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The Effect of Urban Resilience on Residents' Subjective Happiness: Evidence from China

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Abstract: This study aims to analyze the role of urban resilience in residents' subjective happiness in China. Results show that the overall urban resilience is a critical factor in improving residents' subjective happiness, and each sub-class resilience index of cities in the ecological, social, infrastructure, and economic aspects shows positive and significant correlations with residents' subjective happiness. Heterogeneous results show that the effect of urban resilience is greater for residents with higher education or living in cities with larger population size. The mechanism results show that four possible channels are confirmed. The rise of urban resilience raises residents' subjective happiness through increasing residents' income or consumption, improving their health status, and raising their social trust or social integration. The main conclusion drawn from the empirical analysis is that raising urban resilience is an effective strategy to strengthen residents' subjective happiness.

Keywords: urban resilience; principal component analysis; mechanism analysis; residents' subjective happiness

1. Introduction

With the economic development in the past decades, the income and consumption of residents in China have increased continuously. For example, the gross domestic product in China increased from 12,171.74 to 114,366.97 billion during the period from 2002 to 2021, and the average consumption of residents rose from CNY 4270 to CNY 31,072 in the same period. However, there were also some economic fluctuations when economic shocks or COVID-19 occurred. For example, the 2008 financial crisis led to an increase in unemployment and a slowdown in economic growth in China, although the negative economic shock was absorbed and economic growth gradually recovered after a few years. Urban resilience can partly explain the above phenomenon whereby the economic system of a country resists a negative economic shock, recovers from the shock, and returns to an equilibrium again [1–3]. Up to now, most scholars have focused on the clear definition of resilience and have developed three definitions: engineering resilience, ecological resilience, and adaptive resilience. In addition, the influencing factors of urban resilience, such as industrial diversity, technological relatedness, or human capital, have aroused heated discussions [4,5]. However, few studies have paid attention to the consequences of urban resilience or explored the effect of urban resilience.

On the other hand, the subjective well-being and life satisfaction of residents have received attention in China. In the report of the 19th National Congress, the importance of people's happiness and sense of security was emphasized, and it was pointed out that the public service system should be improved, and social justice should be promoted to reach the above goal. Recent subjective happiness literature in China has mostly been concerned about the role of hukou status, environmental quality, housing characteristics,

housing prices, or income, while explanations of the power of the above factors have been relatively limited [6–9]. Further research is needed to analyze why there is a difference in residents' subjective happiness in different cities. Therefore, the link between the urban resilience of cities and residents' subjective happiness is further explored to enrich the existing literature.

In this study, we match data from China Family Panel Studies with the urban resilience data of each city and construct panel data to examine the role of urban resilience in residents' subjective happiness. Findings show that, as urban resilience increases, residents feel more satisfied about their life, and each sub-class resilience index (ecological resilience, economic resilience, infrastructure resilience, and social resilience) of the four aspects is positively related to residents' subjective happiness. Additionally, the effect of urban resilience is much larger and more significant for residents with a high education level or who are living in large cities. Residents are also more likely to have a higher subjective happiness level as urban resilience rises if they live in cities with a lower economic development level. In the robustness checks, after substituting the urban resilience indicators and changing the estimation method, the conclusion and results remain consistent. Three potential mechanisms are explored in this study. First, the increase in economic resilience promotes the rise of personal income and family consumption, which is positively linked to residents' subjective happiness. Second, higher ecological resilience is beneficial for the improvement of residents' health status, reduces the probability of having diseases, raises their self-rated health, and enhances their subjective happiness. Third, an increase in social and infrastructure resilience leads to a rise in residents' social trust and social integration (e.g., increasing their donation behavior or improving their attitudes towards employment problems), which exerts a positive influence on shaping residents' subjective happiness.

Therefore, our study contributes to the existing literature in the following ways. First, we construct a comprehensive urban resilience index with principal component analysis and calculate four sub-class resilience indices: the ecological resilience index, economic resilience index, infrastructure resilience index, and social resilience index. Second, we regard urban resilience as one of the influencing factors of people's subjective happiness and examine the role of urban resilience in individual life with panel data. Third, we further add to the existing literature by exploring the possible channels through which urban resilience exerts a significant influence on people's subjective happiness, such as through increasing social trust, increasing people's income and consumption level, or enhancing their health status.

Overall, the aims of this study are as follows:

1. to examine the effect of the overall urban resilience index and sub-class urban resilience indices (ecological resilience, social resilience, infrastructure resilience, and economic resilience) on residents' subjective happiness with a nationally representative survey;
2. to analyze the heterogenous effect of urban resilience on different groups categorized by residents' year of schooling, regional economic development level, and city size;
3. to explore the underlying mechanisms of the effect of urban resilience, such as increasing personal income and consumption, enhancing residents' health status, and strengthening social integration and social trust.

The remainder of this study is organized as follows. Section 2 reviews the relevant literature. The data source, descriptive statistics, and estimation method are presented in Section 3. The baseline results, heterogeneous results, and robustness results are shown in Section 4. Section 5 presents the possible mechanism results. Section 6 concludes the paper.

