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IMPACT OF GOVERNMENT SUPPORT POLICIES ON REGIONAL ECONOMIC RESILIENCE UNDER THE COVID-19 OUTBREAK

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Abstract. Using the policy package pilot implemented in Hubei Province, China, in April 2020 as a natural experiment, we use the synthetic control (SC) and synthetic difference in differences (SDID) methods to estimate the impact of the Chinese government's support policy on the economic resilience and to analyze the mechanisms by which it impacts. This study finds that the policy package has contributed to the growth of economic resilience in the pilot provinces, with the policy package increasing the average economic resilience of the pilot provinces by 0.062 compared to their potential resilience. The validity and robustness of the above conclusions are objectively confirmed by multidimensional quantitative outcomes such as placebo tests, ranking tests, and replacements in calculating resilience. The mechanism analysis shows that the investment in real estate development, the stimulus for consumption, and the core industry development are virtual channels for the policy package to promote economic resilience growth in the pilot provinces. Moreover, traditional investment in transportation fixed assets plays a minor role. This paper quantitatively corroborates the academic idea that government governance capacity affects regional economic resilience (RER), and research can provide empirical support for regional economic recovery and policy support under a major crisis.

Keywords: COVID-19, government support policies, regional economic resilience, policy packages, synthetic control.

JEL Classification: H12, H50, P25, R11, R58.

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Introduction

The regional economy always encounters various uncertain impacts or disturbances in development. The global financial crisis broke out in 2008, causing many countries and regions to face economic difficulties. Scholars began associating the different manifestations of regional economies under external shocks with resilience (Davies, 2011), triggering a research boom on regional economic resilience (RER). In 2020, the sudden COVID-19 caused the global economy to fall into recession. This COVID-19 pandemic provided a new shock scenario for the study of RER (Hu et al., 2022; Wang et al., 2022). Due to the lack of static characteristics of RER and significant differences in the nature, impact time, and diffusion mechanism of different types of shocks, RER may vary significantly under different shock scenarios. However, existing research is mostly based on the impact scenario of financial crises, analyzing RER's connotation, characteristics, and influencing factors (Davies, 2011; Martin, 2012; Martin &

Sunley, 2020), and there is relatively little research on economic resilience under other types of shocks. The exogenous impact of COVID-19 is different from other crises in the past. The industrial or regional directionality of the crisis is weaker. The development and change of the crisis may not be controlled by human will, and there is a high degree of temporal and spatial uncertainty. When resilience is conceptualized as long-term adaptability in uncertain situations, the resilience of a region to cope with shocks may depend more on human agency elements, including the decisions, behaviors, and actions made by agents to cope with shocks (Bristow & Healy, 2014; Martin & Sunley, 2015). After a regional impact, local agents can respond to the negative impact of the impact and open up new economic growth paths by implementing effective intervention policies (Martin et al., 2015). At present, research on RER in the context of the pandemic's impact has also drawn on the experience of financial crisis response and, to some extent, emphasized the positive role of agents in policy intervention (Brada et al., 2021). Since the outbreak of the pandemic, governments at all levels in various countries have introduced intervention policies to cope with the impact of the pandemic, mainly including containment policies, as well as macroeconomic policies that mainly subsidize distressed enterprises in the form of fiscal and monetary support (Makin & Layton, 2021), usually with support policies formulated later than containment policies (Hale et al., 2021).

In response to the pandemic's impact, government support measures in many developing countries may not be effective due to challenges with monetary policy transmission. Additionally, fiscal space and fiscal multiplier are often limited in these countries (Loayza & Pennings, 2020). As the world's largest developing country, how to respond to sudden public crises and uncertain risks is a great test of China's governance ability. Unlike other countries, China is a highly fiscal decentralized economy, with local governments having greater power to formulate local economic development policies and obtain taxes from local economic growth (Xu, 2011). However, the urgency of public crisis management is mismatched with the limited resources of local governments, which greatly restricts the timeliness and effectiveness of local government intervention. Public financial investment is the key to the success or failure of emergency response to crises (Jerch et al., 2023). When the economic entities of a region lack the necessary resources and capabilities, without external support, including the central government, the regional economy may not fully recover from the interruption (Martin & Sunley, 2015). Existing research increasingly considers the impact of factors outside specific locations on RER, especially those related to national policies (Giannakis & Bruggeman, 2017; Webber et al., 2018). COVID-19 serves as a test of governance and control at multiple levels, and the intervention of national institutions plays an important role in shaping RER (Hu et al., 2022).

Whether and to what extent the national government has taken specific measures to assist the areas that the impact has particularly hit will affect the distribution of RER (Martin, 2012). Following the Covid-19 outbreak, China's state institutions significantly impacted the RER through top-down planning and reorganization of the economy (Hu et al., 2022). As the center of the domestic epidemic caused by COVID-19, the economy of Hubei Province has suffered the most, facing great challenges in recovery and revitalization. In the first quarter of 2020, the GDP of Hubei Province decreased by 39.2% year on year, and other major economic indicators declined to varying degrees. On April 29, 2020, the Chinese government studied and deployed measures to improve regular pandemic prevention and control and determined

a package of policies to support the economic and social development of Hubei Province. Moreover, they have established specific measures in six aspects, including fiscal revenue, financial credit, investment and foreign trade. These measures provide a strong guarantee for the comprehensive restoration of economic and social order as well as the consolidation of long-term development foundations in Hubei Province in the shortest time. According to official data from China, Hubei Province's economy has been steadily recovering. In 2021, the region's GDP reached 5001.294 billion yuan, which is 4.8 percentage points faster than that of the entire country.

The package of policies endorsed by the Chinese central government for local economic recovery and development is an important measure taken to promote the resumption of work and production during the pandemic, providing an opportunity to evaluate the economic effects of government-specific support policies. Based on the panel data from 11 provinces in China spanning the first quarter of 2018 to the fourth quarter of 2021, this paper will utilize the pilot provinces as treatment groups to scientifically evaluate the economic effects of the pilot policy and further explore its channels of action. The article's marginal contribution is demonstrated in the following manner. First, from the perspective of the central government policy intervention to stimulate the recovery and development of the local and regional economy, it enriched the literature on the impact of national support policies on RER in COVID-19. Although the existing literature has touched upon the relationship between government support policies and RER, most of them have focused on the impact of the financial crisis and rarely consider how national institutions' policy interventions affect regional economic recovery and development. This paper will discuss the role of central government support policies in improving RER under the impact of the COVID-19 pandemic, and provide recommendations for improving the efficacy of government-specific support. Secondly, this article presents empirical evidence regarding the efficacy of comprehensive support policies implemented in response to the pandemic's impact. Most existing literature has explored the effectiveness of various support policies to restore overall economic stability during the pandemic from a macro-level perspective or by evaluating selected microeconomic entities as objects of study for a support policy effectiveness assessment. Research on the economic effect of support policies from the regional level is still rare. In addition, most of the economic support policies implemented by the country to cope with the impact of the pandemic need clear regional direction, making it challenging to identify the overall impact of comprehensive support policies on the regional economy. This article will combine the basic situation of pilot policies in local areas and comprehensively use the synthetic control (SC) Method and synthetic difference in differences (SDID) evaluation methods to examine the impact of the Chinese government's package of policies on RER, expanding the scope of quantitative research in this field.

1. Theoretical background and research hypothesis

1.1. Policy background

Hubei Province holds a pivotal position as a market hub, connecting various regions of China and playing a crucial role in the Yangtze River Economic Belt, one of the nation's key strategic initiatives. As severely affected by the pandemic, Hubei has suffered unprecedented economic and social losses. Revitalizing the province's economy will not only aid its recovery but also serve as a catalyst for bolstering the national economy. On April 29, 2020, the central government confirmed a package of policies to support the economic and social development of Hubei. These policies encompass fiscal, tax, and financial credit measures that primarily serve as compensatory and protective actions. For instance, the phased-in reductions in social insurance premiums and taxes aim to alleviate the financial burdens on enterprises and residents, thus enhancing the vitality of market entities. It also covers measures of a developmental nature, such as accelerating the issuance of special bonds to stimulate the steady growth of infrastructure. The investment and foreign trade policies mainly focus on developmental initiatives, such as the construction of critical facilities like pandemic treatment bases, national clinical medical centers, emergency rescue bases, and foreign trade platforms. The projects involved in scientific and technological innovation and industrial policy have a relatively long promotion cycle, mainly focusing on new infrastructure construction, industrial transformation, nurturing of new enterprises, and scientific and technological project incubation. The employment and livelihood policies and poverty alleviation policies are mainly protective policies aimed at specific targets to coordinate and promote the restoration of economic development order. By the end of the reporting period, the central support package for Hubei covers 31 items in 6 aspects, and 28 items have been fully implemented, accounting for 90.3%. Three items need to be continuously promoted across the year. The main tasks being continuously promoted are to support the development of strategic emerging industries, jointly build vital national laboratories and clinical medical research centers at the provincial and ministerial levels, and increase the investment support of industrial funds.

1.2. Connotation and measurement of regional economic resilience

In the early stages of the formation of the concept of RER, scholars mainly emphasized the ability of regional economies to withstand external shocks (Christopherson et al., 2010), and Martin (2012) further extended the concept of RER from the dimension of resilience to the dimension of sustainable growth within regional economic systems. Martin and Sunley (2015) believe that RER is a dynamic self-adjustment ability that mainly includes four dimensions or stages: vulnerability, resistance, robustness, and recovery. This definition focuses on reflecting the dynamic process of system change and has been recognized and adopted by many scholars. In addition, the academic community is still exploring the measurement of RER, and different scholars have designed various measurement methods based on the research focus. On the one hand, based on the system's state, a comprehensive indicator system for economic resilience has been designed (Briguglio et al., 2009; Martin et al., 2016; Shi et al., 2022).

On the other hand, based on the system evolution process, a single indicator is selected to calculate the regional sensitivity index to measure economic resilience (Simmie & Martin, 2010; Martin, 2012). Alternatively, economic resilience can be measured by combining the relationship between core variables in the process of responding to regional shocks, such as using the dynamic relationship between employment and economic growth to estimate the economic situation of each region without external shocks and obtaining economic resilience by comparing the difference between the counterfactual situation and the actual situation (Doran & Fingleton, 2018). By comparison, building a comprehensive indicator system does not require setting a benchmark state as a reference. The indicator system covers a wide range and can depict RER from multiple perspectives.

