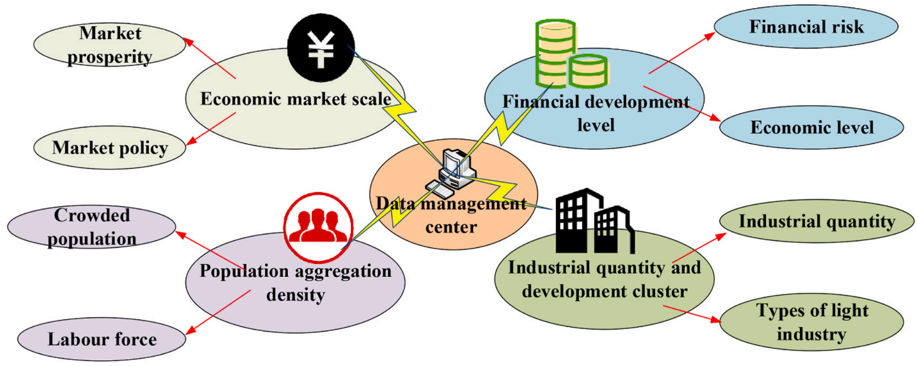

Fig. 2. Economic resilience assessment and management system of resource-oriented cities.

resource-oriented cities, for one thing, is conducive to promoting the whole society to establish awareness of the optimal LC growth path and actively implement it into action to achieve LC growth as soon as possible. Additionally, it is necessary to strengthen the leading responsibility and the government's LC management level. For another, strengthening relevant assessment in such cities can effectively play a supervisory role. Besides, it is crucial to strengthen the awareness of LC growth among all stakeholders and achieve steady growth in the economic level of resource-oriented cities through policy intervention. The growth path of the urban LCE is optimized. The architecture of optimal management of the economic system is displayed in Fig. 3.

3.4. Data acquisition and experimental analysis

This paper uses a simulation experiment methodology to verify the conjecture. At the same time, the specific experimental methods and the computers and other equipment used are given below. First, the study needs to assess indexes of economic resilience in resource-oriented cities. A coal-resource-oriented city A on the mainland is used as the research object through the collation of literature data. City A's urban economic growth index data in the 11 years from 2011–2021 is extracted. Moreover, a traditional city B is selected as the reference object for the experiment to compare the difference between coal resource cities and other ordinary cities regarding economic resilience. The urban economic growth index data of city B in the 11 years from 2011–2021 are also extracted. The main research data sources are the "China Urban Statistical Yearbook", "China Urban Construction Statistical Yearbook", as well as "National Economic and Social Development Statistical Bulletin". The nonlinear function model of econometrics is used to optimize the data, and the measurement work is performed through the analysis of economic indexes data. Besides, this study mainly adopts the existing measurement methods in the field of