2. Literature Review

The concept of regional resilience has aroused heated discussions in recent studies [2,10–13]. It is applied in multiple fields, including ecological, engineering, and economic and social fields [14,15]. For example, Li et al. [14] examined the ecological resilience in relation to the 1988 Yellowstone fire and found that precipitation and soil pH

play a critical role in post-fire forest resilience. The existing economic and urban literature has reached a consensus on the notion of urban resilience; a region can be called a resilient one when it resists the negative economic shock during a crisis period, recovers from the crisis, and bounces back onto the growth path [3,10,16]. Christopherson et al. [10] discussed the definition of regional resilience from the perspective of time and space and regarded a region as resilient one if it maintains economic growth in the relatively long term when it faces a negative economic shock, such as an economic crisis. Martin [2] analyzed the idea of regional resilience in three different scenarios, compared the differences between 'engineering' resilience, 'ecological' resilience, and 'adaptive' resilience, and emphasized how a regional economy can adapt its structure and be reconfigured to maintain a growth path in the long run in the third scenario. Martin and Sunley [3] divided the resilience process into four elements, vulnerability, shocks, resistance, and robustness, and provided a general definition of resilience—the developmental and long-run growth path of a region—and its associations with employment, output, and income trends. Martin et al. [13] analyzed why regions respond to recessions differently, explored the role of urban resilience and economic structure, and found that economic structure plays a critical role in two reactions: recoverability and resistance. Meerow et al. [12] summarized the definitions of regional resilience in recent, relevant studies, proposed a new definition of resilience, and emphasized six conceptual tensions, including the notion of equilibrium, timescale of action, and pathway to resilience.

Some of the literature has attempted to explain why regions react to an economic crisis differently (e.g., the 2008 financial crisis) and which attributes lead to the differentiated reactions [17–22]. For example, Dubé and Polèse [17] used the 2007–2009 recession as an exogenous economic shock, explored the economic resilience in Canadian regions, and concluded that the responses of the regions to a shock are partly consistent with the notion of resilience. In a Slovak context, Hudec et al. [18] constructed the resilience capacity index (RCI) to measure how regions recover from an economic shock with data from 79 districts during two periods—2008–2012 and 2012–2014—and found that more export-oriented districts with higher resilience capacity are exposed to higher vulnerability measured by a relative change in unemployment. Employing an averaging approach, Kitsos and Bishop [19] assessed the recession impact through measuring the employment differences between the pre- and post-recession period and found that the recession impact was deeper in regions with higher employment rates in 2007. Balland et al. [22] used the data from metropolitan areas in the USA from 1975 to 2002 to analyze the resilience of cities and found that the effect sizes of technological crises on cities are different and depend on the knowledge base level of each city. Lagravinese [20] examined whether the recession effect varies across Italian regions by measuring regional resilience by the percentage changes in employment and concluded that regions with a higher proportion of public employees have a greater capability to resist the negative economic shock.

Another line of the literature examined the sources and drivers of urban resilience empirically [5,23–29]. Giannakis and Bruggeman [29] explored regional disparities in economic resilience in the European Union and found that agriculture is one of the most important contributors to economic resilience in intermediate and rural areas. Bristow and Healy [26] found that, compared with other cities, innovation leaders at a time of crisis have advantages in resisting economic shock and recovering from it. Based on a spatial panel model in the US and counterfactual predictions of employment levels, Doran and Fingleton [30] found that industrial structure contributes positively to regional economic resilience. Di Caro [31] used data from Italy from 1992 to 2012 and further concluded that regional differences in economic resilience can be partly attributed to economic diversity, human and social capital, or export performance. Cainelli et al. [5] analyzed the relationship between industrial relatedness and regional economic resilience with data from 16 countries and concluded that technological relatedness exerts a positive influence on economic resilience in the short run. Holl [4] explored the employment differences among different areas in Spain, finding that human capital is a key determinant

of local resilience. Nyström [27] focused on economic resilience to displacements and found that both industrial variety and regional attractiveness are positively correlated with regional resilience to displacement.

Recent subjective happiness literature has focused on the role of personality, income, religion, transportation, unemployment, and housing prices in people's subjective happiness [6,32–35]. Friman et al. [33] examined whether daily travel, such as work commuting or shopping trips, affects people's subjective happiness and found that daily travel shows significant correlations with emotional well-being and life satisfaction both directly and indirectly. Pöhls et al. [36] explored the correlation between religiosity and subjective happiness and pointed out that, only in religious countries, the subjective happiness level of non-religious people is relatively lower. Angelini et al. [34] verified the direct link between cultural assimilation and immigrants' subjective happiness with panel data from Germany, which is unmediated by wages or employment. Focusing on the role of housing prices, Liao et al. [6] analyzed how housing prices affect migrants' subjective happiness and found that family separation and long working hours are possible mechanisms behind the negative effect of housing prices on their subjective happiness. Gorry et al. [37] investigated the effect of retirement on personal health and subjective happiness and found that retirement improves personal subjective happiness, and such improvement occurs within the first four years of retirement.

To sum up, the existing literature mainly discusses the notions of urban resilience, explores the critical determinants of urban resilience in both developed and developing countries, and explains why regions react to shock differently [5,19,26]. Fewer studies explore urban resilience in the context of China, and they mainly focus on the drivers of urban resilience [38,39]. Few studies pay attention to how urban resilience affects individual life and residents' subjective happiness with micro surveys or regard urban resilience as a critical factor for individual subjective well-being. Additionally, the underlying mechanism behind the effect of urban resilience remains unexplored.

3. Data and Method

3.1. Data

This study uses subjective happiness data from the China Family Panel Studies (CFPS) in 2012 and 2018. It is a longitudinal survey, implemented by the China Social Science Survey Center (ISSS) of Peking University, which covers about 31 provinces and includes abundant information about residents' education level, income, consumption, health status, marriage, job history, and subjective attitudes, etc. The panel data are constructed in this paper to assess the effect of urban resilience on residents' subjective happiness.

An indicator is selected from the survey to reflect residents' subjective happiness level. In the survey, people are asked "whether they are satisfied with their life". Answers are scored from 1 to 5. A higher value represents that residents' subjective happiness level is higher. A dummy variable is constructed based on the above question. It takes the value of 1 if the above subjective happiness indicator equals 4 or 5, representing that the residents' subjective happiness level is higher; otherwise, the dummy variable equals 0. Figure 1 shows the distribution of residents' subjective happiness. Over 60% of residents are satisfied with their life, and only 4.06% of residents rate themselves as "*very unsatisfied*".