1.3. Evaluating the economic impact of supporting policies during the COVID-19 pandemic

The research on assessing the economic impacts of supporting policies during COVID-19 has focused mainly on the macro-scale of the country. Regarding the micro impact of policies, existing literature has mostly selected enterprises and vulnerable groups as the core objects for empirical analysis (Wright et al., 2020; Duan et al., 2020). From the resource dependence theory perspective, government support policies provide sufficient resources for market economy entities, enhance their adaptability to the environment, and reduce the impact of the external environment on market entities (Amezcua et al., 2013). However, for the economic recovery of a region, in addition to market entities directly supported by the government, market entities within the region that do not receive direct support will also be affected by spillover effects. Therefore, analyzing subsidy effects only at the micro level is not conducive to a deeper understanding of the role of government support policies in promoting economic growth (Guo & Zhang, 2022). Most previous studies on shock response have shown that supportive policies implemented by governments, such as commonly used fiscal and monetary policies, have played a positive role in regional economic recovery (Eggertsson, 2008; Mishkin, 2009). Among them, the support policies implemented by the government to respond to shocks may be single, non-coherent, or a comprehensive package (Hepburn et al., 2020), and appropriate policy combinations can enhance policy sustainability and the effectiveness of economic recovery (Brainard, 1967; Wang et al., 2023). Due to the ongoing COVID-19 pandemic, the economic effects of supporting policies in various regions have not yet been fully revealed. Therefore, existing research focuses more on the impact of government support policies on RER after the financial crisis. For example, Tan et al. (2020) studied resource-based cities in China and found through the decomposition of RER that regions with abundant resources and central policy support can better withstand the global financial crisis. At present, some scholars have explored the impact of economic support policies implemented by local governments on regional economic growth in the context of the post-pandemic era. For example, Jiang et al. (2023) pointed out that the economic support policies implemented by various provinces in China positively impact regional economic recovery. However, the impact of comprehensive support policies at the national level on RER in the context of the pandemic's impact must be clarified.

On the one hand, there are significant differences in the focus of different support policies within the region, making it difficult to obtain specific data for each policy in empirical analysis to estimate the stimulus effect of the support policies comprehensively. Secondly, not all forms of support are expected to have an economic impact in the short term (Engström et al., 2020). Most policies have a lag effect from their introduction to implementation, and economic entities often need to meet certain conditions to enjoy preferential policies. The existence of lag effects and policy barriers makes it highly likely that economic entities in the region will have negative expectations for future operations due to the impact of the pandemic in the short term and ultimately choose to exit the market. Therefore, empirical testing of the stimulus effect of government support policies on RER during the pandemic has essential theoretical and practical reference significance.

1.4. The package of support policies and economic resilience in the context of the impact of the pandemic

After the impact, regional economies are relatively sensitive to the impact of the combination policies adopted by the government. The adaptability and consistency of the combination policies directly affect the final effectiveness of the region in responding to external shocks (Mei, 2020). Martin et al. (2016) pointed out that the contribution of financial institutions is crucial in responding to economic downturns caused by external shocks. Interest rates are the most direct way for monetary policy to affect the real economy, mainly affecting investment, asset prices, and exchange rates to influence economic recovery and growth (Inoue & Rossi, 2019). During the outbreak of the pandemic, Chinese state-owned banks responded to the government's call to support the lending of small and medium-sized enterprises in Hubei Province by reducing loan interest rates and financing costs (Liu et al., 2022). The main market economy entities can use monetary and credit policies to initiate new economic activities, which may promote regional economic recovery. Fiscal policies usually promote economic growth by increasing expenditures, increasing tax and fee reductions, and expanding the scale of local government special bonds. During periods of economic recession, the government promotes consumption and investment through direct investment. Public capital investment can increase purchasing power and money supply, which is beneficial for promoting regional economic activity (Baxter & King, 1993).

Moreover, local governments can use the low-cost financing advantages of treasury bonds to raise funds to increase tax and fee reductions further. Minor changes in corporate income tax rates can lead to rapid changes in GDP (Thornton, 2007). Other particular support policies mainly focus on implementing major projects, with measures such as special investment in core technology research, support for strategic emerging industries, and construction of major technological infrastructure closely related to economic updates. Sustainable investment projects will positively impact economic development (Doerr et al., 2020). Supported by strong public policies at the local, especially at the national level, structural reforms, new technologies, and re-integration are three factors conducive to addressing the impact of COVID and achieving economic recovery and renewal (Song & Zhou, 2020). Finally, improving social security and development policies can meet the needs of specific groups,

mainly through job creation and short-term demand stimulation (Karim et al., 2020), which is conducive to reducing vulnerability and improving crisis response capabilities. Different policies have different focuses, and they are combined to meet the needs of different stages of the business cycle to achieve a stable and rapid economic recovery.

Based on the above analysis, the article proposes the first hypothesis.

H1. *The Chinese policy package can promote RER.*

The government played the role of a "stress relief wall" during the pandemic, stimulating short-term demand from different economic entities in Hubei Province through measures of compensation and protection such as tax reduction and fee reduction, unemployment benefits distribution, and rent reduction to resist the negative impact of the impact. Short-term economic recovery relies on demand stimulus, while long-term economic growth also requires increased supply (Arnold et al., 2011). The supporting policies inject momentum into stable regional economic growth by implementing development measures such as special investments in core technology research and major technological infrastructure construction. Therefore, this article combines the characteristics of crises and policy backgrounds to extract and summarize the impact paths of three supportive policies on RER.

Economic resilience with funding support can not only change the shape of the economic recovery path but also cope with adverse effects in the recovery process and improve the performance of regional economies (Martin & Sunley, 2015; McCartney et al., 2021). The emphasis on long-term investment in fixed and illiquid assets opens up more possibilities for productive investment and helps overcome the crisis tendency inherent in evolution (Jessop, 2006). Transport infrastructure is the backbone of local and regional economies because it enhances accessibility between consumers and markets, which is linked to conditions of increased resilience in regional economic systems and helps maintain the diversity and accessibility of systems. Chacon-Hurtado et al. (2020) highlighted the importance of analyzing transportation infrastructure and other investment projects beyond just increasing road density. It's essential to consider how these investments can promote diverse employment opportunities for workers after a crisis, ultimately improving the resilience of the local economy. However, where debt is financed, excessive unproductive investment can exacerbate economic fragility (Ansar et al., 2016). Additionally, international competition and high-quality regional development require updated infrastructure under the new situation. Investment focusing on new infrastructure construction has the strongest stimulating effect on the medium- and long-term growth potential (Pradhan et al., 2021). Compared with traditional infrastructure, new infrastructure has a stronger trickle-down effect on micro, small, and medium enterprises (MSMEs). For example, digital finance can break through traditional distance constraints and reduce risk through risk control technologies such as big data and cloud computing, thus reducing the cost of financing for MSMEs, helping them to obtain financing and promoting entrepreneurial activities. And entrepreneurship can provide more jobs and promote regional development (Samila & Sorenson, 2011). Urban fixed asset investment includes not only infrastructure construction, renovation and transformation but also real estate development investment. China is undergoing rapid urbanization, and many cities are experiencing the problem of hot investment in real estate. Real estate investment accounts for a large proportion of fixed asset investment (Wu et al., 2015). Mai et al. (2021) showed that urban fixed

asset investment is positively correlated with urban economic resilience. After the impact of the crisis, policy guidance to promote rational investment in fixed assets is conducive to improving the adverse impact of the crisis on risk resistance. In terms of real estate investment and economic growth in China, Chen et al. (2011) estimated the relationship between real estate investment and regional economic growth using provincial-level data in China, noting that there is a stable long-term relationship between real estate investment and GDP in China, with housing investment being both a driver and a follower of the Chinese economy. Under normal circumstances, real estate investment attracts numerous laborers to enter the real estate industry and promote regional employment. Simultaneously, the increased investment in real estate development also drives the demand for upstream industries, such as cement and steel, and the growth of downstream industries, such as building materials, furniture and decoration, which help drive the economic recovery. Thus, we propose the following hypothesis:

H2. *A package of policies has enhanced RER by increasing fixed investment.*

Previous studies on economic downturns have shown that the consumption-income ratio of most middle and low-income groups will decrease after the crisis, and increased inequality and related demand drag can explain the economy's slow recovery (Cynamon & Fazzari, 2016). The impact of this pandemic on consumption is the most prominent, and the suppressed consumer market is also the most significant drag on the Chinese economy. The international market constantly changes, and the export situation is not optimistic. Stimulating domestic demand is a very effective measure to cope with the impact. Due to the pandemic's impact, some people have temporarily lost their jobs, and credit card repayments have been affected. Therefore, the government adopts the method of directly distributing unemployment benefits, which can maintain the stability of private consumption levels, the stability of the financial system, and ultimately the stability of the overall regional economy. In addition, during periods of economic downturn, vulnerable households are the first to suffer. The disposable income of vulnerable households has decreased significantly, directly affecting their consumption expectations (Kim et al., 2022). From an economic perspective, cash subsidies can contribute to regional economic recovery through income effects. Subsidies can increase the nominal income of subsidy recipients, assuming that prices remain unchanged in the short term, which increases the actual income of subsidy recipients, thereby increasing budget levels and enhancing consumer spending power. The mechanism of the issuance of consumer vouchers on economic recovery is directly manifested as a substitution effect. The government can use the price leverage function of consumption vouchers to issue consumption vouchers to a portion of goods in the market (especially for consumer categories with high price elasticity), causing those goods that do not receive a subsidy from consumption vouchers to lose their price advantage in the market temporarily. Consumers will tend to use consumption vouchers to purchase more affordable goods. Secondly, the issuance of consumer vouchers is mainly aimed at industries where local demand has decreased significantly and the pandemic has greatly impacted businesses. The government can adjust the industry in terms of consumption structure and content, which can reduce the risk of impact on specific sectors, blunt the short-term impact of the crisis on the economy, and help regions achieve rapid self-repair. In addition, during economic downturns, the effect of the government increasing household consumption through transfer payments is very significant (Liu

et al., 2021). The increase in consumption drives enterprise production, provides employment opportunities, and employment promotes consumption. The entire process is not only a virtuous cycle but also has a multiplier effect, which can promote rapid recovery and renewal of the regional economy. In summary, this article proposes the following assumptions:

H3. *A package of policies can enhance RER by stimulating residents' consumption.*

Enterprises have created the most employment opportunities in the economy and are places where productivity is created and real wage decisions are made (Makin & Layton, 2021). The government supports enterprises in core industries, guiding them to carry out production and operation activities actively, helping them develop and grow, and forming a virtuous industrial development cycle (Murphy et al., 1989). At the same time, the government can also use policies such as research and development subsidies and tax incentives to guide supported enterprises to invest more resources in technological innovation activities in order to improve the level of technological innovation of enterprises and their industries, and thereby promote the overall development of the industry. The significance of developing regional core industries for RER lies in establishing new paths for employment growth in the post-crisis recovery and renewal stage, promoting regional structural adjustment (Martin, 2012). On the one hand, the core industries that promote regional economic recovery can be the region's pillar industries. The position of pillar industries in the entire industrial structure of a region is very important, and they have solid external effects on related industries. Due to the high correlation between the pillar and related industries, the knowledge exchange distance between industries is relatively close. It can facilitate and quickly promote communication and exchange between entities, promote industrial resource sharing, stimulate new ideas and knowledge, and generate spillover effects (Boschma, 2015). Moreover, this correlation between industries can lead to the entry of new industries and the decline of old industries, promoting the accelerated evolution of regional industrial structure (Neffke et al., 2011).

