

## Article

# Urban Renewal as a Pathway to Resilience: Quasi-Experimental Evidence from China's Old Residential Community Renovation Program

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## Abstract

Enhancing urban resilience has become a central objective of sustainable urban development, yet there is limited information on whether urban renewal can effectively contribute to this goal. In this study, we investigated whether urban renewal enhanced urban resilience by exploiting China's 2017 pilot policy for the renovation projects of old residential communities as a quasi-natural experiment. Drawing on panel data for 286 prefecture-level- and-above cities from 2010 to 2021, we adopted a difference-in-differences method to estimate the causal impact of urban renewal. The results show that urban renewal significantly improves urban resilience, although the overall magnitude of the effect is modest. Mechanism analyses indicate that this effect operates through three interrelated channels: upgraded physical infrastructure, stronger local government attention, and enhanced technological innovation. Heterogeneity analyses further reveal that the resilience effects are stronger in eastern China, larger cities, fiscally stronger cities, and cities located within urban agglomerations. These findings suggest that urban renewal can serve as a meaningful pathway for resilience enhancement, but its effectiveness depends on local institutional and resource conditions. Overall, the study provides city-level empirical evidence of how spatial governance interventions can support the achievement of Sustainable Development Goal 11 and promote more resilient urban development.

**Keywords:** urban resilience; urban renewal; sustainable development goal; difference-in-differences; China



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## 1. Introduction

Over the past four decades, China has witnessed rapid and sustained urbanization, profoundly transforming its economic structure, spatial organization, and social fabric. The urbanization rate for the resident population increased from 17.9% in 1978 to 66.2% in 2023, while the total built-up urban area expanded from less than 8000 km<sup>2</sup> to over 62,000 km<sup>2</sup> [1]. This dual process of demographic concentration and spatial expansion has been accompanied by an intensified agglomeration of population, capital, and infrastructure within cities, fundamentally reshaping the scale, complexity, and functionality of urban systems [2]. While this large-scale transformation has been instrumental in driving economic growth, improving living standards, and facilitating industrial upgrading, it has simultaneously given rise to a range of complex sustainability challenges [2]. Rapid urban expansion places increasing pressure on infrastructure systems, while intensive land use and industrial

activities have contributed to environmental degradation [3]. At the same time, urban areas are becoming increasingly vulnerable to natural hazards and socio-economic risks [4]. As urban systems become more densely interconnected and functionally interdependent, their vulnerability to disruptions increases correspondingly [5]. In this context, enhancing cities' capacity to withstand, adapt to, and recover from internal disturbances and external shocks has emerged as a central concern for advancing sustainable urban development [6,7].

In response to these challenges, the concept of urban resilience has become prominent in both academic research and policy practice [8]. Originating from ecological and systems thinking, urban resilience emphasizes cities' capacity to absorb disturbances, adapt to changing conditions, and maintain essential functions over time [9]. From a sustainability perspective, resilience extends beyond short-term recovery to encompass long-term adaptability, flexibility, and learning within urban systems [8]. It is increasingly recognized as a critical dimension of sustainable development [10,11], particularly under the growing uncertainty associated with climate change, economic volatility, and public health risks [7]. This orientation is reflected in the global policy agenda, most notably in Sustainable Development Goal 11 (SDG 11), which identifies resilience as a key dimension of sustainable cities [12].

Parallel to this growing emphasis on resilience, there is an increasing need to identify concrete policy instruments through which resilience objectives can be operationalized in practice [11,13,14]. In this regard, urban renewal has emerged as a major policy tool for promoting resilient urban transformation [15]. Unlike the earlier expansion-oriented development model, which relied heavily on outward growth and new land development, urban renewal focuses on the upgrading, regeneration, and optimization of existing built environments [16]. The primary objective is to promote the upgrading and better utilization of existing urban environments while remedying deficiencies in infrastructure and public service provision [17]. Consequently, an increasing number of countries have begun to integrate resilient objectives into their urban renewal strategies, positioning renewal as a key pathway for enhancing urban safety, adaptability, and sustainability. China is no exception. Recent national policy documents have explicitly leveraged urban renewal as a strategic instrument with which to build resilient cities [15].

Despite the convergence of urban renewal and urban resilience in policy discourse, the relationship between the two remains insufficiently understood in the academic literature [18]. Studies have generated valuable insights but tend to examine urban renewal and urban resilience as largely separate domains [19]. Studies of urban renewal have mainly examined its underlying drivers, implementation processes, and corresponding outcomes [16,20], which are most commonly evaluated with respect to the economic, environmental, and social dimensions of sustainability [21]. Additionally, studies on urban resilience tend to emphasize conceptual frameworks [22,23], measurement approaches [24,25], and adaptive strategies [26], with resilience largely framed in terms of risk management. A growing body of research has begun to explore the intersection between these two fields; however, most of these studies rely on case-based approaches. They typically focus on how resilient objectives are incorporated and realized within specific urban renewal projects [27–29]. While these studies provide valuable insights, their findings are often constrained by project-specific and local conditions, thereby limiting the extent to which their findings can be generalized to explain how urban renewal influences urban resilience across cities.

In this study, we seek to answer three key research questions: (1) To what extent does urban renewal improve urban resilience? (2) Through what mechanisms is this influence transmitted? (3) How do these effects vary across cities with diverse resource endowments and spatial conditions? Our analysis is grounded in an integrated perspective that con-

conceptualizes urban renewal as a spatial intervention shaping resilience through physical, institutional, and resource pathways. Within this framework, we apply a difference-in-differences (DID) approach to panel data from 286 cities (2010–2021), leveraging China's 2017 pilot policy for the renovation projects of old residential communities as a quasi-natural experiment. This design allows for a rigorous evaluation of the corresponding resilience-enhancing effects and the transmission mechanisms through which they operate.

The findings offer threefold contributions to the literature on urban sustainability. First, this study collects existing insights into urban renewal and resilience to develop an analytical perspective for examining how renewal policies may influence urban adaptive capacity. Second, by shifting the analytical focus from localized project-level cases to a macro city-level perspective, it provides a broader empirical assessment of the resilience implications of urban renewal. Third, it highlights the heterogeneous and context-dependent nature of these effects, showing how local economic, fiscal, and regional conditions shape the extent to which renewal efforts translate to resilience gains. In doing so, this study contributes theoretical insight and empirical evidence to ongoing discussions on resilience-oriented urban development and the implementation of SDG 11.

This study is organized into five sections. Following this introduction, Section 2 develops the conceptual framework and hypotheses. Section 3 outlines the data, variables, and empirical strategy. Section 4 presents the empirical results. Section 5 discusses the results, and Section 6 concludes with possible policy implications.