Following the existing literature, urban resilience is constructed in four aspects: ecological resilience, social resilience, infrastructure resilience, and economic resilience [2,13,20,38]. Urban resilience data are collected from the *China Regional Statistical Yearbook and China Urban Statistics Yearbook*, and each resilience indicator and its sub-class indicators are listed in Table 1. From the perspective of economic resilience, five second-class indicators are collected: the proportion of tertiary industry in GDP, per capita GDP, the proportion of actual amount of foreign capital in gross domestic product, household deposit balance, and the amount of real estate development investment. Second, five indicators are chosen to reflect the infrastructure resilience level of cities: the number of hospitals, the number of library collection, the number of buses, electricity consumption per capita, and actual urban

road area. For the ecological resilience aspect, greening coverage rate, domestic garbage treatment rate, industrial sulfur dioxide emissions, industrial smoke emissions, industrial wastewater discharge, park and green spaces area, and comprehensive utilization rate of general industrial solid waste are used to measure the ecological resilience of cities. Lastly, the number of doctors, full-time teachers in ordinary middle schools, number of users with internet broadband access, unemployed people, and population density are selected as social resilience indicators. After selecting the above 22 sub-class indicators, the min–max technique is used to normalize these variables, and negative indicators are transformed into positive indicators where a higher value represents a higher level of urban resilience. Considering the correlations among sub-class indicators, the economic resilience index, ecological resilience index, social resilience index, and infrastructure resilience index are calculated with principal component analysis (PCA). Additionally, an overall urban resilience index is also calculated based on the above 22 indicators with the PCA method.
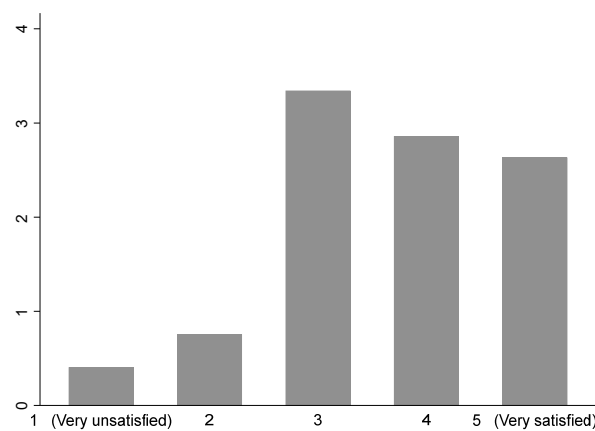
Figure 1. Distribution of subjective happiness.

Table 1. Urban resilience indicators.

Variable	Definition	Indicator Attribute
Panel A. Economic resilience		
Third_GDP	Proportion of tertiary industry in GDP.	+
Per capita GDP	Per capita gross domestic product.	+
Foreign_capital	Proportion of actual amount of foreign capital in gross domestic product in the current year.	+
Saving_balance	Per capita household deposit balance.	+
Real_estate	Completed amount of real estate development investment.	+
Panel B. Infrastructure resilience		
Hospital	Number of hospitals per capita.	+
Book	Public library collection per capita.	+
Bus	Actual number of buses per capita.	+
Road_area	Actual urban road area.	+
Electricity	Electricity consumption per capita.	+
Panel C. Ecological resilience		
Greening_rate	Greening coverage rate of built-up area.	+
Treatment_rate	The harmless treatment rate of domestic garbage.	+
SO2	The emissions of industrial sulfur dioxide per unit of GDP.	−

Table 1. *Cont.*

Variable	Definition	Indicator Attribute
Smoke	The emissions of industrial smoke and dust per unit of GDP.	−
Wastewater	Industrial wastewater discharge per unit of GDP.	−
Green_space	The area of park and green spaces per capita.	+
Solid_waste	The comprehensive utilization rate of general industrial solid waste.	+
Panel D. Social resilience		
Middle_teachers	Number of full-time teachers in ordinary middle schools per capita.	+
Unemployment	Number of urban, registered unemployed people.	−
Doctors	Number of doctors per capita.	+
Internet_access	Number of users with internet broadband access.	+
Population_density	The number of people per km^2.	+

Individual and family characteristics are controlled in the analysis, which are obtained from the CFPS survey and include years of schooling, minority, age, hukou status, family size, gender, marital status, and income. We match urban resilience data with subjective happiness data and, finally, obtain a valid sample of 55,356 individuals between 2012 and 2018, covering about 31 provinces and 116 cities. The descriptive statistics of key variables are listed in Table 2. The average subjective happiness level of residents is relatively high, about 3.66. The average family size of residents is about 4.24, and nearly 49.1% of people are males. More than 70% of people have a rural hukou, and the average logarithmic value of residents' income is about 4.59. Additionally, approximately 80% of residents are married.

Table 2. Summary statistics of key variables.