On the other hand, the core industries that drive regional economic recovery can be strategic emerging industries. After the pandemic, the region needs to update its development path with new industries as support to adapt to changes in the internal and external environment. Previous studies have shown that the productivity improvement brought about by upgrading regional industrial structure is one of the driving forces for sustained economic growth. Suppose specific industries have higher productivity growth potential than other industries. In that case, the industrial structure adjustment that is conducive to the development of these industries will have a significant promoting effect on regional economic growth (Peneder, 2003). In addition, the development of emerging industries has nurtured and created more job opportunities (Johnson, 2019). Especially since the outbreak of the pandemic, the platform-based employment model has gradually been accepted by enterprises and workers. The new employment form will become an essential component of social employment, helping workers maximize their value and enhancing the ability of enterprises to cope with uncertainty. In summary, this article proposes the following assumptions:

H4. *A package of policies can enhance RER by promoting the development of core industries in the region.*

2. Research design

2.1. Evaluation method and model design

In the second quarter of 2020, Hubei Province began to be the only province that was supported by a package of policies. Since other provinces did not receive special support from the central government, we regard the package of policies as a trial for the pilot provinces. In this paper, we will refer to the research of Abadie et al. (2010) and Jia et al. (2021) and conduct a case study on Hubei Province using the SC method. The SC method is based on a weighted average of several control group areas based on data characteristics to construct a "synthetic area" as the control group that matches the most with the economic fundamentals of the treatment group. Then, the impact of the package of policies on RER is evaluated by comparing the trend differences of economic variables between "real regions' and "synthetic regions" before and after the implementation of the support policy.

It is assumed that the RER of 1 + J regions in the $t \in [1, T]$ period is observed. While R_{it}^N is the RER of province i when a package of policies in the t period does not support it, R_{it}^Y is the RER of province i when the policy supports it during t. Since it is assumed that province i will be supported by a policy package in the second quarter of 2020, the RER of all regions from the first quarter of 2018 to the first quarter of 2020 will not be affected by the pilot policies, satisfying the formula $R_{it}^N = R_{it}^Y$. From the second quarter of 2020 to the fourth quarter of 2021, the change in the pilot province's economic resilience due to the policy's implementation is $\alpha_{it} = R_{it}^Y - R_{it}^N$. The economic resilience, R_{it}^Y, of province i after the implementation of the support policy can be observed, while the data R_{it}^N of the province without the implementation of the policy cannot be observed. Therefore, the article uses the factor model based on parametric regression proposed by Abadie et al. (2010) to estimate the "counterfactual" variable R_{it}^N, which is expressed in Equation (1):

$$R_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it}. \tag{1}$$

Equation (1) represents the determining equation of the potential RER, wherein δ_t denotes the time-fixed effects affecting the economic resilience of all regions; Z_i and μ_i are either a set of observable or unobservable control variables that are not affected by a package of policies, relatively; θ_t and λ_t are the corresponding time-varying parameters; ε_{it} denotes the unobservable short-term shocks with a mean of zero.

It is assumed that the fake Hubei is constructed according to the weight vector $W = \left(w_2, \cdots, w_{j+1}\right)$ for each province i except for the province with i = 1 (*i.e.*, the Hubei province). In the weight vector expression, w_j denotes the weight contributed by the jth province in the synthesis of the fake Hubei, and it subjects to $w_j \geq 0$ while $w_2 + \cdots + w_{j+1} = 1$. Hence, the value of the outcome for each province in the control group can be expressed as Equation (2):

$$\sum_{j=2}^{J+1} w_j R_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt}. \tag{2}$$

Suppose there exists a weight vector $W^* = \left(w_2^*, \cdots, w_{j+1}^*\right)$ that satisfies Equation (3):

$$\begin{aligned}&\sum_{j=2}^{J+1} w_j^* R_{j1} = R_{11}, \sum_{j=2}^{J+1} w_j^* R_{j2} = R_{12},\\ &\cdots\\ &\sum_{j=2}^{J+1} w_j^* R_{jT_0} = R_{1T_0}, \sum_{j=2}^{J+1} w_j^* Z_j = Z_1.\end{aligned} \tag{3}$$

If $\sum_{t=1}^{T_0} \lambda_t' \lambda_t$ is a non-singular matrix, then Equation (4) can be obtained:

$$R_{1t}^N - \sum_{j=2}^{J+1} w_j^* R_{jt} = \sum_{j=2}^{J+1} w_j^* \sum_{s=1}^{T_0} \lambda_t \left(\sum_{n=1}^{T_0} \lambda_n' \lambda_n \right)^{-1} \lambda_s' \left(\varepsilon_{js} - \varepsilon_{1s} \right) - \sum_{j=2}^{J+1} w_j^* \left(\varepsilon_{jt} - \varepsilon_{1t} \right). \tag{4}$$

Typically, the time period before implementing policy is longer relative to the time period after implementation, and the mean of the right-hand side of Equation (4) will converge infinitely to 0. Therefore, $\sum_{j=2}^{J+1} w_j^* R_{jt}$ can be utilized as an unbiased estimator of R_{1t}^N, and the estimated impact of the policy package on the RER is expressed as Equation (5):

$$\hat{\alpha}_{1t} = R_{1t} - \sum_{j=2}^{J+1} w_j^* R_{jt}. \tag{5}$$

The specific solution procedure is described in detail in Abadie et al. (2010).

2.2. Control group selection and variable selection

2.2.1. Selection of control group

Among many provinces in China, selecting provinces with similar economic and social development levels to Hubei Province is more comparable. For example, neighboring Hubei provinces have similar cultural, historical, and other common characteristics. Moreover, these provinces have not been supported by the central government with such a wide range of influence and strong pertinence in the sample period, which provides a unique "natural experiment" opportunity to verify the stimulating effect of government support policies on RER. This paper selects the control group concerning the Comparison Report on the Evaluation of the Comprehensive Economic and Social Development Index of 31 Provinces issued by the "Science of the Comprehensive Economic and Social Development Index of China" Research Institute every year. The report evaluates the country's comprehensive economic and social development level of 31 provinces according to the indicators and data released by the government and each province every year. It divides it into four levels according to each province's comprehensive economic and social development index. Among them, Hubei Province is at the third level (level C) affected by the pandemic in 2020, and the other years are at the second level (level B). Therefore, the paper takes the provinces in the second level before the policy implementation (2018 and 2019) as the control group of quasi-natural experiments. Considering that Shanxi Province is close to Hubei Province, the comprehensive economic and social development index is close to that of Hubei Province after the decline in 2020. Therefore, we include Shanxi Province, which ranks in the third level, in the control group. After removing the provinces with more missing data in the sample period, a control group set of 10 provinces was finally obtained.

2.2.2. Variable selection

(1) Synthetic variable

Considering that the spread of the pandemic has not ended and the exploration of new growth paths in the region is a long-term process. This article mainly constructs a comprehensive indicator system through two dimensions to measure RER, which are divided explicitly into impact resistance (the ability to resist external shocks and maintain its structure and function based on factors such as foundation, including economic scale, social development, and foreign investment dependence), adaptability and resilience (the ability to maintain the original economic operation mode after external shocks, including the characteristics of various economic entities adapting to shocks). This article draws on the approach of Shi et al. (2022) and uses the objective weighting method (entropy weighting method) to construct the indicator system of RER. Firstly, based on the indicator's nature, the negative indicator's inverse is taken as a positive value before calculation. To avoid the impact of dimensionality on the results, the minimax idea is used to standardize the data, and the original data matrix is standardized to form a standardized matrix. Secondly, use entropy theory to calculate indicator weights. Table 1 contains the specific indicators.

(2) Selection of predictors

To simulate the pre-event characteristics of the treated group (Hubei Province) as much as possible, based on the common practices of previous literature (Hu et al., 2022; Wang et al., 2022; Chen et al., 2023) and in combination with the typical characteristics of China's regional economy and the availability of data, this paper selects some commonly used factors that affect economic resilience. Specifically, it includes: (1) the level of regional economic development (*NigLig*). In this paper, the average light intensity value of the province is used as the proxy variable of the economic development level. The night light data has the advantages of objectivity and continuity of time and space, which can more objectively measure the economic development level of a region. (2) The degree of foreign economic connection (*fdiSh*) is measured by foreign-invested enterprises' total import and export volume. (3) Human capital (*Book*). The per capita library collection expresses it. (4) Innovation capability (*Inn*). This paper is characterized by the number of invention patents authorized (Weng et al., 2023). (5) Degree of local government support (*Gov*). This paper is characterized by the ratio of total fiscal expenditure to GDP. (6) Information level (*Inf*). Informatization is based on modern communication. This paper is characterized by the number of regional mobile phone users. Among them, local government intervention, as a key factor leading to changes in economic resilience, can better characterize all aspects of the synthetic "treated unit". Considering the potential impact of the package of policies on local government intervention, we introduce its lag variable. Secondly, the change in RER may be related to the magnitude of the shock. In some regions, the economic resilience has decreased significantly, which may be due to the greater impact on these regions than that of other regions, rather than their lower resilience. Moreover, there are differences in the level of resumption of work and production in various regions affected by the shock, which may also affect the recovery of the regional economy. To control for differences in the magnitude of pandemic shocks to various regions, the impact variable (*Shock*) is added to the model. In this paper, the ratio of newly confirmed

Table 1. Regional economic resilience indication system

Primary index	Secondary index	Specific index	Unit	Computing method	Expected impact on RER
Resistance	Economic scale	GDP growth rate	%	(GDP in the current quarter – GDP in the previous quarter)/GDP in the previous quarter	+
		Per capita disposable income of residents	Yuan	(Total family income – income tax payment – individual social security payment – accounting subsidy)/family population	+
	Industrial structure	Advanced industrial structure	%	Added value of the tertiary industry/added value of the secondary industry	+
	Foreign trade dependence	Foreign trade dependence	%	Total import and export of goods/GDP	–
Adaptation and recovery	Financial development	Capital utilization efficiency of banking industry (deposit to loan ratio)	%	Loan balance of financial institutions/deposit balance of financial institutions	+
		Social financing scale	%	Social financing scale/GDP	+
		Market activity of virtual economy	%	Transaction amount of securities/GDP	+
	Enterprise stability	Losses of industrial enterprises above designated size	%	Total losses of industrial enterprises above designated size/total assets of industrial enterprises above designated size	–
	Market vitality	Commodity market activity	%	Total retail sales of social consumer goods/GDP	+
	Government efficiency	Financial self-sufficiency rate	%	Budget revenue/budget expenditure	+
	Social services	Minimum number of residents living guarantee	person	Minimum number of urban residents living guarantee	–

cases in each province to the number of permanent residents is a standardized density index to measure. In addition, this paper also controls the indicator of regional population flow (*PassTra*) because the pandemic prevention and control measures have hindered the flow of population elements between regions to varying degrees. The main influencing factors of passenger turnover are the size of passenger volume and the length of the average passenger journey. This indicator can reflect the impact of the pandemic and the connection between regions from the side.