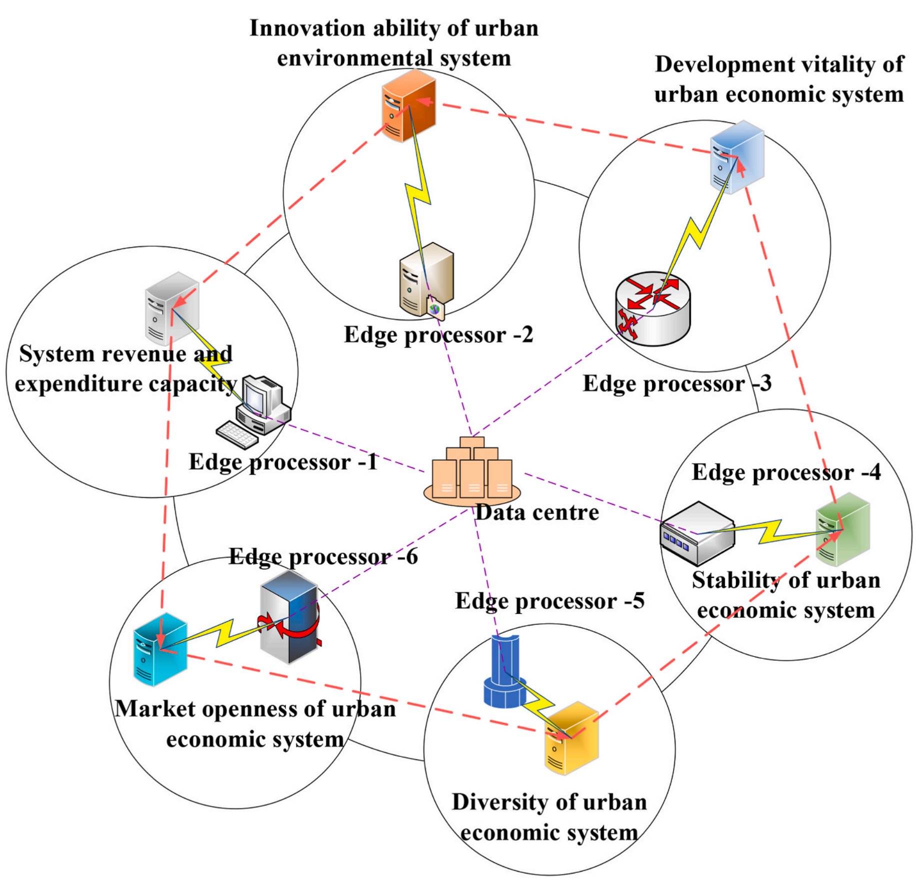

Fig. 3. Growth path architecture of the urban LCE.

information management for analysis, because these methods can directly use known information to explain variables and explain the causal relationship between different variables through the stepwise regression method. The economic growth level between cities A and B is evaluated using factors such as urban economic resilience index, resource consumption, and recovery coefficient, economic resilience of resource-oriented industry growth, resilience index of market economy scale, data sensitivity of economic assessment, and stability of model assessment. The overall performance of economic resilience of coal-resource-oriented cities is analysed. The architectural model of the resilience assessment is revealed in Fig. 4.

Furthermore, in the process of establishing the economic resilience assessment model of resource-oriented cities, it is crucial to evaluate and summarize the economic structure and economic system construction of cities based on scientific principles, systematic principles, and operable principles combined with the resources and economic growth conditions of resource-oriented cities. In the experimental analysis, it is first necessary to preprocess the collected data to eliminate the dimensional and order of magnitude differences of various data indexes. For the data studied here, to analyze the role of carbon emissions in the development of urban economic data, the economic resilience index data of "traditional cities" and "coal cities" are compared to further analyze the role of carbon emissions in urban economic development. The main comparative situation takes Chinese cities as examples, which can also be applied to other foreign cities, thus evaluating the effect of LCE resilience on urban development. Additionally, the research data is collected from the 10 years from 2011 to 2021, and there is a correlation between one or more explanatory variables and error terms in the model, which may lead to the endogenous problem of panel data. In order to solve this problem, the instrumental variable method and the two-stage least square method are used for measurement, and sample screening is employed to further figure out the endogenous problem of variables. The data preprocessing process is performed in SPSS software, and the experimental environment settings of the software are outlined in Table 1.

Table 1
Experimental environment settings.

Experimental environment	Operating system	Memory	Storage hard disk	Video memory	Processor
Specific information	Windows10	16 GB	5.2T	8 GB	i7-7Y75

4. Results and discussion

4.1. Economic resilience indexes and resource consumption assessments for different types of cities

The economic resilience data between coal-resource-oriented and ordinary cities are compared to evaluate the difference in economic resilience and resource consumption between resource-oriented and ordinary cities. In 2011–2021, the trend of economic resilience index data of different cities is portrayed in Fig. 5. Moreover, the resource consumption and recovery of different types of cities are analysed, and the results are illustrated in Fig. 6.

Fig. 5 portrays that in terms of the temporal dynamic evolution trend of economic resilience in various cities, the changing trend of economic resilience in different cities is fluctuating, and the level of data change has improved significantly. From 2011 to 2021, the economic resilience level of coal-resource-oriented and traditional cities fluctuated and increased. In 2011, the economic resilience index of traditional cities was 0.11, and that of coal-resource-oriented cities was 0.22. In 2021, the resilience index of traditional cities increased by 0.30, while that of coal-resource-oriented cities was 0.38. Therefore, the resilience assessment performance of coal-resource-oriented cities is higher than that of traditional cities.