## 2. Conceptual Framework and Research Hypotheses

Although urban resilience has become an important objective of sustainable development, it remains a contested concept [10,30]. For the purpose of this study, we adopt the definition proposed by Meerow et al. [8], which conceptualizes urban resilience as the capacity of urban systems to withstand and recover from disturbances, adapt to changing conditions, and transform structures and process when necessary to sustain long-term functionality and adaptive capacity. Early studies of urban resilience primarily examined the impacts of external shocks—such as floods, earthquakes, typhoons, and public health crises—emphasizing adaptive responses under single-hazard scenarios [31,32]. More recent studies have moved beyond this event-centered perspective toward a more dynamic understanding of resilience, highlighting its continuous cultivation within everyday urban operations and the nature of evolution over time [33–35]. Despite these different emphases, there is a common theme throughout the literature: resilience can be actively strengthened through interventions in urban systems. This understanding is reflected in the two complementary perspectives summarized by Wang et al. [36]—stress-resistant protection and capacity enhancement—both of which emphasize the possibility of strengthening resilience through changes in urban systems.

Building on this insight, we develop an integrated analytical framework that conceptualizes the determinants of urban resilience in three interrelated dimensions: urban form, governance institutions, and local resources. The first dimension, urban form, refers to the physical and spatial configurations of cities [37], including infrastructure systems [38], land use patterns [39], and the built environment [40]. These elements constitute the material foundation of urban resilience by determining the robustness, redundancy, and connectivity of urban systems [18]. Well-functioning infrastructure networks and efficiently organized spatial structures can reduce vulnerability to shocks, enhance system flexibility, and support efficient resource allocation. The second dimension, governance institutions, encompasses policy frameworks, government capacity, stakeholder participation, and coordination mechanisms [8,22,41]. These institutional arrangements shape how cities anticipate, respond to, and learn from risks. Effective governance enhances adaptive capacity

by facilitating collective action, reducing coordination failures, and integrating diverse forms of knowledge and resources into decision-making processes. The third dimension, local resources, reflects the availability and distribution of economic, demographic, and social resources that support resilience-building processes [15,24,42]. They include fiscal capacity [43], human capital [44], industrial diversity [45], and social capital [46], which collectively determine a city's ability to mobilize resources for recovery and adaptation. Importantly, these three dimensions are not independent; rather, they are deeply interconnected and mutually reinforcing. Urban form constitutes the material basis of resilience, governance institution provides the organizational mechanisms through which adaptation and coordination are achieved, and local resources supply the assets necessary to sustain both structural upgrading and institutional effectiveness. Through their continuous interaction, these dimensions jointly shape the evolution of urban resilience over time.

The analytical framework outlined above not only integrates existing theoretical perspectives but also aligns with the sustainability literature that emphasizes the co-evolution of physical systems, institutional processes, and resource dynamics. Against this backdrop, urban renewal can be viewed as a particularly relevant context for understanding how urban resilience is cultivated and sustained over time. Urban renewal is not merely a physical redevelopment strategy aimed at improving the built environment; rather, it represents a broader process through which cities respond to accumulated structural pressures, adapt to changing socioeconomic conditions, and pursue long-term development goals [15]. From this perspective, urban renewal and urban resilience are intrinsically connected, as both are fundamentally concerned with how urban systems navigate changes while maintaining functionality and developmental continuity. This conceptual affinity, however, does not imply that all forms of urban renewal necessarily generate resilience outcomes. Urban renewal is itself a highly heterogeneous concept, encompassing a wide spectrum of interventions ranging from large-scale redevelopment projects to community-level regeneration initiatives. Different forms of renewal may be geared toward distinct objectives and produce divergent social, economic, and spatial consequences [21]. This heterogeneity makes it difficult to derive consistent and generalizable empirical conclusions regarding its effects on urban resilience.

To move beyond the conceptual relationship between urban renewal and urban resilience and examine how this relationship unfolds in practice, it is necessary to situate the analysis within a specific policy context. Against this background, we took the renovation projects for old residential communities in China as the focal empirical context for hypothesis testing. In recent years, China's approach to urban renewal has undergone a strategic shift from large-scale demolition and construction to organic regeneration and stock-based optimization [47]. This transition is particularly relevant because it reflects a broader policy reorientation from spatial expansion to the upgrading and governance of existing urban spaces. Within this paradigm, the projects involving the renovation of old residential communities—mostly built prior to 2000—have emerged as one of the most representative policy instruments of contemporary urban renewal in China [48]. Unlike previous property-directed urban renewal, these projects target not only the revitalization of aging infrastructure, but also broader improvements in community governance, public service provision, and neighborhood living environments. Because they simultaneously affect multiple dimensions of urban development, they provide a valuable opportunity to examine whether and how urban renewal may generate broader resilience implications.

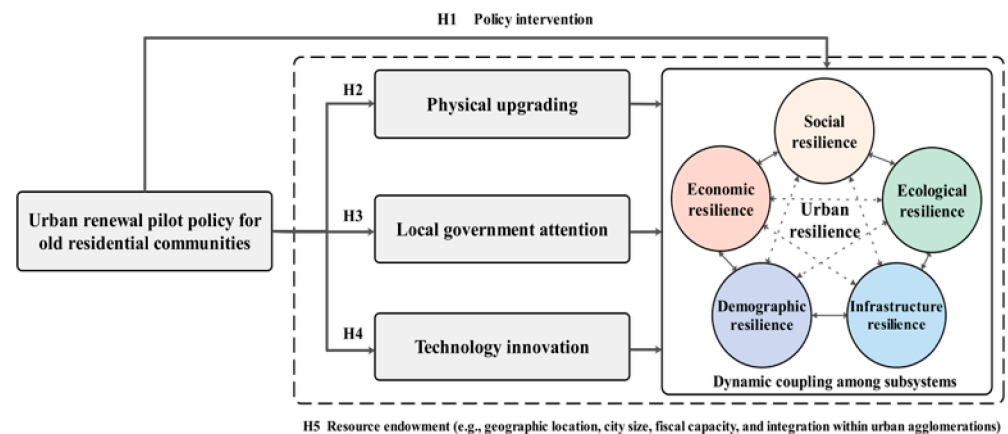
One potential pathway through which the pilot policy may influence urban resilience lies in the upgrading of the physical environment. By comprehensively upgrading critical utility systems—such as water supply, drainage, electricity, and gas—renovation projects can improve structural robustness and strengthen functional redundancy [41]. Furthermore,

improvements in building safety and public space configurations may reduce the risk of single-point failures and enhance adaptability to external disturbances. Collectively, these physical upgrades are expected to improve the capacity of residential areas to withstand and respond to external shocks, thereby contributing to broader urban resilience.