2.3. Data description and sample description

Based on the availability of data and the consistency of statistical caliber, this paper selects the relevant data of 11 provinces from the first quarter of 2018 to the fourth quarter of 2021 to empirically analyze the impact of the package of policies on the RER. Among them, the data on the construction of the economic resilience indication system is mainly from the statistical database of the China Economic Information Network (db.cei.cn). The data on the added value of the regional secondary industry and the added value of the tertiary industry are from the prospective data (qianzhan.com). In the control variables, NPP-VIIRS light data is from the National Geophysical Data Center of the United States (https://eogdata.mines.edu/download_dnb_composites.html); The regional invention patent authorization data was manually retrieved on the China Patent Star Search Platform (cprs.patentstar.com.cn); COVID-19 data is from the wind database (wind.com.cn); The rest of the data are from the statistical database of China Economic and Social Network and the websites of provincial statistical bureaus. This paper deals with the data as follows: (1) Except for the variables measured by proportion or ratio, the other variables are logarithmic. Some missing data are supplemented by linear interpolation. (2) Because the quarterly data of some variables cannot be obtained, they need to be consolidated into quarterly data according to the basic characteristics of the variables. Then, the X-13 program in the EViews software is uniformly called to adjust the data seasonally. (3) When the unit of the price variable is absolute, we use the corresponding price index to deflate. Using quarterly data for analysis should use the quarter-on-quarter index, but China has only published the month-on-month index. With reference to Chen (2008), we multiply the monthly month-on-month price index of the three months in each quarter to get the quarterly month-on-month data and then use the price index corresponding to the variable to carry out the adjustment with the first quarter of 2017 as the base period. The descriptive statistical results of all variables are shown in Table 2.

Table 2. Descriptive analysis results

Variable symbol	Variable descriptions	Mean	Sd	Min	Max
RER	Regional economic resilience	0.362	0.098	0.194	0.618
Shock	Extent of pandemic impact	0.122	1.396	0.000	18.520
Inn	Regional innovation capability	8.333	0.688	5.753	9.506
Gov	Local government intervention	0.200	0.048	0.102	0.315
PassTra	Regional population flow	13.162	0.698	10.276	14.420
Niglig	Regional economic development level	2.531	0.661	1.439	4.344
fdiSh	Degree of external economic ties	6.037	0.849	4.706	7.314
Book	Human capital	0.597	0.186	0.308	1.250
Inf	Informatization level	8.722	0.369	8.136	9.320

3. Simulation of the impact of the package of policies

3.1. Estimation results

The impact of the Chinese government's package of policies should be characterized by the difference between the RER of Hubei and Synthetic Hubei after the second quarter of 2020. Specifically, the Chinese government's package of policies will be implemented in the second quarter of 2020. This paper uses the RER of some quarters before the policy intervention and the regional economic development level, innovation ability, human capital, and other forecast variables to synthesize the virtual control group. The weight is selected to minimize the mean squared prediction error of RER in Hubei and synthetic Hubei in the period before the implementation of the package of policies. This paper uses the nested numerical method to find the optimal synthetic control. Through the calculation of the SC method, Table 3 shows the weight combination of synthetic Hubei. A total of six cities are selected, of which Shandong is the province with the largest weight. The weights between the seven provinces are not linear. When we replace a target province in the seven provinces for simulation, the combined province name and weight will change, indicating no linear interpolation problem.

The changing trend of economic resilience of real Hubei and synthetic Hubei is shown in Figure 1. From the figure, we can see that before the policy package implementation, the economic resilience paths of synthetic Hubei and real Hubei can almost coincide entirely. It indicated that the SC method very well replicates the growth path of Hubei Province's economic resilience before the policy's implementation. After the implementation of the policy, the economic resilience of real Hubei and synthetic Hubei has significantly deviated, and the real economic resilience is far higher than the synthetic value. The average treatment effect of the policy is 0.062, which indicates that implementing a package of policies can promote the improvement of RER. Hypothesis 1 is verified. However, after implementing the package of policies, economic resilience showed a trend of increasing year by year. The growth of economic resilience slowed down briefly at the beginning of 2021, which may be due to the centralized implementation of various support policies in the short term, especially the implementation of compensation and protective measures in the short term to avoid large-scale layoffs and bankruptcy (Loayza & Pennings, 2020). The regional economy has been stable and rapidly recovered. The supportive measures of development nature are mostly in project construction, and the effect is relatively slow. In addition, many supporting measures are still in the process of promotion at the end of 2020, and the medium and long-term impact on economic resilience has not yet emerged.

Table 3. Weights of synthetic provinces in Hubei

Synthetic provinces	Weights
Shandong	0.539
Sichuan	0.218
Hebei	0.164
Henan	0.045
Anhui	0.032
Chongqing	0.002

The article further calculates the economic resilience difference between real and synthetic Hubei before and after the policy pilot. In Figure 2, the difference between real and synthetic Hubei between the first quarter of 2018 and the first quarter of 2020 is roughly parallel to the zero line. During the implementation of the policy in the second quarter of 2020, the real economic resilience of Hubei Province was lower than its synthetic value, with a treatment effect of –0.003. However, from the third quarter of the same year, the treatment effect of its package of policies changed from negative to positive. The possible reason is that the package of policies began to be implemented in late May, and the construction projects are still in the docking and signing stage, indirectly indicating that the policy effect has a certain lag. In the second quarter of 2021, the real economic resilience value of the Hubei was 0.489, and the synthetic Hubei was 0.454, with a difference of 0.035. By the end of 2021, the difference had steadily increased to 0.142, indicating that the implementation of the policy package significantly enhanced the RER, and the stimulus effect continued to increase over time.

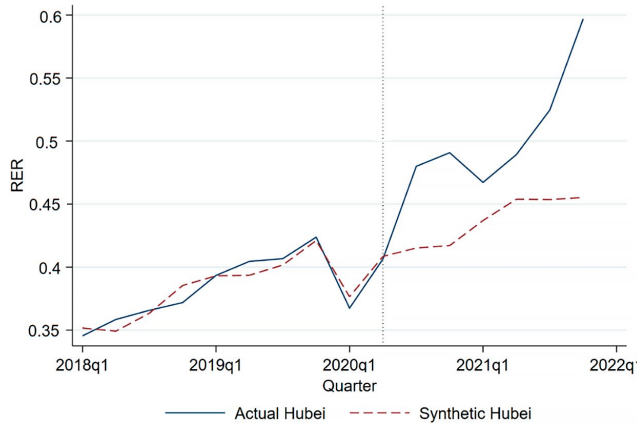

Figure 1. Comparison of economic resilience between real Hubei and synthetic Hubei

Figure 2. The economic resilience gap between real Hubei and synthetic Hubei

3.2. Robustness test

In the above study, we found that the implementation of a package of policies has a positive effect on RER. But is this effect only accidental? Or is it caused by other unobserved factors (such as local economic factors)? This paper uses the placebo test (Abadie & Gardeazabal, 2003; Abadie et al., 2010), the ranking test (Abadie et al., 2010), and the policy effect estimation excluding the spatial spillover effect (Ando, 2015) to complete the robustness test of the above two aspects. In addition, the SC method is more scientific than the Difference-In-Differences (DID) method in selecting the control group, and thus the evaluation results are more effective. In order to verify this scientific nature, the evaluation results based on the DID method are usually used as a robustness test in the existing literature and compared with the evaluation results based on the SC method. Considering that only one individual is treated in this paper, this paper further uses SDID to test the impact of the policy package on the RER.

3.2.1. Placebo test

The basic idea of the placebo test method is to select a province in the control group that has not implemented policies to carry out the same analysis as above. Suppose it is found that there is a huge gap between the real economic resilience and the synthetic economic resilience of this province, and it is consistent with the situation in Hubei. In that case, the SC method does not provide strong evidence to show the impact of the package of policies on the RER. This paper mainly discusses the situation of the two provinces. In the synthetic Hubei, Shandong Province with the largest weight is selected. The largest weight means that in all the control provinces, Shandong Province and Hubei Province have the smallest difference in various economic characteristics. The second is Jiangxi Province, with a weight of 0 (the worst-fitting effect). Take the two extreme cases as treatment groups to test the real sample economic resilience and the synthetic sample economic resilience before and after the implementation of the package of policies.

As shown in Figure 3 and Figure 4, the two provinces' economic resilience changed along the synthetic sample economic resilience trend before the second quarter of 2020. However, after the second quarter of 2020, the real economic resilience of Shandong Province is significantly lower than that of synthetic Shandong Province. Jiangxi Province mainly fluctuates around the economic resilience of synthetic Jiangxi Province. Only after the first quarter of 2021 did it have a slight increase, but it did not produce the same policy effect as Figure 2. It objectively proves that the package of policies has indeed affected the growth of economic resilience in Hubei Province rather than other accidental factors.

3.2.2. Ranking test

So far, our research can prove that the implementation of the package of policies is beneficial to the RER, but whether the impact is significant and statistically significantly different from zero also requires us to answer. Due to the small number of samples in the control group, the statistical inference based on large samples in the past is not suitable for evaluating the significance of the synthetic results. However, it can use the rank test in similar statistics. The basic idea of the test is: to select any province in the control group, assume that it has implemented a package of policies in the second quarter of 2020, use the SC method to

construct its synthetic sample economic resilience, and estimate the policy effect under the assumptions. Then, compare the actual policy effect of Hubei and the assumed policy effect of the control group. Suppose the difference between the actual and assumed policy effect is significant enough. In that case, the effect of the package of policies on the economic resilience of Hubei is significant, not accidental. Referring to the suggestion of Abadie et al. (2010), this paper uses RMSPE (Root Mean Square Prediction Error) to measure the degree of difference in economic resilience between policy pilot provinces (including hypothetical pilot provinces) and their synthetic control groups. The specific approach is to take the implementation period of the policy package as the dividing point. First, calculate the RMSPE value before the implementation of the policy package. Then compare the RMSPE value of the hypothetical pilot provinces with the real pilot provinces. And finally, eliminate the hypothetical pilot provinces whose RMSPE value is more than twice that of the real pilot provinces. As shown in Figure 5, before the policy implementation, the MSPE change degree of economic resilience in Hubei Province was not significantly different from that of the other five provinces. However, the difference gradually expanded after the policy implementation,