Fig. 6 displays that over time, the two cities' internal resource consumption and resource recovery indexes are increasing yearly in changing the resource consumption and recovery performance data of traditional and coal-resource-oriented cities. In 2011, the resource consumption and recovery coefficient of traditional cities were 0.18, while that of resource-oriented cities were 0.33. In 2021, resource-oriented cities' resource consumption and recovery coefficient

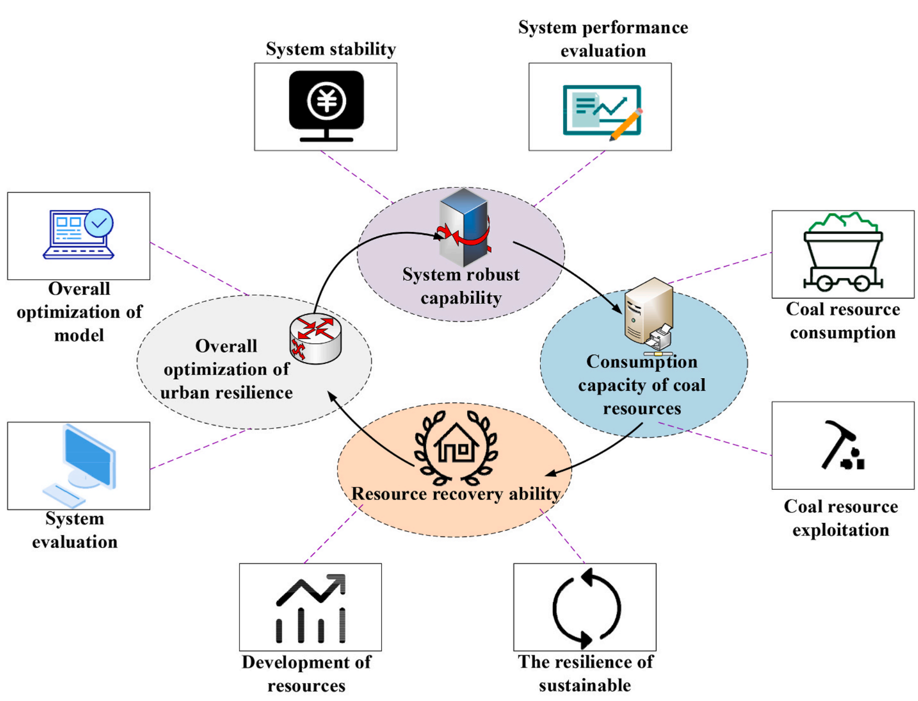

Fig. 4. Architectural model diagram of economic resilience assessment.

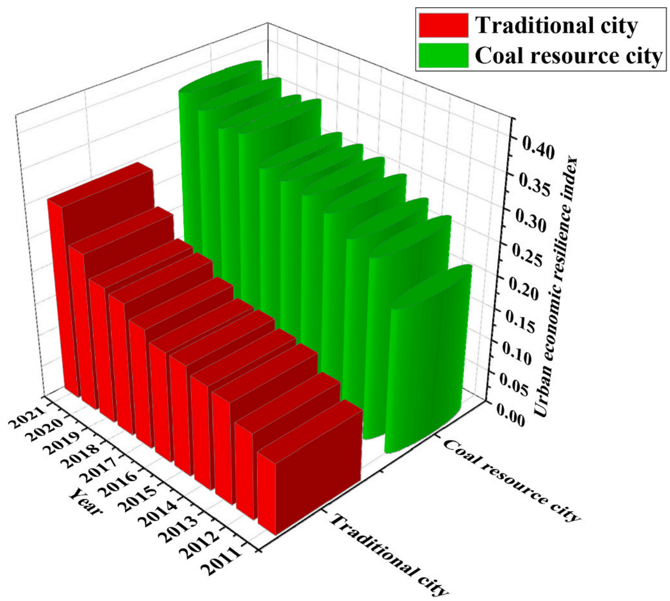

Fig. 5. Changes in economic resilience indexes of traditional and coal-resource-oriented cities.