Variable	Definition	Mean	Std. Dev.
Panel A. Subjective happiness			
Satisfaction	Are you satisfied with your life?	3.656	1.071
Panel B. Individual and family characterisitcs			
Minority	Dummy variable: 1 = minority; 0 = *Han*.	0.006	0.074
Family size	The number of family members.	4.243	1.936
Age	The age of respondents.	46.790	16.730
Male	Dummy variable: 1 = male; 0 = female.	0.491	0.500
Hukou	Dummy variable: 1 = rural hukou; 0 = otherwise.	0.720	0.449
Schooling years	Years of schooling of respondents.	7.133	4.848
Income	The logarithmic value of personal annual income.	4.592	4.958
Marital status	Dummy variable: 1 = married; 0 = otherwise.	0.794	0.404

3.2. Method

A fixed effect model is employed to assess the effect of urban resilience on residents' subjective happiness. The baseline specification is listed as follows:

$$Happiness_{ijt} = \alpha_0 + \alpha_1 resilience_{ijt-1} + X_{ijt} + \delta_t + \pi_j + \omega \tag{1}$$

$Happiness_{ijt}$ is residents' subjective happiness level at year t in city j, which is a dummy variable and equals 1 when residents feel satisfied about their life. $resilience_{ijt-1}$ is the variable of interest, representing the resilience level of cities at year $t-1$ and including

the overall urban resilience index and four sub-class resilience indices calculated with the PCA method: the economic resilience index, the ecological resilience index, the infrastructure resilience index, and the social resilience index. X_{ijt} denotes residents' individual and family characteristics, including minority, gender, years of schooling, marital status, family size, hukou status, age, and income. δ_t is the year fixed effect, and π_j is the provincial fixed effect. The parameter of interest is α_1, which measures whether an increase in urban resilience improves residents' subjective happiness. Considering the dependent variable is a dummy variable, probit models are used to explore the relationship between urban resilience and residents' subjective happiness. The ordered probit models are used in robustness checks, and the dependent variable is treated as a cardinal variable ranging from 1 to 5 [40].

4. Results

4.1. Baseline Results

The effect of urban resilience on residents' subjective happiness is reported in Table 3. Provincial fixed effect, year fixed effect, and individual and family characteristics are controlled in the main analysis. In column (1), the link between the overall urban resilience index and residents' subjective happiness level is reported. As the urban resilience of cities rises, the average subjective happiness level of residents is relatively higher, which is significant at the 5% level. In columns (2) to (5), the correlation between each sub-class resilience index of the four aspects and residents' subjective happiness is reported, respectively. If people live in cities with a higher economic resilience level, they are more likely to feel satisfied with their life. This may be partly attributed to more job chances and higher average personal income in these cities. It is also consistent with the existing literature that higher income enhances the subjective happiness level of residents [35]. Similarly, a higher value of infrastructure resilience of cities leads to a rise in the subjective happiness of residents who live in these cities, which is significant at the 1% level. Additionally, people prefer living in environmentally friendly cities, (e.g., cities with lower industrial smoke and dust emissions or lower industrial sulfur dioxide emissions), and they often rate themselves as "*satisfied*" with their life when they live in cities with a higher ecological resilience value (column 4). The positive correlation between the social resilience of cities and residents' subjective happiness is also found, and it is significant at the 1% level.

Table 3. Effect of urban resilience on residents' subjective happiness[1].

	(1)	(2)	(3)	(4)	(5)
Panel A. urban resilience					
Urban resilience	0.014 **				
	(0.007)				
Economic resilience		0.028 ***			
		(0.006)			
Infrastructure resilience			0.027 ***		
			(0.008)		
Ecological resilience				0.027 **	
				(0.011)	
Social resilience					0.062 ***
					(0.010)
Panel B. Individual and family characteristics					
Minority	−0.090	−0.290 ***	−0.268 ***	−0.068	−0.310 ***
	(0.096)	(0.070)	(0.070)	(0.086)	(0.071)
Family size	0.008 **	0.011 ***	0.011 ***	0.008 **	0.013 ***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

Table 3. *Cont.*

	(1)	(2)	(3)	(4)	(5)
Age	0.008 ***	0.007 ***	0.007 ***	0.008 ***	0.007 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender	−0.083 ***	−0.074 ***	−0.075 ***	−0.082 ***	−0.076 ***
	(0.013)	(0.012)	(0.012)	(0.013)	(0.012)
Hukou	−0.105 ***	−0.124 ***	−0.122 ***	−0.109 ***	−0.124 ***
	(0.017)	(0.015)	(0.016)	(0.017)	(0.015)
Schooling years	−0.000	−0.000	−0.001	0.000	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Income	−0.005 ***	−0.006 ***	−0.006 ***	−0.006 ***	−0.006 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Marital status	0.056 ***	0.063 ***	0.065 ***	0.057 ***	0.065 ***
	(0.017)	(0.015)	(0.015)	(0.016)	(0.015)
Provincial fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
N	43,966	54,606	52,144	45,770	55,356

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels.

Table 3 also provides the results relating to the link between individual characteristics and residents' subjective happiness. In columns (1) to (5), if the family size is larger, residents are more likely to feel satisfied about their life, which is significant at least at the 5% level. Compared with that of young residents, the subjective happiness level of old residents is relatively higher. Compared with females, males are more likely to rate themselves as "unsatisfied", which is significant at the 1% level. It is possible that males often bear more economic burdens in the family, which negatively affects their subjective happiness. Residents with a rural hukou are less likely to feel satisfied about their life in cities, and married residents' subjective happiness level are relatively higher.

4.2. Heterogeneous Results

4.2.1. Heterogeneous Results of Urban Resilience by Years of Schooling

The link between education level and residents' subjective happiness is well recognized in the existing literature [6,41]. We further explore whether the effect of urban resilience varies across different educated groups. The sample is split into two groups according to residents' education level: the high-educated group and the low-educated group. The high-educated group is defined as those whose years of schooling equal 12 or above (more than high school education). Otherwise, residents are categorized into the low-educated group. The heterogenous results are reported in Table 4. In column (1), if high-educated residents live in cities with a higher overall urban resilience index value, they are more likely to feel satisfied about their life, while urban resilience shows no significant correlation with low-educated residents' subjective happiness. In columns (2) to (5), the heterogenous results of the effect of each sub-class resilience index of the four aspects on residents' subjective happiness are reported. The high-educated group feels more satisfied about their life if they live in cities with a higher economic resilience value, which is significant at the 1% level. Additionally, compared with the low-educated group, infrastructure resilience, ecological resilience, and social resilience play a critical positive role in shaping better-educated residents' subjective happiness. It is likely that the high-educated group cares more about the infrastructure quality, social climate, environmental quality, and economic development of cities and are more satisfied with life when they live in cities with higher urban resilience.