Beyond physical upgrading, the implementation of the pilot policy may also affect urban resilience through governance-related processes, among which local government attention represents a particularly important channel. As the projects of renovating old residential communities in China remain predominantly government-led, local governments play a pivotal role in translating central policy directives into practice [49]. Acting as key agents of policy adaptation, they formulate context-specific renovation strategies, coordinate across fragmented administrative departments, and facilitate channels for resident participation [49]. These processes not only ensure effective policy execution but also have the potential to enhance governance responsiveness and coordination capacity, which are widely regarded as important components of urban resilience [47]. A second governance-related channel operates through renovation-induced technological innovation. The implementation of renovation projects creates opportunities to embed new residential technologies into existing urban systems. For instance, some projects may incorporate smart upgrading measures—such as real-time monitoring and energy management systems—while others may emphasize green technologies, including energy-efficient materials and resource-recycling facilities. The integration of such technologies may strengthen the individual communities' adaptive capacity and cumulatively contribute to improving the resilience of the broader urban system.

The resilience implications of the pilot policy are also unlikely to be uniform across cities. Rather, they may vary according to local resource conditions and development contexts. Administrative hierarchy and fiscal capacity jointly determine the intensity of resource allocation for resilience-building [15]. Cities with stronger fiscal capacity can invest not only in basic infrastructure upgrading, but also in advanced monitoring systems, green technologies, and long-term maintenance mechanisms, thereby improving both redundancy and recovery speed. Geographic and environmental conditions further shape differentiated resilience priorities [15,24]: northern cities tend to emphasize energy system resilience, whereas southern coastal cities focus more on flood control and sponge city initiatives. Moreover, integration within urban agglomerations facilitates resource sharing and risk diversification through enhanced factor mobility and cross-regional coordination, generating spillover effects that may further reinforce overall system robustness [5].

Accordingly, the following hypotheses are proposed for empirical examination. H1: The urban renewal pilot targeting old residential communities exerts a significant positive effect on urban resilience. H2: Physical upgrading serves as a mediating channel through which the urban renewal pilot policy enhances urban resilience. H3: Local government attention serves as a mediating channel through which the urban renewal pilot policy influences urban resilience. H4: Technological innovation serves as a mediating channel through which the urban renewal pilot policy influences urban resilience. H5: The impact of the renewal pilot policy on urban resilience is moderated by urban resource endowments (e.g., geographic location, city size, fiscal capacity, and integration within urban agglomerations). Figure 1 shows the above linkages between the implementation of urban renewal pilot policy and urban resilience.



**Figure 1.** Conceptual framework of the renewal pilot policy's effects on urban resilience.

### 3. Materials and Methods

#### 3.1. Model Specification

To evaluate the resilience effects of urban renewal, we utilized China's 2017 pilot policy for the renovation of old residential communities as a quasi-natural experiment. In this pilot program, 15 cities were selected to take the lead in renovating old residential communities. The empirical strategy is based on a difference-in-differences (DID) framework, which compares changes in urban resilience between pilot cities (treatment group) and non-pilot cities (control group) before and after policy implementation. As with many policy pilots in China, the selection of pilot cities was determined through an administrative process rather than random assignment. Consequently, pilot and non-pilot cities may differ in a range of observable and unobservable characteristics. For this reason, the identification does not rely on the strong assumption of random policy allocation. Instead, the DID framework relies on the parallel trends assumption, which suppose that treated and control cities would have followed similar trends in the absence of the policy. To assess the plausibility of this assumption, we conducted event-study and parallel trends tests. In addition, city and year fixed effects were included to account for time-invariant city characteristics and common temporal shocks, while propensity-score matching-difference-in-differences (PSM-DID) estimation was employed as a robustness check to mitigate potential biases arising from observable pre-treatment differences between pilot and non-pilot cities. The baseline model is specified as follows:

$$\text{urban resilience}_{it} = \alpha + \beta(\text{Treat}_i \times \text{Post}_t) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where  $\text{urban resilience}_{it}$  denotes the level of urban resilience in city  $i$  at time  $t$ ;  $\text{Treat}_i$  is a binary variable equal to one for cities selected as pilot cities and zero otherwise;  $\text{Post}_t$  is a time dummy equal to 1 for years after 2017 and 0 otherwise; and the interaction term  $\text{Treat}_i \times \text{Post}_t$  (DID) captures the policy effect of urban renewal.  $X_{it}$  represents a set of control variables, and  $\mu_i$  and  $\lambda_t$  represent city and year fixed effects respectively, whereas  $\varepsilon_{it}$  denotes the stochastic error component. The estimated coefficient  $\beta$  measures the average impact of the urban renewal policy on urban resilience and constitutes the key parameter in the model.  $\alpha$  is the intercept term, representing the baseline value of urban resilience when there is no treatment effect, no control variables, and the fixed effects equal zero.

#### 3.2. Variable Definitions

Urban resilience is the dependent variable. Following Ribeiro and Gonçalves's [23] approach, cities can be conceptualized as complex systems whose overall resilience emerges from the resilience of multiple interrelated subsystems. This multidimensional perspective

has been widely adopted in the urban resilience literature and provides the theoretical basis for resilience measurement at the city level [15]. Building on this established approach, we operationalize urban resilience through a multidimensional evaluation system consisting of five dimensions (i.e., economic, social, ecological, infrastructural, and demographic dimensions) and 28 indicators (for which full information can be found in Appendix A). The entropy-weighted TOPSIS method is then employed to aggregate these indicators into a comprehensive urban resilience index.

The key explanatory variable is the DID interaction term  $Treat_i \times Post_t$ , which captures the implementation of the old residential community renewal pilot policy.

To examine the underlying mechanisms, three mediating variables were introduced. First, physical upgrading was measured as the total fixed-asset investment expenditure in infrastructure sectors within a city. Second, local government attention was constructed from municipal government work reports using a seed-guided latent dirichlet allocation (LDA) topic model implemented in Python 3.12.10. Following standard text-analysis procedures, we processed the reports through word segmentation, stop-word removal, and dictionary construction. A set of renewal-related seed terms was used to identify policy-relevant text segments, after which the LDA model was employed to extract latent topics. The topic most closely associated with old residential community renovation was then identified based on keyword composition and topic-match scores, and the corresponding document-topic probability was used to measure local government attention. Third, technological innovation was constructed using invention patent data from the China National Intellectual Property Administration. Patent values were estimated through a patent renewal model and aggregated to form a city-level innovation index provided by the Fudan-TSE Research Institute of Innovation and Digital Economy.

To mitigate potential omitted variable bias, several control variables were included, namely population density, urbanization rate, foreign direct investment, gross domestic product, the number of Internet users, and cultural resources. These variables capture key dimensions of urban development that may influence urban resilience.