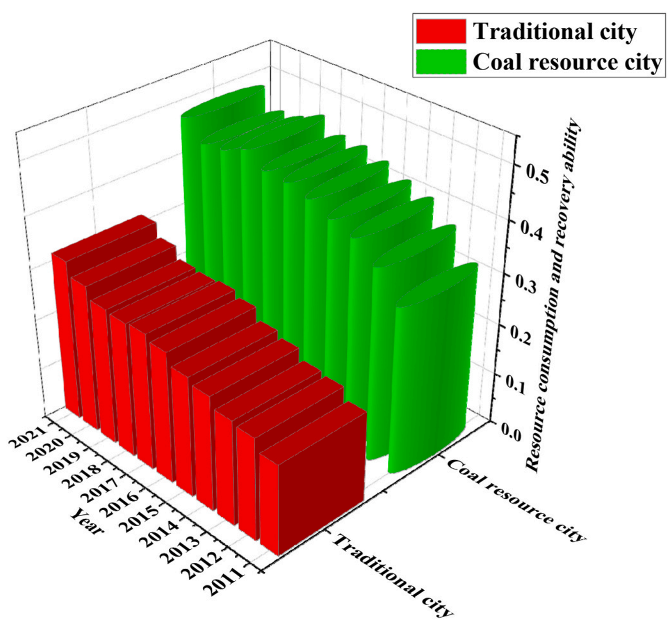

Fig. 6. Changes in resource consumption and resource recovery coefficient in traditional and coal-resource-oriented cities.

increased by 0.48. Thus, the resource consumption gap between two cities is gradually growing.

4.2. Growth of resource-oriented industries and assessment of market economy scale in different kinds of cities

The horizontal values are used here to reflect the fact that coal resource cities and traditional cities actually grow in tandem. Beyond that, it is necessary to consider the scale efficiency of the city's resource-oriented industry growth and market economy in developing resource-oriented cities. The statistics on the resource industry growth data of resource-oriented and ordinary cities are suggested in Fig. 7. Statistics are provided on the change of resilience indexes of the scale of the market economy in these two different cities over time. The results are outlined in Fig. 8.

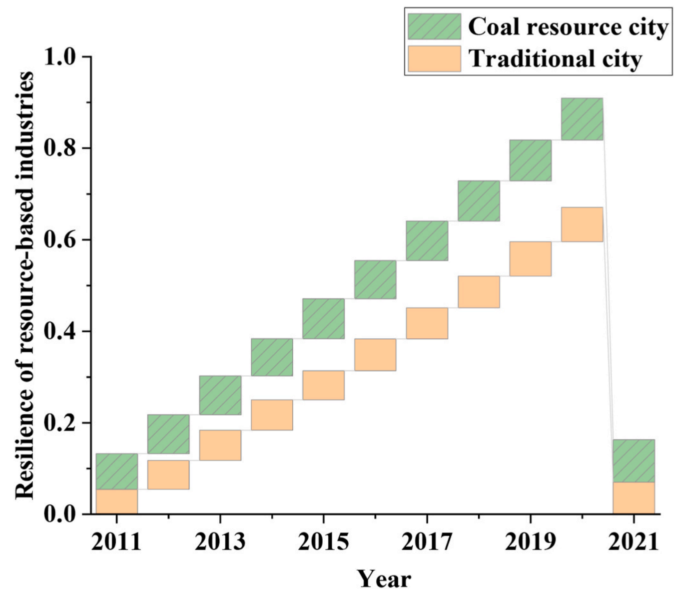

Fig. 7. Growth trend of economic resilience of resource-oriented industry growth in different cities over time.

Fig. 7 implies that the economic resilience of the growth of resource-oriented industries in diverse cities continues to grow with time, and the growth of resource-oriented industries is vital in promoting the economic level of cities. In traditional cities, the economic resilience data of industrial growth was 0.054 in 2011 and increased to 0.070 in 2021. In resource-oriented cities, the economic resilience index of industrial growth was 0.078 in 2011, and the economic resilience index rose to 0.093 in 2021. Therefore, the growth of resource-oriented industries is the only way to promote the sustainable economic growth of coal cities.