Table 4. Effect of urban resilience on residents' subjective happiness by years of schooling.

	(1)	(2)	(3)	(4)	(5)
	Urban Resilience	Economic Resilience	Infrastructure Resilience	Ecological Resilience	Social Resilience
Panel A. The high-educated group					
Satisfaction	0.051 ***	0.053 ***	0.060 ***	0.063 ***	0.091 ***
	(0.012)	(0.011)	(0.014)	(0.020)	(0.017)
N	10,796	13,237	12,612	11,210	13,448
Panel B. The low-educated group					
Satisfaction	−0.003	0.010	0.007	0.012	0.046 ***
	(0.008)	(0.008)	(0.010)	(0.013)	(0.012)
N	33,170	41,369	39,532	34,560	41,908
Individual and family characteristics	YES	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics include age, marital status, minority, family size, gender, hukou, and income.

4.2.2. Heterogeneous Results of Urban Resilience by City Size

We further examine the extent to which residents living in small cities and large cities differ in response to urban resilience. The sample is categorized into two groups based on the population size of the cities: small cities and large cities. When the population size of a city is more than the average population size of all cities, it is categorized into the small city group; otherwise, a city belongs to the large city group. In panels A and B, columns (1) to (5) summarize the effects of urban resilience on the subjective happiness of residents in small cities and large cities, respectively. Compared with people in small cities, the overall urban resilience exerts a greater positive effect on the subjective happiness of residents living in relatively large cities. For each sub-class resilience index, a similar conclusion can be drawn from the results in Table 5; as the economic resilience, infrastructure resilience, and social resilience rise, residents in large cities are more likely to feel satisfied about their life, which is significant at the 1% level, while residents in small cities place more emphasis on ecological resilience and feel more satisfied if the ecological resilience of their cities increases. The above heterogenous results indicate that the overall urban resilience, economic resilience, infrastructure resilience, and social resilience play a more critical role in shaping the subjective happiness level of residents in large cities.

Table 5. Effect of urban resilience on residents' subjective happiness by city size.

	(1)	(2)	(3)	(4)	(5)
	Urban Resilience	Economic Resilience	Infrastructure Resilience	Ecological Resilience	Social Resilience
Panel A. Small cities					
Satisfaction	0.020 **	0.031 ***	0.007	0.025 **	0.051 ***
	(0.010)	(0.011)	(0.012)	(0.012)	(0.013)
N	27,190	35,000	33,260	28,882	35,695
Panel B. Large cities					
Satisfaction	0.032 *	0.051 ***	0.074 ***	0.064	0.100 ***
	(0.017)	(0.011)	(0.014)	(0.045)	(0.017)
N	16,776	19,606	18,884	16,888	19,661

Table 5. *Cont.*

	(1)	(2)	(3)	(4)	(5)
	Urban Resilience	**Economic Resilience**	**Infrastructure Resilience**	**Ecological Resilience**	**Social Resilience**
Individual and family characteristics	YES	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics include age, marital status, schooling years, minority, family size, gender, hukou, and income.

4.2.3. Heterogeneous Results of Urban Resilience by Economic Development Level

Economic development is usually regarded as one of the important determinants of residents' subjective happiness [42]. Therefore, residents are split into two groups according to the economic development level of cities where they live. A city is categorized into the higher economic development group if its GDP is higher than the average GDP of all cities; otherwise, it is categorized into the lower economic development group. The heterogeneous results by economic development level are reported in Table 6. In column (1), for residents living in cities with relatively low economic development, the overall urban resilience shows a significant correlation with their subjective happiness, which is significant at the 5% level. In columns (2) to (5), a consistent conclusion can be drawn that residents are more likely to feel satisfied about their life if the economic resilience, ecological resilience, and social resilience of their cities increase, which are significant at the 1% level. Additionally, there is no significant difference in the link between infrastructure resilience and the subjective happiness for the two groups of residents. It indicates that, in cities with lower GDP, residents pay more attention to the economic development, environmental quality (e.g., greening rate or wastewater discharge), and the number of doctors or teachers, etc., which are positively correlated with residents' subjective happiness.

Table 6. Effect of urban resilience on residents' subjective happiness by economic development level.

	(1)	(2)	(3)	(4)	(5)
	Urban Resilience	**Economic Resilience**	**Infrastructure Resilience**	**Ecological Resilience**	**Social Resilience**
Panel A. The lower economic development group					
Satisfaction	0.022 **	0.037 ***	0.014	0.034 ***	0.064 ***
	(0.010)	(0.011)	(0.013)	(0.012)	(0.015)
N	33,182	42,185	40,247	34,940	42,411
Panel B. The higher economic development group					
Satisfaction	−0.001	0.007	0.030	-0.177	0.031
	(0.024)	(0.016)	(0.025)	(0.119)	(0.026)
N	10,784	12,421	11,897	10,830	12,945
Individual and family characteristics	YES	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics include age, marital status, schooling years, minority, family size, gender, hukou, and income.