### 3.3. Data Sources and Processing

We employed a sample covering 286 prefecture-level and above Chinese cities over the 2010–2021 period, providing a sufficiently long observation window before and after the implementation of the 2017 pilot policy. The treatment group consisted of cities selected as pilot cities, while the control group comprised the other cities that were not included in the pilot program. Together, the groups formed a balanced panel dataset with 3432 observations. Data for the urban resilience index, control variables, and infrastructure investment were primarily obtained from the China City Statistical Yearbook, the China Urban Construction Statistical Yearbook, and annual statistical bulletins of city governments. The information is available at <https://data.cnki.net> and <https://www.macrodats.cn/article/1147472707> (both accessed 30 September 2025). The urban innovation capacity index was derived from the reports published by the Fudan-TSE Research Institute of Innovation and Digital Economy, which was available at <https://ride.fudan.edu.cn/info/1020/1274.htm> (accessed on 12 November 2025). Data on local government attention were obtained through text analysis of municipal government work reports, which were retrieved from the official websites of city governments. To address missing data, we prioritized supplementing information from official statistical bulletins and government disclosures. Additionally, linear interpolation was applied to fill in remaining missing values, whereas observations with substantial gaps were removed to enhance reliability. Descriptive statistics for the main variables are reported in Table 1.

**Table 1.** Descriptive statistics of the key variables.

| Variable                   | Mean  | Std. Dev | Min   | Max    |
|----------------------------|-------|----------|-------|--------|
| Urban resilience           | 0.069 | 0.076    | 0.021 | 0.644  |
| Population density         | 0.380 | 0.256    | 0.031 | 1.505  |
| Urbanization rate          | 0.553 | 0.152    | 0.181 | 1.000  |
| Foreign direct investment  | 0.963 | 3.639    | 0.000 | 173.5  |
| Gross domestic product     | 7.372 | 0.981    | 4.645 | 22.556 |
| Internet users             | 1.093 | 1.298    | 0.010 | 15.360 |
| Cultural resources         | 3.284 | 7.652    | 0.064 | 179.85 |
| Physical upgrading         | 0.074 | 0.109    | 0.001 | 1.268  |
| Local government attention | 0.166 | 0.209    | 0.000 | 0.968  |
| Technology innovation      | 1.702 | 1.410    | 0.011 | 7.976  |

## 4. Results

### 4.1. Baseline Regression Analyses

Table 2 presents the baseline DID estimates of the impact of urban renewal pilot policy on urban resilience. Across all models, relatively high  $R^2$  values were observed because of the two-way fixed-effects specification. In addition, the coefficient of the DID term remained positive and statistically significant at the 1% level, providing consistent evidence that the policy helps improve urban resilience. The estimated coefficient declined from 0.061 in the baseline specification to 0.014 after the inclusion of control variables and two-way fixed effects. This reduction suggests that part of the initial estimate reflects cross-city heterogeneity and broader temporal factors that are subsequently absorbed by the more stringent specifications. Importantly, the coefficient remained remarkably stable once both city and year fixed effects were introduced, indicating that the positive policy effect is not driven by time-invariant city characteristics or common shocks. Although the final estimated effect appeared modest in absolute terms, it corresponded to approximately 20.3% of the sample mean level of urban resilience and about 0.18 standard deviations. These magnitudes suggest that urban renewal is associated with a positive but moderate improvement in urban resilience after accounting for pre-existing differences across cities and broader temporal trends. These results are consistent with the findings of Yu et al. [50] and Jiang et al. [15].

**Table 2.** Baseline regression results.

| Variables          | Model (1)            | Model (2)            | Model (3)            |
|--------------------|----------------------|----------------------|----------------------|
| DID                | 0.061 ***<br>(0.014) | 0.015 ***<br>(0.003) | 0.014 ***<br>(0.003) |
| Constant           | 0.067 ***<br>(0.001) | 0.002<br>(0.021)     | 0.044 ***<br>(0.001) |
| Control variables  | No                   | Yes                  | Yes                  |
| Year fixed effects | No                   | No                   | Yes                  |
| City fixed effects | No                   | Yes                  | Yes                  |
| Observations       | 3432                 | 3432                 | 3432                 |
| $R^2$              | 0.014                | 0.976                | 0.977                |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* indicate that the regression results were significant at 1% levels respectively.

### 4.2. Robustness Checks Results

Six different tests were carried out to verify the reliability of the baseline findings. First, a parallel trends test was performed to validate the DID identification assumption. Using 2016 as the reference period, dynamic effects were estimated to test for pre-treatment

differences across groups. Second, a placebo test was implemented through a mixed randomization procedure. Specifically, 15 cities were randomly designated as pseudo-treated units with randomly generated policy timing, and the process was repeated 500 times. Third, the dependent variable was re-measured using the entropy method to replace the entropy-weighted TOPSIS approach adopted in the baseline model. Fourth, to address potential outliers, municipalities directly under the central government were excluded, and the dependent variable was winsorized at the 1% and 5% levels. Fifth, a PSM–DID approach was employed by matching treated and control cities based on observable characteristics. Sixth, additional policy controls were included to account for potential confounding effects, such as sponge city initiatives, smart city programs, and the “Broadband China” strategy. Overall, the estimated results remained robust and qualitatively consistent across these alternative specifications (the results of robustness analyses are detailed in Appendix B). Therefore, both the baseline results and robustness checking results provide empirical support for Hypothesis 1, suggesting that urban renewal functions as an effective spatial governance tool for strengthening urban resilience. At the same time, the relatively moderate effect size implies that resilience building is a gradual and cumulative process, influenced by multiple factors beyond a single policy intervention. This highlights the importance of examining the underlying mechanisms through which urban renewal operates, as well as the contextual conditions that shape its effectiveness.

#### 4.3. Channel Analyses

Following Yang et al. [51] and Wu et al. [52], we explored several theoretical relevant channels through which urban renewal may contribute to urban resilience. Specifically, separate regressions were estimated for physical upgrading, local government attention, and technological innovation, with the DID term serving as the key explanatory variable. Table 3 reports positive and statistically significant coefficients of the DID term across all specifications, indicating that the pilot policy is associated with greater infrastructure investment, increased local government attention, and enhanced technological innovation. These findings suggest that urban renewal influences a range of physical, institutional, and technological factors that have been identified in the literature as important determinants of urban resilience. Specifically, improvements in physical infrastructure are generally considered conducive to enhancing the robustness and redundancy of urban systems [38]. Increased government attention may facilitate policy coordination, resource mobilization, and adaptive governance [53], while technological innovation may strengthen cities’ capacity to adapt to changing conditions through knowledge creation and technological upgrading [50]. Thus, the results provide evidence that urban renewal is associated with several factors that are widely regarded as important for resilience-building, thereby offering insight into the potential pathways through which the policy may contribute to improvements in urban resilience.