Fig. 8 shows that the size of the urban market economy has an essential impact on assessing economic resilience indexes. Among them, economic resilience indexes mainly reflect the economic growth level of resource-oriented cities. In 2011, the resilience index of the market economy of traditional cities was 0.075, while that of coal-resource-oriented cities was 0.112 at this time, which was higher than that of

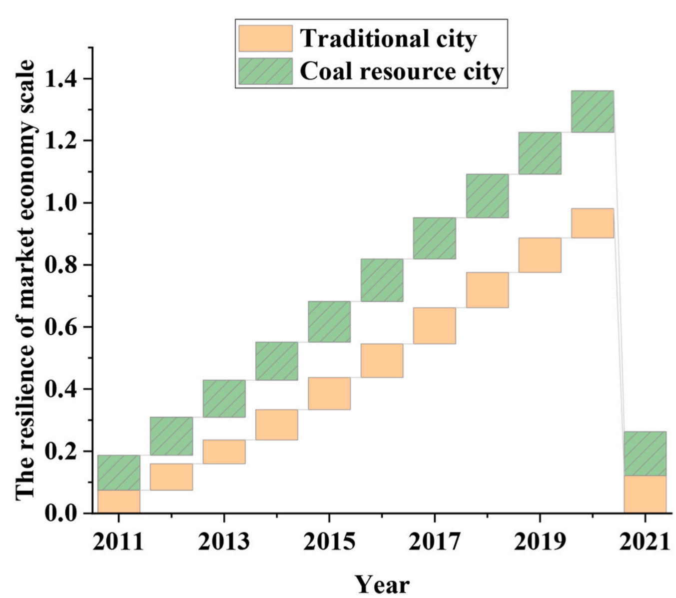

Fig. 8. Growth trend of resilience indexes of the market economic scale in different cities over time.

conventional cities. In 2021, the resilience index of the market economy of traditional cities and coal-resource-oriented cities was 0.122, and 0.141. In coal cities, emerging industrial clusters develop. It can be seen that the scale of the market economy in cities is large, and the indexes of economic resilience are higher than those of traditional cities.

4.3. Comparison of the results of economic assessment of different kinds of cities

It is necessary to compare the assessment results of economic indexes of different kinds of cities to assess the resilience growth indexes of coal-resource-oriented cities. The data sensitivity curves of the economic assessment of different city types in the system are plotted in Fig. 9. Moreover, the model stability data of economic assessment of different city types are studied, and the results are demonstrated in Fig. 10.

Fig. 9 reveals that in the urban growth system, the sensitivity of economic indexes of traditional and resource-oriented cities is increasing yearly. In 2011, the data sensitivity index of traditional cities was 0.16, while that of coal cities was 0.25. In 2021, the data sensitivity index of coal resource cities and traditional cities was 0.24 and 0.19, indicating that the data sensitivity index of coal resource cities has declined. Coal-resource-oriented cities have a larger number of processing industries, so they are more sensitive to data on market economic fluctuations. A significant decline in economic indexes may cause a severe crisis, so it is necessary to pay enough attention to cities' economic indexes and data sensitivity.

The stability of resilience assessments in economic systems is compared between different city types. In 2011, the economic resilience assessment stability of traditional cities and coal-resource-oriented cities was 0.185, and 0.307. In 2019, traditional cities' and coal-resource-oriented cities' economic resilience assessment stability was 0.457 and 0.481. In 2021, the economic resilience assessment stability of these two types of cities was 0.527 and 0.562, respectively. For the stability of urban economic systems, the stability level of coal-resource-oriented cities is significantly higher than that of traditional cities. Beyond that, from the empirical results, Figs. 5 and 6 display the economic resilience index and resource consumption evaluation coefficient of different cities. Figs. 7 and 8 describe the evaluation coefficient of the market economy scale, while Figs. 9 and 10 express the evaluation results of the economic system of different city types. There is an internal logical relationship between these figures, which is mainly reflected in the variations of economic data between coal-resource-oriented cities and traditional cities. The empirical results demonstrate that coal-resource-oriented cities are more sensitive to the evaluation results of market economic data, and the range of economic indexes depends more on the planning and scheduling of urban resources.