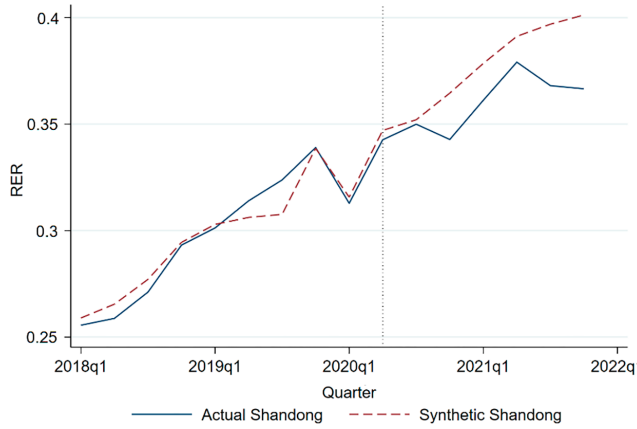

Figure 3. Placebo test in Shandong Province with the largest weight

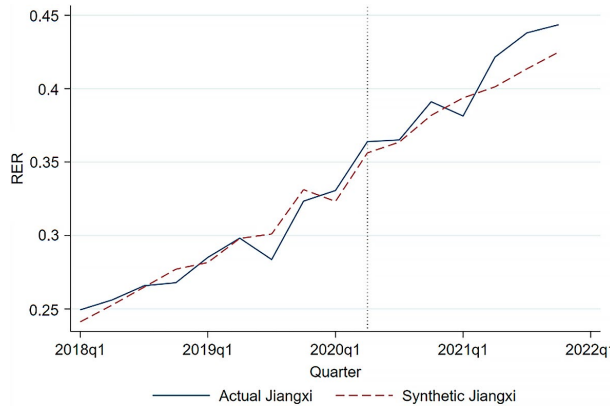

Figure 4. Placebo test in Jiangxi Province with the lowest weight

and the curve was at the outermost of the MSPE distribution in the other five provinces. It can be concluded through the above ranking test that the reform and opening-up policy has a positive impact on China's economic growth and has a certain significance.

3.2.3. Policy effect estimation excluding spatial spillover effect

Considering that Hubei Province's access to a package of policy support will more or less have a positive or negative spillover effect on neighboring provinces, if these neighboring provinces are added to the control group, it may have some interference with the identification of policy effects. Therefore, five provinces geographically bordering the treatment group were removed from the control group. After constructing a new control group sample, the SC method is used again to estimate the impact of the implementation of the package of policies in Hubei Province on the RER of the treatment group. The specific estimation strategy is consistent with the previous article. Figure 6 shows the treatment effect of the economic resilience of Hubei Province after excluding the neighboring spatial provinces.

From Figure 6, the trend and direction of the policy treatment effect after excluding the geographically adjacent provinces are consistent with the previously estimated results. After

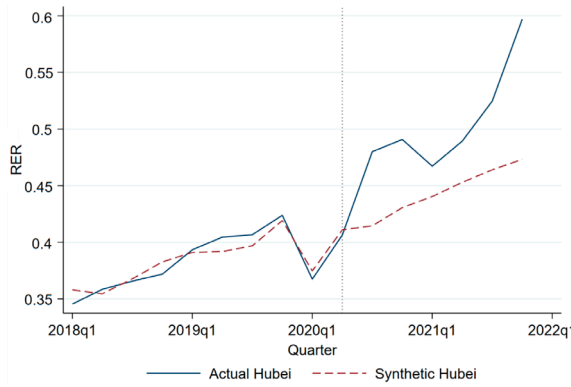

Figure 5. Ranking test method

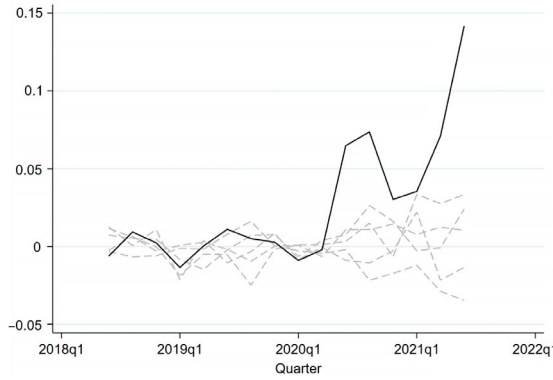

Figure 6. Estimation of the causal effects after excluding geographically adjacent provinces

excluding the sample of neighboring provinces in the control group, the average causal effects of the policies package in Hubei Province decreased from 0.062 to 0.050 compared with the original estimate. It indicates that implementing the package of policies in Hubei Province may have a positive spillover effect on the economic resilience of neighboring provinces.

3.2.4. Synthetic difference in differences method test

Arkhangelsky et al. (2021) proposed a new estimator, Synthetic Difference in Differences (SDID), which combines the advantages of DID and SC and is less dependent on parallel trends and large panel data. Like the SC method, SDID matches pre-treatment trends by re-weighting, thus weakening the dependence on parallel trends. Similarly, SDID is invariant to additive unit-level shifts. To compare with the SC method, estimate the size of the policy's treatment effect, and confirm the statistical significance of the treatment effect, the article uses SDID to re-estimate the treatment effect of implementing a package of policies to enhance the RER.

Assuming we have a balanced panel dataset with N individuals in period T. The dependent variable observed for the ith individual in the tth period is Y_{it}, and the dummy variable $W_{it} \in \{0,1\}$ measures whether the individual is affected after the event occurs. It is also assumed that the first N_{co} individuals (control) are not treated, and the last $N_{tr} = N - N_{co}$ individuals (treated) will be affected by the policy after T_{pre} periods. The estimation process of SDID consists of the following four steps: (1) calculating the regularization parameter ζ; (2) calculating unit weights $\hat{\omega}_i^{sdid}$, so that the pre-treatment trend of the treatment group is as similar as possible to the pre-treatment trend of the control group, e.g., $\sum_{i=1}^{N_{co}} \hat{\omega}_i^{sdid} Y_{it} \approx N_{tr}^{-1} \sum_{i=N_{co+1}}^{N} Y_{it}$, holds true for all $t = 1, \cdots, T_{pre}$; (3) calculating time weights $\hat{\lambda}_t^{sdid}$ to balance the pre-treatment time trend with the post-treatment time trend; (4) ultimately, obtaining the average treatment effect τ of the policy implementation by employing the vector of individual weights and the vector of time weights, combined with the regression of a traditional DID model containing two-way fixed effects.

The estimated equation for the SDID regression is displayed in Equation (6):

$$\left(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) = \underset{\tau,\mu,\alpha,\beta}{\arg\min} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} \left(Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau\right)^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid} \right\}. \quad (6)$$

Table 4 shows the regression results of SDID. The average treatment effect in column (1) is significantly positive, basically consistent with the simulation results of the SC method. In column (2), SDID is run by using covariates in the way of projection. The coefficient is still significantly positive, but there is a decline. The average economic resilience of the post-implementation treatment group is relatively increased by 0.059. During our research period, the average economic resilience of provinces was 0.362, so the average economic resilience of provinces suffering from severe external shocks increased by 0.059, which has obvious economic significance. To sum up, implementing the policy package is conducive to improving RER, and hypothesis 1 is verified again.

Table 4. Synthetic difference-in-differences estimation results

Variable	Regional economic resilience	
	(1)	(2)
Treatment	0.067*** (0.016)	0.059*** (0.020)
Control variables	No	Yes

Note: (1) The value in parentheses below the coefficient is the standard error. (2) ***, **, and * denote 1%, 5%, and 10% significance levels, respective.

3.2.5. Replace the agent variable of economic resilience

To avoid the possible defects of methods for measuring comprehensive indicators, this study uses the established method of RER measurement for the robustness test (Martin & Gardiner, 2019). This method uses a core variable to measure the degree of response regarding the impact, and its calculation formula is shown in Equation (7):

$$Res_i^t = \frac{\frac{Y_i^t - Y_i^{t-k}}{Y_i^{t-k}} - \frac{Y_r^t - Y_r^{t-k}}{Y_r^{t-k}}}{\left|\frac{Y_r^t - Y_r^{t-k}}{Y_r^{t-k}}\right|}. \tag{7}$$

In Equation (7), Res_i^t is the relative economic resilience of the ith province during the tth period. Moreover, Y_i^t and Y_i^{t-k} are the quantitative indicator of each province over the time t or $t - k$, and Y_r^t and Y_r^{t-k} are the quantitative indicator of the sample provinces over the time t or $t - k$.

To facilitate comparative analysis among the provinces, the results can be centered as Equation (8):

$$R_i = \left[Res_i^t - \sum_i^n Res_i^t / n \right] (-1)^p. \tag{8}$$

In Equation (8), n is the total number of provinces and $(-1)^p$ is the correction factor. Since the selected economic indicator is positive (regional GDP), p takes the value of 0; otherwise, $p = 1$. Up to this point, R_i can be directly used to compare each province's economic resilience level. A smaller the R_i value indicates that the province's economic resilience is lower compared to the whole region.

Based on the calculation of the SC method (Table 5), the average causal effect of the implementation of the package of policies on the RER is 0.334 during the entire post-event window period. After implementing policies, Hubei Province's economic resilience continued to grow, from 0.738 in the second quarter of 2020 to 1.378 in the first quarter of 2021. The growth of economic resilience declined slightly in the second quarter of 2021. It maintained rapid growth after the third quarter of 2021, indicating that the stimulus effect of the support policy does have a certain lag. By the end of 2020, 31 of the six aspects of the package of policies have been implemented, and 28 of them have been implemented. The policies that need to be promoted throughout the year are mainly those of a development nature.

In the short term, the centralized implementation of many policies has promoted the rapid recovery of the regional economy. This finding is similar to the benchmark simulation results. It shows that no matter what method is adopted to measure economic resilience, the package of policies has a significant promoting effect on RER.

Table 5. Robustness test of replacement economic resilience measurement method

Time	Actual outcome	Synthetic outcome	Treatment effect
2020q3	–0.645	0.093	–0.738
2020q4	1.166	0.001	1.165
2021q1	1.109	–0.268	1.378
2021q2	–0.186	–0.107	–0.079
2021q3	–0.032	0.126	–0.159
2021q4	0.321	–0.116	0.437
Mean	0.289	–0.045	0.334

4. Mechanism analysis

The previous article has revealed the role of a package of policies on the RER in general but has not yet answered the question of how to support policies that affect economic resilience. As mentioned above, the theoretical analysis of this paper summarizes three possible impact mechanisms. In this section, we will quantitatively analyze the impact of the package of policies on fixed investment, consumption stimulus, and industrial development to identify the mechanism behind the impact of the package of policies on RER. Considering that the package of policies is not randomly distributed, and only one sample province has implemented the self-created area policy, the conclusion drawn by directly using the intermediary effect regression test policy mechanism may not be reliable. Therefore, based on the practice of relevant research (Bonander et al., 2016), we will continue to use the SC method to test the causal effect between the package of policies and the improvement of RER. In addition, we considered that when most of the mechanism variables are used as the synthetic fitting targets, the synthetic control group with a similar pre-test trend with the treatment group can only be constructed through linear combination. So, the estimated results of SDID and corresponding significance are also reported for comparative analysis.