**Table 3.** Mechanism analysis results.

| Variables         | Physical Upgrading  | Local Government Attention | Technology Innovation |
|-------------------|---------------------|----------------------------|-----------------------|
| DID               | 0.054 **<br>(0.021) | 0.047 ***<br>(0.010)       | 0.307 ***<br>(0.034)  |
| Constant          | −0.079<br>(0.093)   | 0.235 ***<br>(0.089)       | 0.678<br>(0.560)      |
| Control variables | Yes                 | Yes                        | Yes                   |

Table 3. *Cont.*

| Variables          | Physical Upgrading | Local Government Attention | Technology Innovation |
|--------------------|--------------------|----------------------------|-----------------------|
| Year fixed effects | Yes                | Yes                        | Yes                   |
| City fixed effects | Yes                | Yes                        | Yes                   |
| Observations       | 3432               | 3432                       | 3432                  |
| $R^2$              | 0.495              | 0.834                      | 0.968                 |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* and \*\* indicate that the regression results are were significant at the 1% and 5% levels, respectively.

#### 4.4. Heterogeneity Analyses

As discussed in the theoretical framework, the resilience effects of urban renewal are unlikely to be uniform across cities because the capacity to translate renewal interventions into resilience gains depends on the local conditions. Therefore, we conducted heterogeneity analyses in four dimensions: region, city size, fiscal capacity, and urban agglomeration integration (the heterogeneity analysis results above are detailed in Appendix C). The results revealed substantial variation in the magnitude of policy effects across different groups. First, positive and significant effects were observed in eastern, central, and western China, whereas the estimated coefficient for northeastern cities was smaller and statistically insignificant. Second, urban renewal generated resilience gains across all city-size categories, but the magnitude of the effect increased markedly with city size. Third, the positive effect was statistically significant only among cities with higher fiscal self-sufficiency, suggesting that adequate fiscal resources may facilitate the translation of renewal investments into resilience gains. Fourth, while positive effects were identified in both agglomeration and non-agglomeration cities, the estimated effect was considerably larger for cities within urban agglomerations. Overall, the results are consistent with the findings of Yu et al. [50] and Jiang et al. [15]. They also suggest that the effectiveness of urban renewal is systematically conditioned by city-level structural characteristics, rather than being driven solely by the policy intervention itself.

## 5. Discussion

In the context of growing climate, environmental, and socio-economic uncertainties, enhancing urban resilience has become a central objective of sustainable urban development and an important component of SDG 11 [12]. Against this backdrop, we examined whether urban renewal can contribute to resilience-building by exploiting the 2017 pilot policy for the renovation projects of old residential communities as a quasi-natural experiment. The findings challenge a tendency within both policy and academic debates to view resilience as a direct outcome of physical urban transformation. Urban renewal is often justified through an engineering-oriented logic in which deteriorated spaces are treated as sources of vulnerability, and physical upgrading is expected to generate resilience gains. While our results confirm the importance of improvements to the built environment, they also indicate that urban renewal contributes to resilience by creating opportunities for institutions, actors, and technologies to reorganize their responses to risk and uncertainty. In this sense, resilience is less a product of construction and more an outcome of governance [54]. This finding echoes broader shifts in resilience theory from engineering conceptions focused on stability and recovery to governance-oriented perspectives that emphasize adaptation, learning, and transformation [55].

This interpretation also helps explain why the relationship between urban renewal and resilience remains contingent rather than universal [15]. Urban renewal is not a single policy instrument but a diverse set of practices pursued under different political, economic, and social objectives [21]. In many contexts, renewal is oriented primarily toward economic

growth, land redevelopment, property valorization, or urban competitiveness. Under such circumstances, resilience may be invoked as a policy aspiration without fundamentally shaping how renewal is implemented. In contrast, the renovation of old residential communities examined in this study is closely linked to the management of everyday urban risks, including infrastructure deterioration, environmental hazards, and deficiencies in public services. Its resilience effects therefore derive not only from what is renewed, but also from the particular governance logic through which renewal is pursued. This distinction suggests that resilience should not be understood as an automatic outcome of urban renewal. Rather, it emerges when renewal is oriented toward reducing vulnerabilities, strengthening adaptive capacities, and improving the ability of urban systems to respond to future uncertainties. Other forms of renewal may generate very different outcomes, including displacement, socio-spatial exclusion, or new forms of vulnerability, even where physical conditions are improved [21].

The heterogeneous effects identified across cities further reinforce this argument. Cities with stronger economic foundations, greater fiscal capacity, and deeper regional integration are better able to translate renewal investments into resilience gains. This suggests that urban renewal does not create resilience from scratch, it works by activating and amplifying capacities that already exist within local institutional environments [15]. In other words, resilience is best understood as an emergent property arising from the interaction between renewal interventions and pre-existing governance conditions. Consequently, the effectiveness of urban renewal depends not only on the resources invested in projects, but also on the institutional capacities available for coordinating, learning, and adapting throughout the renewal process.

## 6. Conclusions

This study examined whether urban renewal contributes to urban resilience by exploiting the 2017 pilot policy. Using panel data from 286 Chinese cities over the 2010–2021 period, we found that urban renewal has a positive and statistically significant effect on urban resilience. The effects function through the combined influence of physical upgrading, governance processes, and technological adaptation, while varying across cities with different economic, fiscal, and regional characteristics. Together, these findings suggest that the relationship between urban renewal and resilience is neither singular nor uniform but shaped by multiple interacting processes and local conditions.

These findings carry important implications for policy. Specifically speaking, cities differ substantially in their economic foundations, governance arrangements, and fiscal resources, which influence their ability to translate renewal investments into resilience gains. Consequently, resilience should not be treated as an automatic by-product of physical upgrading. Instead, resilience considerations should be embedded throughout the governance of renewal, including project design, stakeholder coordination, implementation, monitoring, and adaptation. Particular attention should be paid to strengthening institutional capacity and ensuring that renewal initiatives remain responsive to local vulnerabilities and risk conditions. At the same time, differentiated support mechanisms are needed to enable less-developed and fiscally constrained cities to benefit from resilience-oriented renewal strategies. Therefore, maximizing the resilience benefits of urban renewal requires place-based approaches that align renewal strategies with local institutional and developmental contexts.