4.2.4. Heterogeneous Results of Urban Resilience by Regions

Considering that the correlation between urban resilience and residents' subjective happiness may vary across different regions, the samples are split into three groups: the western region, eastern region, and central region. Table 7 presents the results of the effect of

urban resilience on residents' subjective happiness by region. In column (1), the overall urban resilience of cities is significantly and positively correlated with the subjective happiness level of residents in the eastern region, which is significant at the 5% level, while in the western region and central region, as the overall urban resilience rises, residents' subjective happiness does not increase significantly. In columns (2) to (5), findings show that each sub-class resilience index shows positive correlations with residents' subjective happiness in the eastern region; for example, the coefficient of ecological resilience is 0.044, which is significant at the 1% level. However, in the central region, residents' subjective happiness is significantly enhanced when the ecological resilience of cities increases, and there is no significant link between other sub-class resilience indices and residents' subjective happiness. In the western region, as the economic resilience and social resilience rise, residents are more satisfied with their life, which indicates that residents in the western region place more emphasis on economic development and the number of doctors, teachers, and unemployed people when they assess subjective happiness and life quality.

Table 7. Effect of urban resilience on residents' subjective happiness by regions.

	(1)	(2)	(3)	(4)	(5)
	Urban Resilience	Economic Resilience	Infrastructure Resilience	Ecological Resilience	Social Resilience
Panel A. Western region					
Satisfaction	−0.003	0.030 *	0.025	−0.106 ***	0.046 *
	(0.012)	(0.017)	(0.019)	(0.026)	(0.025)
N	10,532	13,420	13,064	10,879	13,687
Panel B. Eastern region					
Satisfaction	0.020 **	0.030 ***	0.039 ***	0.044 ***	0.075 ***
	(0.010)	(0.008)	(0.010)	(0.013)	(0.011)
N	18,334	23,712	22,388	19,125	24,183
Panel C. Central region					
Satisfaction	0.020	−0.003	−0.030	0.120 ***	0.025
	(0.014)	(0.016)	(0.019)	(0.031)	(0.024)
N	15,100	17,474	16,692	15,766	17,486
Individual and family characteristics	YES	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics include age, marital status, schooling years, minority, family size, gender, hukou, and income.

4.3. Robustness Check[2]

The above results are estimated with probit models, and the dependent variable is treated as a dummy variable. To examine the effect of urban resilience more accurately, we first change estimation models; the ordinary least squares method (OLS) is employed to explore the effect of urban resilience. In panel A of Table 8, after changing estimation method, the results remain consistent; the overall urban resilience index and each sub-class resilience index are positively associated with residents' subjective happiness. As the urban resilience rises, residents are more satisfied with their life. Furthermore, the coefficient of social resilience is relatively larger (0.022), which is significant at the 1% level. It further supports our main conclusion that urban resilience is a critical factor for residents' subjective happiness.

Table 8. Robustness checks after changing estimation models or substituting indicators.

	(1)	(2)	(3)	(4)	(5)	(6)
	Urban Resilience	Economic Resilience	Infrastructure Resilience	Ecological Resilience	Social Resilience	New Resilience Index
Panel A. Changing estimated method (OLS)						
Satisfaction	0.004 *	0.009 ***	0.008 ***	0.009 **	0.022 ***	
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	
N	43,966	54,606	52,144	45,770	55,356	
adj. *R²*	0.138	0.130	0.129	0.141	0.131	
Panel B. Substituting urban resilience indicators						
Satisfaction						0.063 ***
						(0.009)
N						55,356
Panel C. Changing estimated method (ordered probit models)						
Satisfaction	0.004 **	0.003 **	0.004 **	0.006 **	0.011 ***	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
N	43,966	54,606	52,144	45,770	55,356	
Panel D. Substituting subjective happiness variable						
Satisfaction	0.028 ***	0.030 ***	0.043 ***	0.026 **	0.052 ***	
	(0.009)	(0.009)	(0.013)	(0.011)	(0.014)	
N	26,492	32,561	32,072	27,742	32,795	
Individual and family characteristics	YES	YES	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics include age, marital status, schooling years, minority, family size, gender, hukou, and income.

Second, following the existing literature, unemployment and GDP are usually used as urban resilience indicators [2,13,38]. Therefore, we construct a new resilience index based on the above indicators with the PCA method. The results are shown in panel B of Table 8. After substituting the urban resilience index, a positive link between the urban resilience of cities and residents' subjective happiness is found. Residents are more likely to feel happy if they live in cities with a higher urban resilience value, which is significant at the 1% level. It indicates that our baseline results are robust and credible.

Third, instead of treating residents' subjective happiness as a dummy variable, we transform it into a cardinal variable, which ranges from 1 (very unsatisfied) to 5 (very satisfied). Ordered probit models are used to estimate the relationship between urban resilience and residents' subjective happiness. Results are presented in panel C of Table 8. The overall urban resilience index and each sub-class resilience index are significantly and positively related to residents' subjective happiness. The increase of the overall urban resilience, economic resilience, infrastructure resilience, ecological resilience, and social resilience is conducive to the improvement of residents' subjective happiness.

Fourth, in the main analysis, the question of how people feel satisfied about their life is used to measure their subjective happiness level. Here, we substitute it with a question of their satisfaction level in family life[3] and run the regressions again. The results are shown in panel D. The results are robust even after changing the proxy variable. The overall urban resilience index and each sub-class resilience index are positively correlated with individuals' subjective happiness.

5. Mechanism Results

These findings in the previous sections show that urban resilience has a beneficial effect on residents' subjective happiness. Apart from the direct effect of urban resilience, we attempt to further explore the possible channels through which urban resilience shows significant correlations with residents' subjective happiness. Three potential mechanisms are examined in this section. First, if residents live in cities with a higher economic resilience value, their income and family consumption are relatively higher, which is positively correlated with their subjective happiness. Second, the increased ecological resilience is beneficial for the improvement of residents' health status, such as decreasing the probability of having diseases or increasing their self-rated health, and so shows positive correlation with residents' subjective happiness. Third, a rise in the infrastructure and social resilience of cities leads to an increase in residents' social integration and social trust level, such as increasing their donation behavior and improving their attitudes towards the employment problem in the country, which raises their subjective happiness.