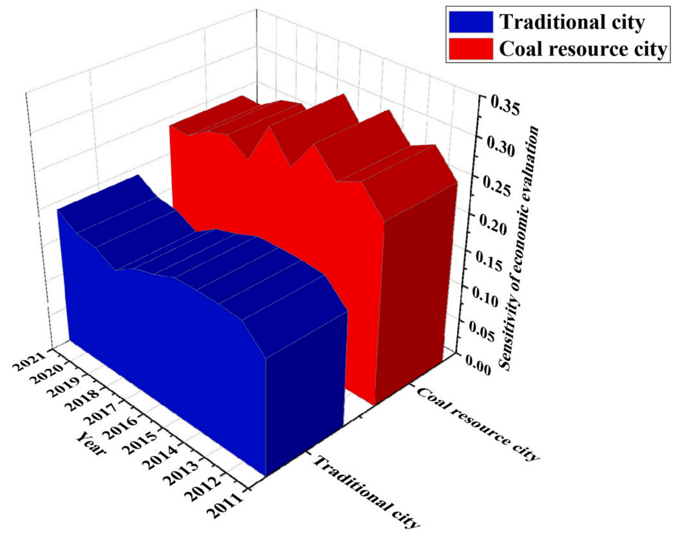

Fig. 9. Trends in data sensitivity of economic assessment of different kinds of cities in the system.

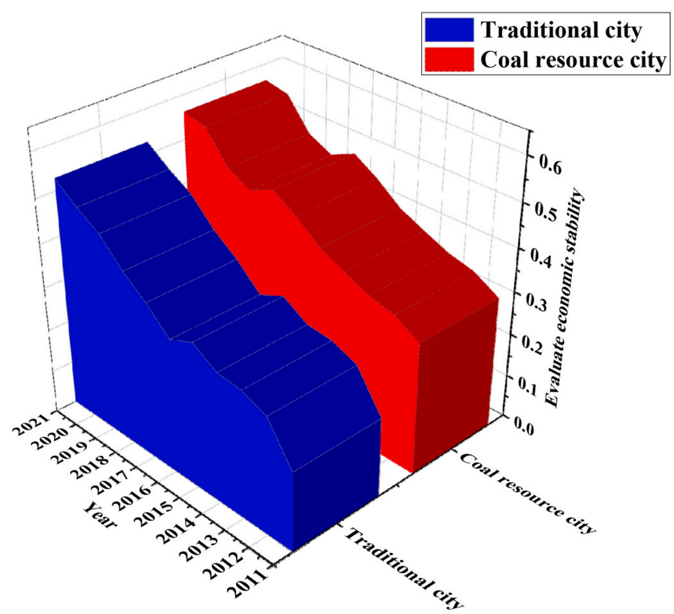

Fig. 10. Model stability trends of economic assessment of different city types in the system.

5. Conclusion

In recent years, the economic system and urban-rural integration structure of coal-resource-oriented cities have significantly been affected by the growth of an LCE. In the growth process of resource-oriented cities, this study collates the research literature related to urban economic resilience assessment and policy intervention for developing urban infrastructure and economic systems. First, an economic resilience assessment system for coal-resource-oriented cities is established starting from the background of an LCE. Then the optimization strategy of the economic growth path is systematically explored by analysing the government's policy intervention. The results are as follows. In 2021, the resilience index of the market economy of traditional cities and coal-resource-oriented cities was 0.122 and 0.141. However, there are some limitations. The main limitation of this study is that in the process of constructing the assessment indexes of the urban economic system, the selection of indexes is not perfect. Therefore, future exploration should evaluate the economic resilience of cities from multiple perspectives to improve the economic assessment mechanism of coal-resource-oriented cities.

Author statement

The authors declared no mutual conflict of interest.

Conceptualization, Zeyu Wang; Methodology, Zeyu Wang; Software, Zeyu Wang; Validation, Zeyu Wang; Formal Analysis, Yue Deng and Wanyi Jiang; Investigation, Zeyu Wang and Yue Deng; Resources, Zeyu Wang; Data Curation, Wanyi Jiang; Writing – Original Draft Preparation, Yue Deng, Zeyu Wang; Writing – Review & Editing, Zeyu Wang; Visualization, Zeyu Wang; Supervision, Yue Deng and Zeyu Wang; Project Administration, Yue Deng and Zeyu Wang.

Data availability

The authors do not have permission to share data.

References

Andersen, A.D., Marín, A., Simensen, E.O., 2018. Innovation in natural resource-based industries: a pathway to development? Introduction to special issue. Innovat. Dev. 8 (1), 1–27. https://doi.org/10.1080/2157930X.2018.1439293.