Beyond its policy implications, this study contributes to the literature in several ways. First, it provides empirical evidence that urban renewal can serve not only as a spatial development strategy, but also as a governance instrument for enhancing urban resilience. Second, the study moves beyond documenting policy effects by revealing the governance

and developmental pathways through which urban renewal contributes to resilience-building, thereby opening the black box linking renewal interventions and resilience outcomes. Third, the findings demonstrate that the resilience effects of urban renewal are context-dependent rather than automatic, highlighting the importance of local institutional and developmental conditions in shaping policy effectiveness. Thus, these contributions suggest that resilience-oriented urban renewal should be understood not simply as a physical transformation process, but as a governance challenge involving the interaction between spatial interventions, institutional capacity, and local development conditions.

Finally, this study also has limitations. First, while the urban resilience index is constructed based on established approaches in the literature, it may not fully capture the multifaceted and evolving nature of urban resilience. Second, it focuses on a specific policy intervention and a limited set of mechanisms, leaving out factors such as social capital, community-level dynamics, and institutional trust. Third, the relatively short observation period may not fully capture the long-term effects of urban renewal on resilience, and caution is therefore warranted when extrapolating the findings beyond the study period. Fourth, the findings are derived from the institutional context of China, potentially limiting their direct applicability to other settings. Future research could extend this work by examining additional social mechanisms, adopting longer observation windows, and exploring the applicability of similar frameworks in different institutional contexts.

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## Abbreviations

The following abbreviations are used in this manuscript:

|         |                                                                |
|---------|----------------------------------------------------------------|
| DID     | Difference-in-differences                                      |
| SDG11   | Sustainable Development Goal 11                                |
| TOPSIS  | Technique for order preference by similarity to ideal solution |
| LDA     | Latent Dirichlet allocation                                    |
| PSM-DID | Propensity-score-matching difference-in-differences            |

## Appendix A

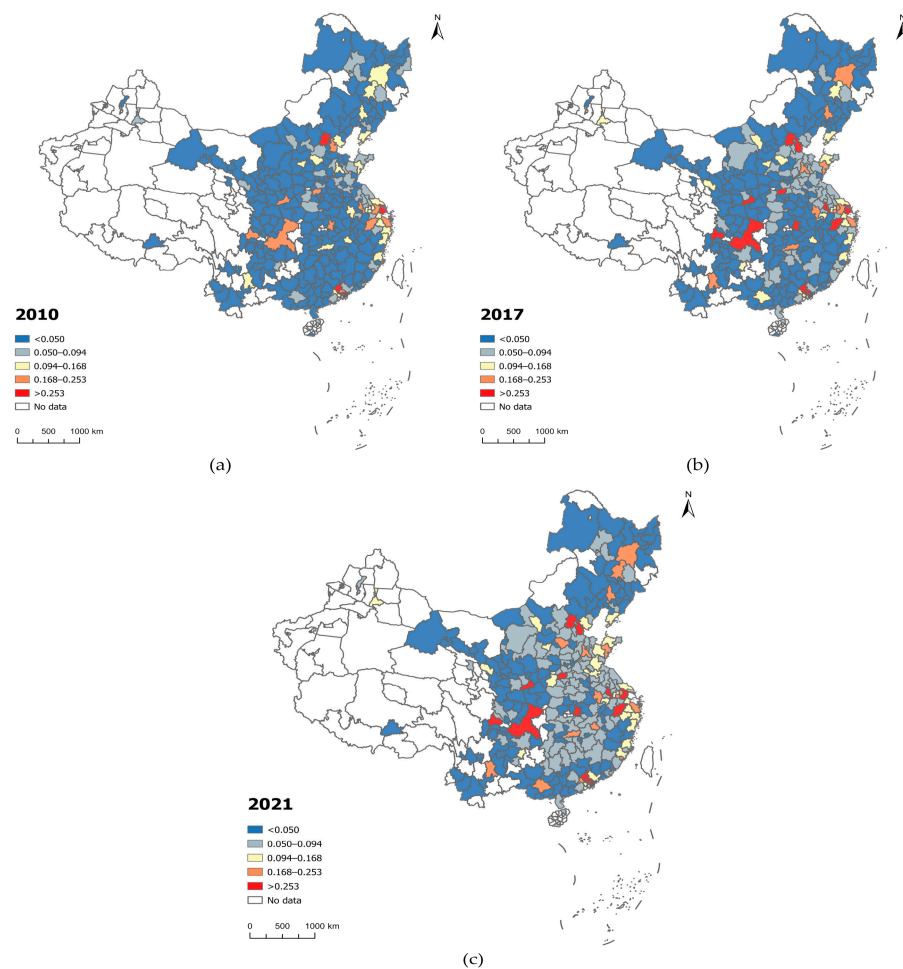
Urban resilience was measured using an evaluation system composed of five dimensions and 28 indicators developed in this study. Economic resilience was measured via

six indicators, such as the registered urban unemployment rate. Social resilience was captured by seven indicators, including the number of hospital beds. Ecological resilience was assessed through six indicators, such as industrial sulfur dioxide emissions. Infrastructural resilience incorporated six indicators, including the length of urban drainage pipelines. Demographic resilience was represented by three indicators, such as the share of residents aged 65 years and older.

**Table A1.** The indicators of the urban resilience index.

| Criterion Layer                 | Sub-Criterion Layer                    | Indicator Layer                                                                                                                                                             |
|---------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Urban economic resilience       | Stability of economic operation        | Registered urban unemployment rate<br>Tertiary industry's share in GDP                                                                                                      |
|                                 | Economic development support capacity  | Number of above-scale industrial enterprises<br>GDP per capita                                                                                                              |
|                                 | Innovation input intensity             | Share of education expenditure in local general public budget expenditure<br>Share of science and technology expenditure in local general public budget expenditure         |
| Urban social resilience         | Social services and supply             | Share of employment in tertiary industry<br>Postal and telecommunications business revenue                                                                                  |
|                                 | Education and talent support           | Number of students enrolled in higher education institutions                                                                                                                |
|                                 | Healthcare security level              | Number of beds in medical and health institutions                                                                                                                           |
|                                 | Residents' income and social security  | Average wage of employed staff<br>Number of participants with basic urban employee pension insurance<br>Number of participants in unemployment insurance                    |
| Urban ecological resilience     | Pollution emissions and treatment      | Industrial sulfur dioxide emissions<br>Harmless treatment rate of domestic waste<br>Centralized treatment rate of urban sewage<br>Treatment capacity of urban sewage plants |
|                                 | Greening and ecological space          | Green coverage rate of built area<br>Per capita green park area                                                                                                             |
| Urban infrastructure resilience | Drainage and road facilities           | Length of urban drainage pipelines<br>Per capita urban road area                                                                                                            |
|                                 | Public services facilities             | Number of public toilets in cities                                                                                                                                          |
|                                 | Transport and urban living support     | Number of public buses and trolleybuses in operation<br>Per capita daily domestic water consumption<br>Gas penetration rate                                                 |
| Urban demographic resilience    | Population structure and human capital | Share of population aged 65 and above<br>Average years of schooling of the urban population                                                                                 |
|                                 | Public management human resources      | Number of employees in the public administration and social organizations sectors                                                                                           |

For demonstrative purposes, we calculated the resilience levels of 286 cities across China for the years 2010, 2017, and 2021. As shown, over time, the resilience level of Chinese cities has increased, particularly in the eastern and central regions.