5.1. The Increase of Income and Consumption

The economic resilience of cities exerts a positive influence on residents' income and consumption level. For example, if the economic development level, per capita GDP, and the proportion of tertiary industry in GDP of cities are higher, more job chances are provided in these cities, and it is more likely for residents to be able to improve their income level and increase their family consumption in cities. Increased income and family consumption are conducive to satisfying personal daily needs, increasing satisfaction with living standards, and improving residents' subjective happiness [43].

To verify the above hypothesis, four indicators of income and consumption are selected from the survey: personal income, expenditure on clothing, expenditure on heating, and other expenditure. Respondents' answers are about the composition of family consumption in the past 12 months. Three consumption indicators are used to explore the underlying mechanisms of the link between economic resilience and residents' subjective happiness. Apart from the family expenditure on clothing and heating, other expenditure (e.g., purchasing lottery tickets or paying fines) is also chosen. Table 9 shows the results. In column (1), as the economic resilience of cities rises, there is an increase in residents' income, which is significant at the 1% level. Columns (2) to (4) present the results of the relationship between economic resilience and residents' family consumption. The economic resilience of cities is significantly and positively correlated with residents' expenditure (e.g., expenditure on clothing or heating and other expenditure), which is significant at the 1% level. In general, the increase of economic resilience leads to a rise in residents' family consumption, which satisfies residents' daily needs better and improves residents' subjective happiness and life quality. It supports our hypothesis that, if residents live in cities with higher economic resilience, their income and family consumption are relatively higher, which improves their subjective happiness.

Table 9. The rise of income and family consumption.

	(1)	(2)	(3)	(4)
	Income (Logarithmic Value)	**The Expenditure on Clothing**	**The Expenditure on Heating**	**The Other Expenditure**
Economic resilience	0.216 ***	0.120 ***	0.082 ***	0.498 ***
	(0.022)	(0.008)	(0.011)	(0.046)
N	55,356	55,356	55,356	55,356
adj. R^2	0.213	0.169	0.301	0.099
Individual and family characteristics	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics are controlled.

5.2. The Improvement of Health Status

Environmental quality has been verified as a critical determinant of residents' health status. For example, improved air quality and decreased air pollutants lead to a decrease in the probability of having chronic disease or respiratory disease for residents [44]. Additionally, the urban green spaces and greening rate of cities provide long-term health benefits to residents in relation to mental health and physical health and reduce residents' health expenditure [45,46]. Hence, if the ecological resilience of cities is higher, the greening rate and the green space area are larger, and the industrial pollutant emissions are lower, residents are less likely to suffer from chronic diseases or physical discomfort. The environmentally friendly quality enhances the health status of residents and increases their subjective happiness in cities.

To verify the above hypothesis, four health variables are selected from the survey: self-rated health, chronic disease, physical discomfort, and being overweight. Respondents are asked how they would rate their health status. The answers are scored from 1 (excellent) to 5 (poor). A dummy variable is constructed based on the above question and equals 1 if residents think their health status is excellent or very good. A higher value represents better self-rated health of residents. Second, respondents are asked "have they had any doctor-diagnosed chronic disease in the past six months". A dummy variable is constructed to reflect their health condition or having a chronic disease and equals 1 if they have a chronic disease. Third, the survey also has a question of whether respondents have felt any physical discomfort in the past two weeks. A dummy variable is constructed and equals 1 if respondents answer "yes". Lastly, BMI is calculated according to residents' height and weight, and a dummy variable is constructed to reflect whether residents are overweight or not (BMI is more than 24).

The results are presented in Table 10. In column (1), the ecological resilience of cities is positively related to the self-rated health of residents, which is significant at the 5% level. As the ecological resilience rises, people are more satisfied with their health status and tend to rate their self-rated health as "excellent". In columns (2) to (4), we draw a similar conclusion; the ecological resilience of cities plays a positive role in reducing the probability of having chronic disease, feeling physical discomfort, and being overweight for residents, which is significant at least at the 5% level. The above results indicate that the health status of residents is better when they live in cities with higher ecological resilience, and they are less likely to suffer from diseases or feel physical discomfort, which is beneficial for the improvement of their subjective happiness.

Table 10. The improvement of personal health.

	(1)	(2)	(3)	(4)
	Self-Rated Health	**Chronic Disease**	**Physical Discomfort**	**Overweight**
Ecological resilience	0.017 **	−0.027 ***	−0.021 ***	−0.009 **
	(0.009)	(0.005)	(0.004)	(0.004)
N	44,878	43,272	43,272	44,878
adj. R^2	0.154	0.807	0.058	0.023
Individual and family characteristics	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics are controlled.

5.3. The Increase of Social Integration and Social Trust

Residents feel more satisfied and have a higher social integration level when they live in cities with a higher infrastructure level and enjoy medical, public transportation, and electricity services. Additionally, having a lower unemployment rate or more teachers and doctors is beneficial for the formation of a good social atmosphere, which is conducive to the rise of social trust and social identity and improves residents' subjective happiness [47]. In short, infrastructure resilience and social resilience may improve residents' subjective happiness level through strengthening their social integration level and raising their social trust.