Acquiring statistics on new infrastructure spending within the overall fixed asset investment is challenging. This article aims to identify a viable growth trajectory in fixed asset investment amidst the influence of the pandemic. It primarily examines the two key avenues of real estate development and transportation fixed asset investment. Regarding the development of core industries in the region, the total output value of the construction industry in Hubei Province consistently ranks among the top three in the country, ranking first in the central region. It is a pillar industry with many related industries, strong driving capacity, large employment capacity, and high contribution. On the other hand, the construction of many key projects in the package of policies needs to be carried out by the construction

industry, such as the public health system reinforcement project. In addition, the information technology service industry belongs to a knowledge-intensive industry with a wide range of application fields and strong penetration ability. The strength of its technological innovation ability directly affects the level of information technology and competitiveness of relevant enterprises or industries. It plays a vital role in the upgrading and adjustment of regional structures. So this article ultimately selects the construction industry and software and information technology service industry as representatives of core industry development for analysis.

Table 6 examines the mechanism of the "investment-driven" package of policies. After the implementation of the package of policies, the actual value of the investment in real estate development in Hubei is significantly greater than its synthetic value. The estimated amount of SDID is slightly higher than the estimated amount of SC, and the treatment effect is significant by at least 1%. The real value of the average value of fixed asset investment in transportation is 5.515, and its corresponding synthetic value is 5.557. The difference between the two is –0.042. Moreover, this negative effect only occurred after the second quarter of 2021, and the estimate of SDID also failed to pass the significance level test of at least 10%, which also verified the view of hypothesis 2. According to the neoclassical economic growth theory, fixed asset investment as a flow will be converted into material capital stock, which will affect the stable level of the economy. There is a long-term equilibrium relationship between real estate development investment and economic growth in Hubei Province. Affected by COVID-19, the real estate market in Hubei Province has been dramatically impacted, and the base is relatively low. A package of policies transfused blood into real estate through credit and bonds and increased investment in real estate development is conducive to promoting the recovery and growth of the regional economy. Real estate development investment is not only an important component of GDP but also impacts the added value of other industries through the upstream and downstream pull of the industrial chain. In the process of real estate development, many manufacturing industries, such as cement, steel, and glass, are driven by the direct consumption of many building materials. On the other hand, consumption activities related to housing will promote the development of household appliances, furniture, home textiles, and other manufacturing industries. In addition, real estate development and sales will also have a strong pulling effect on logistics, finance, and other tertiary industries.

The investment in fixed assets of traditional transportation has not become the highlight of the impact of a package of policies on RER. Ansar et al. (2016) mentioned that the short-term economic effects of investing in traditional infrastructure are insignificant. In the recessionary period after a crisis shock to the economic system, the government may be inclined to invest in high-quality infrastructure development investments to improve RER based on a comprehensive assessment of the current level of transportation infrastructure development. Although traditional infrastructure has a strong supply capacity improvement for the economy, it weakens consumer demand. As the stock of infrastructure and public capital increases, there is a corresponding decline in its marginal rate of return, which significantly weakens the sustained pull effect of traditional infrastructure projects on economic growth. Secondly, because this paper uses the investment amount of roads and waterways as predictor variables, and the main direction of the policy package is new infrastructure, such as high-speed

intercity railroads and urban rail transit, the economic effect of fixed asset investment in roads and waterways may not be obvious. With the pandemic's impact, investment in railroad infrastructure is more beneficial to China's economic growth. According to Bi's (2023) investment simulations, investments targeting rail infrastructure will be more cost-effective than road and air infrastructure investments after the pandemic. To support long-term regional economic growth, the government must create an environment conducive to investment.

From the results in Table 7, it is not difficult to find that since implementing the policies package. The real value of the consumption-income ratio of Hubei residents is more significant than its synthetic value, and the estimated amount of SDID has passed the significance level test of at least 10%. Hypothesis 3 of this paper has been verified. By the first quarter of 2021, the difference between the synthetic value and the real value of the consumer income ratio of residents has changed from negative to positive. And the difference has increased from –0.041 in the second quarter of 2020 to 0.053 in the first quarter of 2021. After the first quarter of 2021, the growth trend remained relatively stable. The package of policies will work from the aspects of reducing the tax burden, providing financial support, and creating a consumption environment, significantly boosting the consumption demand of residents by issuing consumption vouchers, car purchase subsidies, and other policies. Consumption is the final demand, the key link to smooth the regional economic cycle, and has a lasting driving force for the economy. By pulling consumption to pry the market, we can signal the formation of consumption orientation to the market's main body, realize the market's role in allocating resources, and promote economic development. The stimulus measures can boost the recovery of the regional economy by amplifying the multiplier effect of consumption.

From the quantitative results in Table 8, the pillar industries and emerging industries in Hubei Province have been developed to a certain extent after the implementation of the package of policies, which is consistent with the expectation of Hypothesis 4. The estimated results from the number of employees, the amount of newly signed contracts, and industrial income are relatively stable. There is no significant difference between the estimates of SC and SDID. For the economic development of a region, in addition to the diversity, modularity, and correlation of industries, the industry's type, or the industry's resilience, is also the main factor that determines economic resilience. Regional pillar industries tend to be highly correlated, with strong driving capacity and overall employment. The government provides financial credit support, project bidding support, material supply, and other aspects to promote the comprehensive resumption of production in the construction industry. With the support of the national economic recovery plan, the development of the construction industry in Hubei Province plays an irreplaceable role in expanding employment, increasing fiscal and tax revenues, improving the living environment, and driving and extending the development of supporting industries. Moreover, it is conducive to the recovery of the regional economy. According to Shen et al.'s (2016) definition of the new economic sector, the new information technology and information service industry belong to the new economic sector. The new economic sector has a strong dynamic adjustment ability, which can reallocate resources to cope with the changing environment and ensure its competitive advantages continue. And it can rapidly generate and absorb innovation results and spread innovation to other industries

Table 6. Mechanism analysis: investment promotion

Variable	Real estate development investment				Transportation fixed asset investment			
	Actual outcome	Synthetic outcome	Treatment effect	SDID ATT	Actual outcome	Synthetic outcome	Treatment effect	SDID ATT
Mean	7.219	6.965	0.254	0.355*** (0.054)	5.515	5.557	–0.042	–0.030 (0.368)

Note: (1) The value in parentheses below the coefficient is the standard error. (2) ***, **, and * denote 1%, 5%, and 10% significance levels, respective.

Table 7. Mechanism analysis: consumption stimulation

Variable	Consumption to income ratio			
	Actual outcome	Synthetic outcome	Treatment effect	SDID ATT
Mean	0.731	0.721	0.010	0.022* (0.013)

Note: (1) The value in parentheses below the coefficient is the standard error. (2) ***, **, and * denote 1%, 5%, and 10% significance levels, respective.

Table 8. Mechanism analysis: core industries development

Industry	Variable	Actual outcome	Synthetic outcome	Treatment effect	SDID ATT
Pillar industries	Number of people employed in the construction industry	5.203	5.166	0.037	0.099*** (0.043)
	Amount of new contracts signed in the construction industry	8.713	8.612	0.101	0.036** (0.019)
Emerging industries	Software and information technology services revenue	7.651	7.544	0.107	0.194*** (0.030)

Note: (1) The value in parentheses below the coefficient is the standard error. (2) ***, **, and * denote 1%, 5%, and 10% significance levels, respective.

through technical services, thus driving the recovery of the entire regional economy (Martin et al., 2015). Moreover, the new economy represents the direction of regional industrial structure adjustment and production factor restructuring. If the regions focus on the new economic sectors after the impact, they will enter a more adaptive growth path in the "post-crisis" period, thus showing greater resilience.

Conclusions

Facing the complex and ever-changing internal and external environment, the significance of resilience for the high-quality development of a regional economy is self-evident. Due to differences in the scale of transmission, impact targets, extent, and duration of different crises, the characteristics and mechanisms of resilience may change (Martin et al., 2016). As a sudden major uncertain event, the impact of the COVID-19 pandemic on economic

development is a typical external impact. In responding to the uncertain shocks, the role played by the agents' initiative in the region has gradually been taken seriously, especially a series of dynamic decisions made by the government to resist the impact of the COVID-19 pandemic. Due to the impact of COVID-19, economic growth in some regions has become more complex. The Chinese government has actively introduced special support policies for economic recovery and development in some regions, and the policy package is one of the most important support policies. Against this background, this paper uses the panel data of 11 provinces from the first quarter of 2018 to the fourth quarter of 2021 to systematically examine the relationship between the central government's support policies and the RER after the pandemic outbreak. Due to the unique nature of the sample, this article uses SC and SDID methods for research. It estimates the average causal impact of a package of policies on RER through counterfactual simulations. The results indicate that the growth effect of the package of policies has increased the average economic resilience of Hubei Province by 0.062 since the second quarter of 2021, and the policy effect is gradually showing over time. We conducted a multi-dimensional robustness test on the above main results using the placebo test, ranking test, the SC estimation excluding adjacent spatial samples, the SDID method, and the measurement method of adjusting economic resilience. The results show that the policy package has indeed played a significant role in promoting RER. After the implementation of the package of policies, the three driving forces for the improvement of RER are real estate development investment and consumption stimulus, as well as the development of core industries. However, the traditional transportation fixed assets investment conducive to improving economic resilience has not been significantly improved because of the implementation of the package of policies.

Policy implications

After the pandemic outbreak, the central government should promulgate effective, comprehensive support policies in time for the areas seriously affected by the impact. However, the implementation of the special support policy should be continuous, and the support policy should not be terminated suddenly. Or it would undermine the whole purpose of the support plan (Devereux et al., 2020). At present, it seems that the support policies implemented by most governments are aimed at mitigating the short-term impact. If there are no reasonable alternative measures, the support policies may not be sufficient to compensate for the long-term impact of COVID-19. In the short term, the government should focus on implementing compensation and protective policies to avoid large-scale layoffs and the overall collapse of enterprises (Loayza & Pennings, 2020). Due to the closure of unnecessary sectors and stagnation of economic activities caused by the pandemic, traditional fiscal and monetary policies may no longer be effective (C. D. Romer & D. H. Romer, 2022; Guerrieri et al., 2022), so a new combination of fiscal and monetary policies are needed. For example, in terms of fiscal policy, fiscal subsidies should adhere to the principle of paying equal attention to enterprises and residents. They should directly increase residents' disposable income and promote the accelerated recovery of consumption to guide the expansion of enterprise production. Research in developed countries has shown that direct transfer payments and temporary tax relief for

residents facing difficulties have played a significant role in relief efforts (Chetty et al., 2020; Bachmann et al., 2021). Support policies should pay more attention to economic growth in the medium and long term. First, temporary fiscal policies to deal with the pandemic, such as tax relief and government guarantees, should be withdrawn in time to avoid distorting market behavior and causing efficiency losses. Secondly, the supporting policies should focus on the key elements to improve the region's economic resilience, such as promoting economic recovery through consumer stimulus, increased fixed asset investment, and support for core industries. It needs to be clear that the expansion of production of enterprises caused by consumption is the effective supply, and the expansion of investment caused by consumption can form effective investment. Therefore, we need to fully support policies in optimizing the income distribution pattern and boosting consumption. Finally, the government should pay more attention to the medium and long-term goals and support some investment projects involving future technology, infrastructure, and climate protection in the policy that will positively impact long-term economic development (Chapman, 2007). The implementation of comprehensive support policies can effectively blunt the adverse effects caused by external shocks, open up a new path for regional economic growth, and promote the improvement of RER.