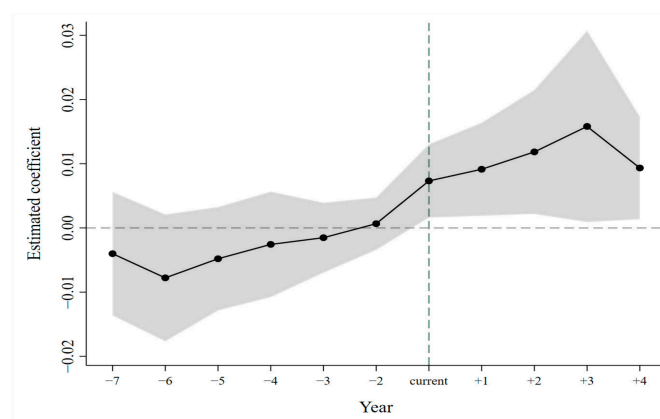


**Figure A1.** (a) The variations in urban resilience in 2010; (b) The variations in urban resilience in 2017; (c) The variations in urban resilience in 2021.

## Appendix B

### Appendix B.1. Parallel Trends Test

Figure A2 and Table A2 report event-study estimates for the parallel trends test (Appendix B.1). The pre-treatment coefficients were statistically insignificant and centered around zero, indicating there were no baseline differences between groups. In contrast, the post-policy estimates turned positive and significant, suggesting that there is a favorable policy effect consistent with the baseline results.



**Figure A2.** The parallel trends plot.

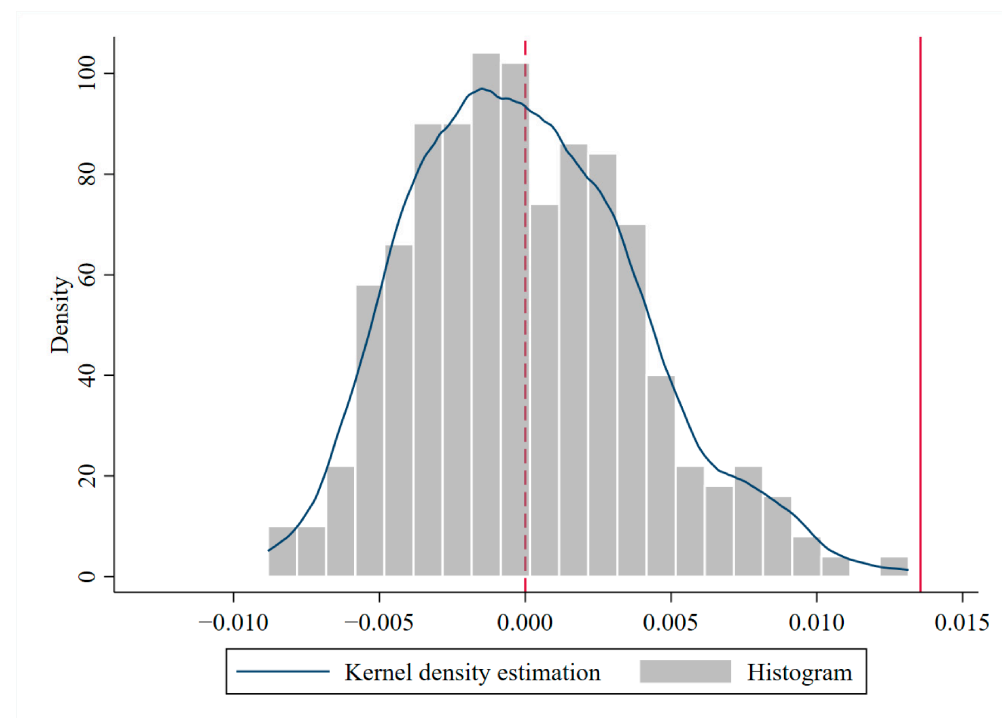
**Table A2.** Event-study estimates for the parallel trends test.

| Period          | Coefficient | Standard Error | p-Value |
|-----------------|-------------|----------------|---------|
| −7              | −0.004      | 0.006          | 0.493   |
| −6              | −0.008      | 0.006          | 0.195   |
| −5              | −0.005      | 0.005          | 0.326   |
| −4              | −0.003      | 0.005          | 0.608   |
| −3              | −0.002      | 0.003          | 0.646   |
| −2              | 0.001       | 0.002          | 0.789   |
| Current (t = 0) | 0.007       | 0.003          | 0.035   |
| +1              | 0.009       | 0.004          | 0.038   |
| +2              | 0.012       | 0.006          | 0.044   |
| +3              | 0.016       | 0.009          | 0.081   |
| +4              | 0.009       | 0.005          | 0.054   |

Note: The period immediately preceding policy implementation ( $t = -1$ ) was omitted as the reference period. A joint significance test of all pre-treatment coefficients yielded  $F(6, 3118) = 0.59$  ( $p = 0.741$ ), indicating that the parallel trends assumption cannot be rejected.

### Appendix B.2. Placebo Test

Figure A3 reports the results of the placebo test. The estimated coefficients were centered around zero and approximately normally distributed, with no effects comparable to the baseline. When treatment status and timing were randomly assigned, the estimated effects disappeared, and the null hypothesis that there is no treatment effect could not be rejected at conventional significance levels, suggesting that the baseline results are unlikely to be driven by unobserved time-varying confounders. The dashed red line in the Kernel density plot marks zero, and the solid red line indicates the baseline estimate.

**Figure A3.** The estimation results of the placebo test.

### Appendix B.3. The Results of Other Robustness Checks

A series of robustness checks were conducted by remeasuring the dependent variable using the entropy method, applying 1% and 5% winsorization, excluding extreme observations (e.g., municipalities directly under the central government), and implement-

ing a PSM–DID approach. As shown in Table A3, the results are consistent with the baseline estimates.