Batty, M., 2020. The Coronavirus crisis: what will the post-pandemic city look like? Environ. Plan. B Urban Anal. City Sci. 47 (4), 547–552. https://doi.org/10.1177/2399808320926912.

Brokalaki, Z., Comunian, R., 2021. Beyond the hype: art and the city in economic crisis. City 25 (3–4), 396–418. https://doi.org/10.1080/13604813.2021.1935766.

Bulut, N.S., Çarkaxhiu Bulut, G., Yorguner Küpeli, N., Genç, H.A., Aktaş, İ., Yaşar, V., Topçuoğlu, V., 2019. Living in difficult conditions: an analysis of the factors associated with resilience in youth of a disadvantaged city. Psychaiat Clin. Psych. 29 (4), 587–596. https://doi.org/10.1080/24750573.2018.1505281.

Deng, X., Jin, G., He, S., Wang, C., Li, Z., Wang, Z., Chen, J., 2021. Research progress and prospect on development geography. J. Geogr. Sci. 31 (3), 437–455. https://doi.org/10.1007/s11442-021-1852-x.

Di Pietro, F., Lecca, P., Salotti, S., 2021. Regional economic resilience in the European Union: a numerical general equilibrium analysis. Spatial Econ. Anal. 16 (3), 287–312. https://doi.org/10.1080/17421772.2020.1846768.

Fagerberg, J., 2018. Mobilizing innovation for sustainability transitions: a comment on transformative innovation policy. Res. Pol. 47 (9), 1568–1576. https://doi.org/10.1016/j.respol.2018.08.012.

Faggian, A., Gemmiti, R., Jaquet, T., Santini, I., 2018. Regional economic resilience: the experience of the Italian local labor systems. Reg. Stud. Reg. Sci. 60 (2), 393–410. https://doi.org/10.1007/s00168-017-0822-9.

Gazzola, P., Pavione, E., Pezzetti, R., Grechi, D., 2020. Trends in the fashion industry. The perception of sustainability and circular economy: a gender/generation quantitative approach. Sustainability 12 (7), 2809. https://doi.org/10.3390/su12072809.

Ionescu, L., 2021. Transitioning to a low-carbon economy. Geopolit. Hist. Int. Relat. 13 (1), 86–96. https://doi.org/10.22381/GHIR13120218.

Jiang, W., Cai, Y., Tian, J., 2019. The application of minimum cumulative resistance model in the assessment of urban ecological land use efficiency. Arabian J. Geosci. 12 (23), 1–7. https://doi.org/10.1007/s12517-019-4888-9.

Jing, Z., Wang, J., 2020. Sustainable development evaluation of the society–economy–environment in a resource-based city of China: a complex network approach. J. Clean. Prod. 263, 121510 https://doi.org/10.1016/j.jclepro.2020.121510.

Li, W., Zhang, P., 2021. Relationship and integrated development of low-carbon economy, food safety, and agricultural mechanization. Environ. Sci. Pollut. Res. 28 (48), 68679–68689. https://doi.org/10.1007/s11356-021-15465-2.

Liu, K., Qiao, Y., Shi, T., Zhou, Q., 2021. Study on coupling coordination and spatiotemporal heterogeneity between economic development and ecological environment of cities along the Yellow River Basin. Environ. Sci. Pollut. Res. 28 (6), 6898–6912. https://doi.org/10.1007/s11356-020-11051-0.

Liu, Y., Wang, M., Feng, C., 2020. Inequalities of China's regional low-carbon development. Geopolitics, J. Environ. Manage. 274, 111042 https://doi.org/10.1016/j.jenvman.2020.111042.

Louche, C., Busch, T., Crifo, P., Marcus, A., 2019. Financial markets and the transition to a low-carbon economy: challenging the dominant logics. Organ. Environ. 32 (1), 3–17. https://doi.org/10.1177/1086026619831516.

Madaleno, M., Nathan, M., Overman, H., Waights, S., 2022. Incubators, accelerators and urban economic development. Urban Stud. 59 (2), 281–300. https://doi.org/10.1177/00420980211004209.