The implementation of supporting policies should also be targeted. For example, stimulating residents' consumption can promote RER, but the consumption stimulus policy should reflect the heterogeneity of different groups because different groups have different consumption characteristics. According to economic theory, low-income groups have a higher marginal propensity to consume and are forced to reduce high-level consumption due to budget constraints (Carroll et al., 2017). Therefore, large-scale transfer payments to low-income groups will be directly converted into large-scale, high-level consumption. In addition, the multiplier effect is also a potent stimulus for the entire regional economy. The impact of improved consumption in this pandemic is far greater than that of guaranteed consumption for different types of demand differences. Targeted subsidies for improved consumption, such as tourism, should be introduced to promote the rapid rebound of improved consumption. However, at the same time, we should also consider the indemnification of consumption subsidies. In addition, when supporting regional core industries, on the one hand, we should pay attention to industries with obvious recovery effects and strong driving effects in the short term. The selection of industries should focus on the recipient areas' industrial structure and resource conditions because the supported industries may not have comparative advantages in the recipient areas, and the impact of the impact (Bulte et al., 2018), the effect of assistance may be counterproductive. Secondly, industrial support may not be very effective compared with more direct measures to solve unemployment and stimulate consumption. Because such aid can only indirectly affect the target (such as employment), enterprises may not use the aid as planned. Adding some additional supplements will help to align the goals of recipients with those of policymakers and ensure that aid becomes more effective (Engström et al., 2020). For example, support can be conditional on using funds to hire or retain labor. On the other hand, we should focus on long-term economic growth and increase the cultivation of emerging industries. We should invest as much as possible in industries that are technologically related to the original industries in the region because the rise and fall of the industry largely depend on the industrial relevance at the regional level (Neffke et al., 2011).

Limitations

This study also has limitations. First of all, due to the relatively short time from the pandemic outbreak, the main discussion is the impact of the support policy in the short term. Some support projects have relatively long construction cycles, and the long-term economic effects of policies still need to be tested. Secondly, the connotation of RER is relatively rich, and the ability to innovate and transform is also an important dimension of RER. However, considering that the development of the new growth path of the regional economy is a long-term process, and it is difficult to obtain quarterly data on R&D investment and talent security, this paper mainly constructs the indicator system from the aspects of impact resistance, adaptation, and resilience. Third, the implementation of the package of policies is only carried out in Hubei Province. Therefore, this paper only discusses the policy effects in Hubei Province. A single treatment group makes it difficult for the article to explore regional differences in policy impact, spatial spillover effects, and other perspectives. With the deepening of the policy, based on the availability of monthly and annual data in the future, it can be further refined to the prefecture-level city level for verification. The core purpose of this study is to provide empirical evidence for the effectiveness of implementing comprehensive support policies since the pandemic. From the regional level, it is difficult to separate the respective effects of different policies. Because some policies may be inefficient or have not played a promoting role, it is necessary to use the specific support data of the various policies to explore from the perspective of the micro subject.

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References

Abadie, A., & Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American Economic Review*, *93*(1), 113–132. https://doi.org/10.1257/000282803321455188

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, *105*(490), 493–505. https://doi.org/10.1198/jasa.2009.ap08746

Amezcua, A. S., Grimes, M. G., Bradley, S. W., & Wiklund, J. (2013). Organizational sponsorship and founding environments: A contingency view on the survival of business-incubated firms, 1994–2007. *Academy of Management Journal*, *56*(6), 1628–1654. https://doi.org/10.5465/amj.2011.0652

Ando, M. (2015). Dreams of urbanization: Quantitative case studies on the local impacts of nuclear power facilities using the synthetic control method. *Journal of Urban Economics*, *85*, 68–85. https://doi.org/10.1016/j.jue.2014.10.005

Ansar, A., Flyvbjerg, B., Budzier, A., & Lunn, D. (2016). Does infrastructure investment lead to economic growth or economic fragility? Evidence from China. *Oxford Review of Economic Policy*, *32*(3), 360–390. https://doi.org/10.1093/oxrep/grw022

Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W., & Wager, S. (2021). Synthetic difference-in-differences. *American Economic Review*, *111*(12), 4088–4118. https://doi.org/10.1257/aer.20190159

Arnold, J. M., Brys, B., Heady, C., Johansson, Å., Schwellnus, C., & Vartia, L. (2011). Tax policy for economic recovery and growth. *The Economic Journal*, *121*(550), F59–F80. https://doi.org/10.1111/j.1468-0297.2010.02415.x

Bachmann, R., Born, B., Goldfayn-Frank, O., Kocharkov, G., Luetticke, R., & Weber, M. (2021). *A temporary vat cut as unconventional fiscal policy* (No. w29442). National Bureau of Economic Research. https://doi.org/10.3386/w29442

Baxter, M., & King, R. G. (1993). Fiscal policy in general equilibrium. *The American Economic Review*, *83*(3), 315–334. https://www.jstor.org/stable/2117521

Bi, M. (2023). Impact of COVID-19 on environmental regulation and economic growth in China: A Way forward for green economic recovery. *Economic Analysis and Policy*, *77*, 1001–1015. https://doi.org/10.1016/j.eap.2022.12.015

Bonander, C., Jakobsson, N., Podestà, F., & Svensson, M. (2016). Universities as engines for regional growth? Using the synthetic control method to analyze the effects of research universities. *Regional Science and Urban Economics*, *60*, 198–207. https://doi.org/10.1016/j.regsciurbeco.2016.07.008

Boschma, R. (2015). Towards an evolutionary perspective on regional resilience. *Regional Studies*, *49*(5), 733–751. https://doi.org/10.1080/00343404.2014.959481

Brada, J. C., Gajewski, P., & Kutan, A. M. (2021). Economic resiliency and recovery, lessons from the financial crisis for the COVID-19 pandemic: A regional perspective from Central and Eastern Europe. *International Review of Financial Analysis*, *74*, Article 101658. https://doi.org/10.1016/j.irfa.2021.101658

Brainard, W. C. (1967). Uncertainty and the Effectiveness of Policy. *The American Economic Review*, *57*(2), 411–425. https://www.jstor.org/stable/1821642

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2009). Economic vulnerability and resilience: Concepts and measurements. *Oxford Development Studies*, *37*(3), 229–247. https://doi.org/10.1080/13600810903089893

Bristow, G., & Healy, A. (2014). Regional resilience: an agency perspective. *Regional studies*, *48*(5), 923–935. https://doi.org/10.1080/00343404.2013.854879

Bulte, E., Xu, L., & Zhang, X. (2018). Post-disaster aid and development of the manufacturing sector: Lessons from a natural experiment in China. *European Economic Review*, *101*, 441–458. https://doi.org/10.1016/j.euroecorev.2017.10.019

Carroll, C., Slacalek, J., Tokuoka, K., & White, M. N. (2017). The distribution of wealth and the marginal propensity to consume. *Quantitative Economics*, *8*(3), 977–1020. https://doi.org/10.3982/qe694

Chacon-Hurtado, D., Kumar, I., Gkritza, K., Fricker, J. D., & Beaulieu, L. J. (2020). The role of transportation accessibility in regional economic resilience. *Journal of Transport Geography*, *84*, Article 102695. https://doi.org/10.1016/j.jtrangeo.2020.102695

Chapman, L. (2007). Transport and climate change: A review. *Journal of Transport Geography*, *15*(5), 354–367. https://doi.org/10.1016/j.jtrangeo.2006.11.008

Chen, J., Guo, F., & Zhu, A. (2011). The housing-led growth hypothesis revisited: evidence from the Chinese provincial panel data. *Urban Studies*, *48*(10), 2049–2067. https://doi.org/10.1177/0042098010379281

Chen, Y. (2008). Research on new Keynesian Phillips curve in China. *Economic Research Journal*, *12*, 50–64. https://doi.org/10.3969/j.issn.2095-607X.2015.04.006

Chen, Y., Li, K., & Zhou, Q. (2023). Spatial differentiation of urban economic resilience and its influencing factors: Evidence from Baidu migration big data. *Technological and Economic Development of Economy*, *29*(2), 353–381. https://doi.org/10.3846/tede.2023.17869

Chetty, R., Friedman, J. N., Hendren, N., Stepner, M., & The Opportunity Insights Team. (2020). *How did COVID-19 and stabilization policies affect spending and employment? A new real-time economic tracker based on private sector data* (Vol. 91, pp. 1689–1699). National Bureau of Economic Research.

Christopherson, S., Michie, J., & Tyler, P. (2010). Regional resilience: theoretical and empirical perspectives. *Cambridge Journal of Regions, Economy and Society*, *3*(1), 3–10. https://doi.org/10.1093/cjres/rsq004

Cynamon, B. Z., & Fazzari, S. M. (2016). Inequality, the Great Recession and slow recovery. *Cambridge Journal of Economics*, *40*(2), 373–399. https://doi.org/10.1093/cje/bev016

Davies, S. (2011). Regional resilience in the 2008–2010 downturn: comparative evidence from European countries. *Cambridge Journal of Regions, Economy and Society*, *4*(3), 369–382. https://doi.org/10.1093/cjres/rsr019

Devereux, M. P., Güçeri, İ., Simmler, M., & Tam, E. H. (2020). Discretionary fiscal responses to the COVID-19 pandemic. *Oxford Review of Economic Policy*, *36*(Supplement_1), S225–S241. https://doi.org/10.1093/oxrep/graa019

Doerr, L., Dorn, F., Gaebler, S., & Potrafke, N. (2020). How new airport infrastructure promotes tourism: Evidence from a synthetic control approach in German regions. *Regional Studies*, *54*(10), 1402–1412. https://doi.org/10.1080/00343404.2020.1714022

Doran, J., & Fingleton, B. (2018). US metropolitan area resilience: insights from dynamic spatial panel estimation. *Environment and Planning A: Economy and Space*, *50*(1), 111–132. https://doi.org/10.1177/0308518X17736067

Duan, H., Wang, S., & Yang, C. (2020). Coronavirus: limit short-term economic damage. *Nature*, *578*(7796), 515–516. https://doi.org/10.1038/d41586-020-00522-6

Eggertsson, G. B. (2008). Great Expectations and the End of the Depression. *American Economic Review*, *98*(4), 1476–1516. https://doi.org/10.1257/aer.98.4.1476