**Table A3.** Results of the robustness checks.

| Variables          | Re-Measuring Dependent Variable | Outlier Exclusion    | Winsorized 1%        | Winsorized 5%        | PSM-DID              |
|--------------------|---------------------------------|----------------------|----------------------|----------------------|----------------------|
| DID                | 0.012 ***<br>(0.003)            | 0.014 ***<br>(0.003) | 0.013 ***<br>(0.002) | 0.010 ***<br>(0.002) | 0.013 ***<br>(0.003) |
| Constant           | 0.019<br>(0.020)                | 0.036 **<br>(0.016)  | 0.038 **<br>(0.016)  | 0.040 ***<br>(0.013) | 0.052<br>(0.021)     |
| Control variables  | Yes                             | Yes                  | Yes                  | Yes                  | Yes                  |
| Year fixed effects | Yes                             | Yes                  | Yes                  | Yes                  | Yes                  |
| City fixed effects | Yes                             | Yes                  | Yes                  | Yes                  | Yes                  |
| Observations       | 3432                            | 3384                 | 3432                 | 3432                 | 2424                 |
| $R^2$              | 0.979                           | 0.968                | 0.978                | 0.973                | 0.975                |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* and \*\* indicate that the regression results are were significant at the 1% and 5% levels, respectively.

#### Appendix B.4. Excluding Potential Confounding Effects from Other Policies

To mitigate confounding effects from other policy interventions, the baseline model was further expanded to include dummy variables for major pilot programs, such as the sponge city initiative, smart-city development, and the “Broadband China” strategy. Table A4 shows that the baseline findings were robust to the inclusion of these additional controls.

**Table A4.** Controlling for other concurrent policies.

| Variables              | Urban Resilience     | Urban Resilience     | Urban Resilience     |
|------------------------|----------------------|----------------------|----------------------|
| DID                    | 0.013 ***<br>(0.003) | 0.014 ***<br>(0.003) | 0.013 ***<br>(0.003) |
| Sponge city policy     | 0.018 ***<br>(0.002) |                      |                      |
| Smart city policy      |                      | 0.004 ***<br>(0.001) |                      |
| Broadband China policy |                      |                      | 0.007 ***<br>(0.001) |
| Constant               | 0.045 ***<br>(0.015) | 0.042 ***<br>(0.016) | 0.043 ***<br>(0.016) |
| Control variables      | Yes                  | Yes                  | Yes                  |
| Year fixed effects     | Yes                  | Yes                  | Yes                  |
| City fixed effects     | Yes                  | Yes                  | Yes                  |
| Observations           | 3432                 | 3432                 | 3432                 |
| $R^2$                  | 0.978                | 0.977                | 0.978                |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* indicate that the regression results are were significant at the 1% levels.

## Appendix C

### Appendix C.1. Regional Heterogeneity

The 286 cities included in the sample were grouped into four geographic regions, namely eastern, central, western, and northeastern China. Subsample regressions were then conducted to examine regional heterogeneity in the policy effects. The results are reported in Table A5.

**Table A5.** The results of the regional heterogeneity analyses.

| Variables          | Eastern China        | Central China        | Western China        | Northeastern China   |
|--------------------|----------------------|----------------------|----------------------|----------------------|
| DID                | 0.014 ***<br>(0.005) | 0.011 ***<br>(0.004) | 0.012 ***<br>(0.003) | 0.004<br>(0.004)     |
| Constant           | −0.057<br>(0.048)    | −0.052<br>(0.038)    | 0.000<br>(0.013)     | 0.035 ***<br>(0.004) |
| Control variables  | Yes                  | Yes                  | Yes                  | Yes                  |
| Year fixed effects | Yes                  | Yes                  | Yes                  | Yes                  |
| City fixed effects | Yes                  | Yes                  | Yes                  | Yes                  |
| Observations       | 1032                 | 960                  | 1032                 | 408                  |
| R <sup>2</sup>     | 0.984                | 0.963                | 0.973                | 0.981                |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* indicate that the regression results are were significant at the 1% levels.

### Appendix C.2. Scale Heterogeneity

Cities were classified into megacities (>10 million urban residents), large cities (5–10 million), and other cities (<5 million) according to the official city-size classification. Subsample regressions were then conducted to examine heterogeneity by city size. The results are reported in Table A6.

**Table A6.** The results of the scale heterogeneity analyses.

| Variables          | Megacities            | Large Cities         | Other Cities         |
|--------------------|-----------------------|----------------------|----------------------|
| DID                | 0.066 ***<br>(0.015)  | 0.022 ***<br>(0.004) | 0.006 ***<br>(0.002) |
| Constant           | −0.618 ***<br>(0.219) | −0.092 **<br>(0.038) | 0.030 ***<br>(0.006) |
| Control variables  | Yes                   | Yes                  | Yes                  |
| Year fixed effects | Yes                   | Yes                  | Yes                  |
| City fixed effects | Yes                   | Yes                  | Yes                  |
| Observations       | 189                   | 873                  | 2367                 |
| R <sup>2</sup>     | 0.988                 | 0.976                | 0.868                |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* and \*\* indicate that the regression results are were significant at the 1% and 5% levels, respectively.

### Appendix C.3. Fiscal Self-Sufficiency Capacity Heterogeneity

We defined fiscal self-sufficiency capacity as the ratio of general public budget revenue to expenditure. The sample was then divided into high and low groups, and the regression results are reported in Table A7.

**Table A7.** The results of fiscal self-sufficiency capacity heterogeneity analyses.

| Variables          | High Capacity Group   | Low Capacity Group   |
|--------------------|-----------------------|----------------------|
| DID                | 0.015 ***<br>(0.004)  | 0.001<br>(0.001)     |
| Constant           | −0.116 ***<br>(0.024) | 0.024 ***<br>(0.004) |
| Control variables  | Yes                   | Yes                  |
| Year fixed effects | Yes                   | Yes                  |

**Table A7.** *Cont.*

| Variables          | High Capacity Group | Low Capacity Group |
|--------------------|---------------------|--------------------|
| City fixed effects | Yes                 | Yes                |
| Observations       | 1701                | 1708               |
| $R^2$              | 0.981               | 0.840              |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* indicate that the regression results are were significant at the 1% levels.

#### Appendix C.4. Urban Agglomeration Affiliation Heterogeneity

We divided the 286 sample cities into two groups: cities located within urban agglomerations and cities outside urban agglomerations. The results are reported in Table A8.

**Table A8.** The results of urban agglomeration affiliation heterogeneity analyses.

| Variables          | Agglomeration Cities | Non-Agglomeration Cities |
|--------------------|----------------------|--------------------------|
| DID                | 0.029 ***<br>(0.006) | 0.004 *<br>(0.002)       |
| Constant           | −0.021<br>(0.019)    | 0.043 ***<br>(0.010)     |
| Control variables  | Yes                  | Yes                      |
| Year fixed effects | Yes                  | Yes                      |
| City fixed effects | Yes                  | Yes                      |
| Observations       | 1728                 | 1704                     |
| $R^2$              | 0.979                | 0.976                    |

Note: (1) The coefficients in parentheses are robust standard errors. (2) \*\*\* and \* indicate that the regression results are were significant at the 1% and 10% levels, respectively.

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