Mensah, J., 2019. Sustainable development: meaning, history, principles, pillars, and implications for human action: literature review. Cogent soc.sci. 5 (1), 1653531 https://doi.org/10.1080/23311886.2019.1653531.

Murshed, M., Ahmed, Z., Alam, M.S., Mahmood, H., Rehman, A., Dagar, V., 2021. Reinvigorating the role of clean energy transition for achieving a low-carbon economy: evidence from Bangladesh. Environ. Sci. Pollut. Res. 28 (47), 67689–67710. https://doi.org/10.1007/s11356-021-15352-w.

Pretorius, O., Drewes, E., van Aswegen, M., Malan, G., 2021. A policy approach towards achieving regional economic resilience in developing countries: evidence from the SADC. Sustainability 13 (5), 2674. https://doi.org/10.3390/su13052674.

Saputro, G.E., Suwito, S., 2022. Economic resilience in asymmetric warfare. Jurnal pertahanan: media informasi ttg kajian & strategi pertahanan yang mengedepankan identity. Nasionalism & Integrity 8 (1), 109–117. https://doi.org/10.33172/jp.v8i1.1587.

Sarker, M.N.I., Hossin, M.A., Anusara, J., Chanthamith, B., Kumar, N., 2018. Practices of low carbon economy in China: challenges and opportunities for economic development. Low Carbon Econ. 9 (1), 18. https://doi.org/10.4236/lce.2018.91002.

Surya, B., Muhibuddin, A., Suriani, S., Rasyidi, E.S., Baharuddin, B., Fitriyah, A.T., Abubakar, H., 2021. Economic assessment, use of renewable energy, and sustainable urban development Mamminasata Metropolitan, Indonesia. Sustainability 13 (3), 1165. https://doi.org/10.3390/su13031165.

Wang, N., Lee, J.C.K., Zhang, J., Chen, H., Li, H., 2018. Evaluation of Urban circular economy development: an empirical research of 40 cities in China. J. Clean. Prod. 180, 876–887. https://doi.org/10.1016/j.jclepro.2018.01.089.

Wang, Y., Yu, L., 2021. Can the current environmental tax rate promote green technology innovation?-Evidence from China's resource-based industries. J. Clean. Prod. 278, 123443 https://doi.org/10.1016/j.jclepro.2020.123443.

Wang, Z., Lu, J., Li, M., Yang, S., Wang, Y., Cheng, X., 2022. Edge computing and blockchain in enterprise performance and venture capital management. Comput. Intel. Neurosci. 2022. https://doi.org/10.1155/2022/2914936.

Xiao, Y., Li, Y., Huang, H., 2021. Conflict or coordination? Assessment of coordinated development between socioeconomic and ecological environment in resource-based cities: evidence from Sichuan province of China. Environ. Sci. Pollut. Res. 28 (46), 66327–66339. https://doi.org/10.1007/s11356-021-15740-2.

Yang, W., Zhao, R., Chuai, X., Xiao, L., Cao, L., Zhang, Z., Yao, L., 2019. China's pathway to a low carbon economy. Carbon Bal. Manag. 14 (1), 1–12. https://doi.org/10.1186/s13021-019-0130-z.

Yu, J., Li, J., Zhang, W., 2019. Identification and classification of resource-based cities in China. J. Geogr. Sci. 29 (8), 1300–1314. https://doi.org/10.1007/s11442-019-1660-8.

Zhang, Y., Shen, L., Shuai, C., Tan, Y., Ren, Y., Wu, Y., 2019. Is the low-carbon economy efficient in terms of sustainable development? A global perspective. Sustain. Dev. 27 (1), 130–152. https://doi.org/10.1002/sd.1884.

Yue Deng, associate professor at the Institute of Quality Development Strategy of Wuhan University, focuses on labor and labor security, and the role of labor in the digital economy. Contact Email: dengyue@whu.edu.cn

Wanyi Jiang , Institute of Quality Development Strategy, Wuhan University , Wuhan 430072, CN , Luojia Hill, Wuchang District, Wuhan 430072, Hubei, CN , mailto:jwanyi1026@163.com

Zeyu Wang, male, holds a doctor's degree in management. He is currently an assitant professor at the School of Public Administration, Guangzhou University. His research interest is digital economy and management innovation. Email: theowang@gzhu.edu.cn