To verify the above hypothesis, four indicators about social integration and social trust are selected from the survey: the assessment of employment problem and medical service problem, social trust, and donation behavior. The survey has two questions relating to residents' attitudes towards the employment problem and the medical service problem in China. Answers range from 0 (not severe) to 10 (extremely severe). Two dummy variables are constructed to reflect residents' assessment of the above problems and equal 1 if the original indicator is more than 8. Second, respondents are asked "whether they think that most people are trustworthy". A dummy variable is constructed and equals 1 if residents think that most people are trustworthy, representing a higher social trust level. Last, respondents are interviewed "whether they have donated to any organizations or individuals in the past 12 months". We use it as a social integration indicator and treat it as a binary variable (1 = yes).

Results are shown in Table 11. In columns (1) to (2), panels A and B present that both infrastructure resilience and social resilience have a beneficial effect on residents' assessment of the employment and medical services problems, which increases their social integration and social identity level and is significant at the 1% level. In column (3), it is shown that residents tend to think most people in the country are trustworthy if they live in cities with higher infrastructure resilience and social resilience. Results in column (4) show that residents are more likely to donate to organizations or individuals as the infrastructure resilience and social resilience of their cities rise. The above results support our hypothesis that, when residents live in cities with higher infrastructure resilience and social resilience, their social integration and social trust level are relatively higher, which plays a positive role in their subjective happiness.

Table 11. The increase of social integration and social trust.

	(1)	(2)	(3)	(4)
	The Employment Problem	**The Medical Service Problem**	**Social Trust**	**Donation Behavior**
Panel A. Infrastructure resilience				
Infrastructure resilience	−0.117 ***	−0.104 ***	0.025 ***	0.019 **
	(0.034)	(0.033)	(0.008)	(0.008)
N	52,144	52,144	52,144	52,144
Panel B. Social resilience				
Social resilience	−0.025 ***	−0.050 ***	0.037 ***	0.014 **
	(0.002)	(0.009)	(0.009)	(0.006)
N	55,356	55,356	55,356	55,356
Individual and family characteristics	YES	YES	YES	YES
Provincial fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES

Notes: Robust standard errors are reported in parentheses. ***/**/* indicates significance at the 1%/5%/10% levels. Individual and family characteristics are controlled.

One may worry that a potential tautological problem possibly affects the above mechanism results, since the resilience indicators are directly or indirectly included in the mechanism analysis. Although one-year lagged indicators are used to avoid such a problem, it is still possible that tautological indicators affect our results. Therefore, we conduct several robustness checks. First, we reconstruct urban resilience index after excluding the most tautological indicators, such as per capita GDP, the proportion of tertiary industry in GDP, the number of hospitals per capita, the number of urban registered unemployed people, and the number of doctors per capita, and run the regressions again. Second, we recalculate the economic resilience index after excluding per capita GDP and the proportion of tertiary industry in GDP, reconstruct the infrastructure resilience index after excluding the number of hospitals per capita, and recalculate the social resilience index after excluding the number of urban registered unemployed people and the number of doctors per capita. Third, we explore the relationship between urban resilience and these mechanism variables with three-year lagged resilience data. In the above cases, the mechanism results are consistent.

6. Conclusions

Existing studies mainly focused on the notion of urban resilience and attempted to explore the sources of urban resilience in both developing and developed countries, while few of them further explored whether urban resilience plays a critical role in residents' subjective happiness and examined underlying mechanisms behind the link [5,19,26]. This study fills the gap by examining the role of urban resilience in residents' subjective happiness, constructing the sub-class resilience indices of the four aspects, and further exploring the possible channels through which urban resilience is associated with residents' subjective happiness.

Using a nationally representative survey in China, we constructed panel data from 2012 to 2018 to analyze the link between the overall urban resilience, each sub-class resilience index, and residents' subjective happiness. Results show that, as urban resilience increases, residents feel more satisfied about their life, and the ecological resilience, infrastructure resilience, social resilience, and economic resilience of cities are positively correlated with residents' subjective happiness. Heterogenous results show that residents in large cities with a higher urban resilience value are more satisfied with their life. Additionally, the effect of urban resilience varies across different economic development groups measured by the GDP of cities, and urban resilience has a greater positive effect on residents' subjective

happiness when they live in cities with lower economic development. We conducted several robustness checks to test whether the baseline results are robust and credible. We changed the estimation method and substituted the urban resilience indicators with unemployment and GDP, and a consistent conclusion was drawn.

Three possible mechanisms were explored in our study. First, residents' income and family consumption are relatively higher in cities with higher economic resilience, which satisfies their daily needs better and enhances their satisfaction of living standards and the overall subjective happiness. Second, higher ecological resilience of cities enhances residents' health status with regard to having chronic diseases, having physical discomfort, and self-rated health, and they feel more satisfied about life when they live in these cities. Third, residents tend to increase their donation behavior and social trust and have a positive assessment of the employment and medical service problems if they live in cities with higher infrastructure and social resilience value. Increased social integration and social trust are positively linked to residents' subjective happiness.

Several policy implications can be inferred from the above empirical results. First, improving urban resilience is an effective strategy to enhance residents' subjective happiness. More efforts can be exerted to improve the unemployment rate, environmental quality, economic development, and medical resources of cities, which enhance residents' welfare and life quality. Second, a policy aimed at strengthening social welfare and increasing urban resilience can be implemented differently according to the city size, region, and economic development level of the city. More emphasis should be placed on the improvement of urban resilience for cities with lower economic development and larger population size. The link between residents' health, income level, social integration, and subjective happiness cannot be ignored, and the above issues can be improved simultaneously under the framework of urban resilience.

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Notes

[1] Even when we winsorize the subjective happiness variable at the fifth and ninety-fifth percentile and ruled out the influence of outliers, the results are consistent.

[2] We control for respondents' intelligence and impatience with the interview or aggregate the subjective happiness to the city level and estimate the effect of urban resilience again. The results are robust and consistent.

[3] The question is asked in the 2012 CFPS survey, and there are sample differences among the different panels of Table 8.

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