Engström, G., Gars, J., Jaakkola, N., Lindahl, T., Spiro, D., & van Benthem, A. A. (2020). What policies address both the coronavirus crisis and the climate crisis?. *Environmental and Resource Economics*, *76*, 789–810. https://doi.org/10.1007/s10640-020-00451-y

Giannakis, E., & Bruggeman, A. (2017). Economic crisis and regional resilience: Evidence from Greece. *Papers in Regional Science*, *96*(3), 451–476. https://doi.org/10.1111/pirs.12206

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2022). Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?. *American Economic Review*, *112*(5), 1437–1474. https://doi.org/10.1257/aer.20201063

Guo, Y., & Zhang, H. (2022). Spillovers of innovation subsidies on regional industry growth: Evidence from China. *Economic Modelling*, *112*, Article 105869. https://doi.org/10.1016/j.econmod.2022.105869

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S., & Tatlow, H. (2021). A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nature Human Behaviour*, *5*(4), 529–538. https://doi.org/10.1038/s41562-021-01079-8

Hepburn, C., O'Callaghan, B., Stern, N., Stiglitz, J., & Zenghelis, D. (2020). Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?. *Oxford Review of Economic Policy*, *36*(Supplement_1), S359–S381. https://doi.org/10.1093/oxrep/graa015

Hu, X., Li, L., & Dong, K. (2022). What matters for regional economic resilience amid COVID-19? Evidence from cities in Northeast China. *Cities*, *120*, Article 103440. https://doi.org/10.1016/j.cities.2021.103440

Inoue, A., & Rossi, B. (2019). The effects of conventional and unconventional monetary policy on exchange rates. *Journal of International Economics*, *118*, 419–447. https://doi.org/10.1016/j.jinteco.2019.01.015

Jerch, R., Kahn, M. E., & Lin, G. C. (2023). Local public finance dynamics and hurricane shocks. *Journal of Urban Economics*, *134*, Article 103516. https://doi.org/10.1016/j.jue.2022.103516

Jessop, B. (2006). *Spatial fixes*, *temporal fixes and spatio-temporal fixes*. Blackwell Publishing. https://doi.org/10.1002/9780470773581.ch8

Jia, J., Liang, X., & Ma, G. (2021). Political hierarchy and regional economic development: Evidence from a spatial discontinuity in China. *Journal of Public Economics*, *194*, Article 104352. https://doi.org/10.1016/j.jpubeco.2020.104352

Jiang, D., Li, W., Yu, J., & Zhang, Y. (2023). Do governmental policy interventions help urban economic recovery? Experimental evidence from China's provinces governance amid the COVID-19 pandemic. *Growth & Change*, *54*(2), 507–528. https://doi.org/10.1111/grow.12661

Johnson, M. R. (2019). Inclusion and exclusion in the digital economy: Disability and mental health as a live streamer on Twitch. tv. *Information, Communication & Society*, *22*(4), 506–520. https://doi.org/10.1080/1369118X.2018.1476575

Karim, M. R., Islam, M. T., & Talukder, B. (2020). COVID-19' s impacts on migrant workers from Bangladesh: In search of policy intervention. *World Development*, *136*, Article 105123. https://doi.org/10.1016/j.worlddev.2020.105123

Kim, S., Koh, K., & Zhang, X. (2022). Short-term impact of COVID-19 on consumption spending and its underlying mechanisms: Evidence from Singapore. *Canadian Journal of Economics/Revue Canadienne D'économique*, *55*, 115–134. https://doi.org/10.1111/caje.12538

Liu, Q., Shen, Q., Li, Z., & Chen, S. (2021). Stimulating consumption at low budget: Evidence from a large-scale policy experiment amid the COVID-19 pandemic. *Management Science*, *67*(12), 7291–7307. https://doi.org/10.1287/mnsc.2021.4119

Liu, Y., Zhang, Y., Fang, H., & Chen, X. (2022). SMEs' line of credit under the COVID-19: evidence from China. *Small Business Economics*, *58*, 807–828. https://doi.org/10.1007/s11187-021-00474-9

Loayza, N., & Pennings, S. M. (2020). Macroeconomic policy in the time of COVID-19: A primer for developing countries. *World Bank Research and Policy Briefs*, *28*, 1–9. https://doi.org/10.1596/33540

Mai, X., Zhan, C., & Chan, R. C. (2021). The nexus between (re) production of space and economic resilience: An analysis of Chinese cities. *Habitat International*, *109*, Article 102326. https://doi.org/10.1016/j.habitatint.2021.102326

Makin, A. J., & Layton, A. (2021). The global fiscal response to COVID-19: Risks and repercussions. *Economic Analysis and Policy*, *69*, 340–349. https://doi.org/10.1016/j.eap.2020.12.016

Martin, R. (2012). Regional economic resilience, hysteresis and recessionary shocks. *Journal of Economic Geography*, *12*(1), 1–32. https://doi.org/10.1093/jeg/lbr019

Martin, R., & Gardiner, B. (2019). The resilience of cities to economic shocks: A tale of four recessions (and the challenge of Brexit). *Papers in Regional Science*, *98*(4), 1801–1832. https://doi.org/10.1111/pirs.12430

Martin, R., & Sunley, P. (2015). On the notion of regional economic resilience: conceptualization and explanation. *Journal of Economic Geography*, *15*(1), 1–42. https://doi.org/10.1093/jeg/lbu015

Martin, R., & Sunley, P. (2020). Regional economic resilience: Evolution and evaluation. In G. Bristow & A. Healey (Eds.), *Handbook on regional economic resilience* (pp. 10–35). Edward Elgar. https://doi.org/10.4337/9781785360862.00007

Martin, R., Sunley, P., & Tyler, P. (2015). Local growth evolutions: recession, resilience and recovery. *Cambridge Journal of Regions, Economy and Society*, *8*(2), 141–148. https://doi.org/10.1093/cjres/rsv012

Martin, R., Sunley, P., Gardiner, B., & Tyler, P. (2016). How regions react to recessions: Resilience and the role of economic structure. *Regional Studies*, *50*(4), 561–585. https://doi.org/10.1080/00343404.2015.1136410

McCartney, G., Pinto, J., & Liu, M. (2021). City resilience and recovery from COVID-19: The case of Macao. *Cities*, *112*, Article 103130. https://doi.org/10.1016/j.cities.2021.103130

Mei, C. (2020). Policy style, consistency and the effectiveness of the policy mix in China's fight against COVID-19. *Policy and Society*, *39*(3), 309–325. https://doi.org/10.1080/14494035.2020.1787627

Mishkin, F. S. (2009). Is monetary policy effective during financial crises?. *American Economic Review*, *99*(2), 573–577. https://doi.org/10.1257/aer.99.2.573

Murphy, K. M., Shleifer, A., & Vishny, R. W. (1989). Industrialization and the big push. *Journal of Political Economy*, *97*(5), 1003–1026. https://doi.org/10.1086/261641

Neffke, F., Henning, M., & Boschma, R. (2011). How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography*, *87*(3), 237–265. https://doi.org/10.1111/j.1944-8287.2011.01121.x

Peneder, M. (2003). Industrial structure and aggregate growth. *Structural Change and Economic Dynamics*, *14*(4), 427–448. https://doi.org/10.1016/S0954-349X(02)00052-8

Pradhan, R. P., Arvin, M. B., & Nair, M. (2021). Urbanization, transportation infrastructure, ICT, and economic growth: A temporal causal analysis. *Cities*, *115*, Article 103213. https://doi.org/10.1016/j.cities.2021.103213

Romer, C. D., & Romer, D. H. (2022). A social insurance perspective on pandemic fiscal policy: Implications for unemployment insurance and hazard pay. *Journal of Economic Perspectives*, *36*(2), 3–28. https://doi.org/10.1257/jep.36.2.3

Samila, S., & Sorenson, O. (2011). Venture capital, entrepreneurship, and economic growth. *The Review of Economics and Statistics*, *93*(1), 338–349. https://doi.org/10.1162/REST_a_00066

Shen, Y., Shen, M., & Chen, Q. (2016). Measurement of the new economy in China: Big data approach. *China Economic Journal*, *9*(3), 304–316. https://doi.org/10.1080/17538963.2016.1211384

Shi, T., Qiao, Y., Zhou, Q., & Zhang, J. (2022). The regional differences and random convergence of urban resilience in China. *Technological and Economic Development of Economy*, *28*(4), 979–1002. https://doi.org/10.3846/tede.2022.16721

Simmie, J., & Martin, R. (2010). The economic resilience of regions: Towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society*, *3*(1), 27–43. https://doi.org/10.1093/cjres/rsp029

Song, L., & Zhou, Y. (2020). The COVID-19 pandemic and its impact on the global economy: What does it take to turn crisis into opportunity?. *China & World Economy*, *28*(4), 1–25. https://doi.org/10.1111/cwe.12349

Tan, J., Hu, X., Hassink, R., & Ni, J. (2020). Industrial structure or agency: What affects regional economic resilience? Evidence from resource-based cities in China. *Cities*, *106*, Article 102906. https://doi.org/10.1016/j.cities.2020.102906

Thornton, J. (2007). Fiscal decentralization and economic growth reconsidered. *Journal of Urban Economics*, *61*(1), 64–70. https://doi.org/10.1016/j.jue.2006.06.001

Wang, X., Wang, L., Zhang, X., & Fan, F. (2022). The spatiotemporal evolution of COVID-19 in China and its impact on urban economic resilience. *China Economic Review*, *74*, Article 101806. https://doi.org/10.1016/j.chieco.2022.101806

Wang, Y., Wang, X., Zhang, Z., Cui, Z., & Zhang, Y. (2023). Role of fiscal and monetary policies for economic recovery in China. *Economic Analysis and Policy*, *77*, 51–63. https://doi.org/10.1016/j.eap.2022.10.011

Webber, D. J., Healy, A., & Bristow, G. (2018). Regional growth paths and resilience: A European analysis. *Economic Geography*, *94*(4), 355–375. https://doi.org/10.1080/00130095.2017.1419057

Weng, Z., Fan, F., Yang, B., & Zhang, H. (2023). Regional differences and drivers of patent transfer-in between Chinese cities: A city absorptive capacity perspective. *Technology Analysis & Strategic Management*. https://doi.org/10.1080/09537325.2023.2242509

Wright, A. L., Sonin, K., Driscoll, J., & Wilson, J. (2020). Poverty and economic dislocation reduce compliance with COVID-19 shelter-in-place protocols. *Journal of Economic Behavior & Organization*, *180*, 544–554. https://doi.org/10.1016/j.jebo.2020.10.008

Wu, J., Gyourko, J., & Deng, Y. (2015). Real estate collateral value and investment: The case of China. *Journal of Urban Economics*, *86*, 43–53. https://doi.org/10.1016/j.jue.2014.12.006

Xu, C. (2011). The fundamental institutions of China's reforms and development. *Journal of Economic Literature*, *49*(4), 1076–1151. https://doi.org/10.1257/jel.49.4.1076