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Research on the Impact of the Digital Economy on Urban Resilience from a Dual Perspective: Evidence from 293 Prefecture-Level and Above Cities in China

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Abstract. With the global economy slowing down and the risks becoming more and more complicated, it has become an important strategy to promote urban resilience, which can help us achieve sustainable development. By analyzing the annual data of 293 cities in China from 2013 to 2022, this study examines the different impacts of digital economy on urban economic sustainability and environmental adaptability with a dual methodological framework. It is found that digital economy can obviously enhance the stability of urban economy, in which technological innovation plays a partial intermediary role. Its impact on ecological resilience shows an inverted U-shaped curve: the initial energy rebound effect will hinder ecological resilience, but with the wider application of digital technology, this effect will be transformed into enhancement. This study reveals the dual mechanism (both advantages and disadvantages) of digital economy affecting urban resilience, and provides theoretical reference and policy guidance for coordinating digital economic progress and resilient urban development.

Keywords: digital economy, urban resilience, economic resilience, ecological resilience

1. Introduction

Nowadays, with the global economic recession and more and more complex risks, cities, the main engines of our social and economic development, are facing unprecedented challenges. The increasingly unstable environment has exposed some deep-rooted weaknesses in the urban system, so we must make changes and adopt more far-sighted strategies to predict and prevent potential disasters in advance. Building the resilience of the city is now our primary task to achieve high-quality and sustainable development. The report from the 20th CPC National Congress emphasizes that people-centered urban development requires us to do better in planning, construction and management. In particular, it proposes to speed up the transformation of megacities and promote urban renewal, with the ultimate goal of building "Livable, Resilient and Smart Cities". At the same time, the "14th Five-Year Plan" also emphasizes this method, and explicitly proposes to build a powerful urban center to improve the quality of life and living standards of all people. Strengthening a city's ability to cope with shocks can make the city more stable and livable, which in turn will promote the city's progress and speed up its development. At the same time, the rapid development

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of digital economy has become a major driving force for economic expansion, which is deeply related to the resilience of cities. As digital technology goes deeper and deeper into the way of resource allocation and urban management, it becomes very important to make good use of the power of digital economy to enhance urban resilience and successfully reduce potential social risks.

According to prevailing research, the digital economy fortifies economic stability by streamlining resource distribution [1] and fostering technological advancements [2], yet they overlook its differentiated impact on various dimensions of resilience. A few scholars have begun examining specific dimensions: He et al. [3] developed a multidimensional economic resilience index system, while Sun [4] studied environmental resilience characteristics. Despite this, an absence of comprehensive examination persists regarding the unequal effects of the digital economy on environmental and economic stability. Particularly at the ecological resilience level, the promotion of digital technologies may be accompanied by energy rebound effects [5] and increased electronic waste, leading to heightened environmental pressures. This "digital paradox" phenomenon warrants in-depth exploration.

This research analyzes the dual impact of digital economy on urban adaptability through an innovative dual-lens framework. While it bolsters economic resilience via technological innovation, its initial scale expansion and associated energy use can hinder ecological resilience. Based on panel data from 293 Chinese cities at the prefecture level and above from 2013 to 2022, this study conducts empirical tests using a bidirectional fixed effects model and a mediation analysis model. The findings offer a conceptual foundation and policy framework for aligning digital economy advancement with resilient urban development.

2. Theoretical analysis and research hypotheses

2.1. Direct impact of the digital economy on urban economic resilience

In recent years, our domestic researchers pay more and more attention to the complex relationship between digital economy and urban economic strength. Many surveys have proved that the digital field is helpful to improve the economic resilience of cities, and it also helps people to understand how it works. First of all, the digital economy can make the economic system better resist interference and recover quickly. The continuous progress of digital technology optimizes the distribution of production resources, improves the overall efficiency, and expands public services, which can enhance the economic stability of big cities. In addition, digital innovation has also spawned some emerging industries, which mainly focus on technologies such as the Internet, artificial intelligence and smart devices. By promoting the digital and intelligent transformation of traditional industries, these new growth points can not only bring more productivity, but also fundamentally enhance the ability of economic adaptation and transformation. Consequently, by establishing innovative sources of value generation, the digital economy accelerates the transition toward superior economic performance and restructures competitive market dynamics, ultimately reinforcing the governance and adaptive functions within urban economic frameworks [6]. Collectively, existing literature converges on the view that digital growth enhances urban economic stability, forming the basis for our initial hypothesis:

Hypothesis 1: The digital economy substantially strengthens urban economic resilience.

2.2. The mediating role of technological innovation

Existing research has pointed out that technological innovation is one of the key pathways through which digital economy fortifies metropolitan economic sustainability. In the digital era, technological innovation demonstrates features fundamentally different from conventional approaches: Data, as a new type of production factor, profoundly reshapes the organizational forms and operational efficiency of technological innovation through its extensive pervasiveness and coverage. The digital economy constructs a multi-tiered innovation support system, breaking through the temporal and spatial constraints of traditional R&D and substantially improving the overall efficiency of innovation activities. Concurrently, technological innovation exerts positive effects on economic resilience. On one hand, it has spawned new business models such as the platform economy and sharing economy, which not only extend industrial and value chains but also open diversified development paths for market entities, enhancing their risk-coping capabilities. On the other hand, technological innovation strengthens enterprises' competitiveness in domestic and international markets by increasing the added value of products and services, enabling them to demonstrate greater adaptability and resilience during economic fluctuations. Based on the above analysis, this paper proposes Hypothesis 2:

Hypothesis 2: The digital economy indirectly promotes the enhancement of urban economic resilience by driving technological innovation.

2.3. Nonlinear impact of the digital economy on urban ecological resilience

The impact mechanism of the digital economy on urban ecological resilience is complex, involving multiple transmission pathways. First, the rapid development of the digital economy, through its integration with the green economy, plays a positive role in improving ecological efficiency. On one hand, digital technologies themselves generate minimal pollution and significantly enhance the efficiency of traditional factors. By optimizing energy allocation and enabling precise control over production processes, they effectively reduce resource consumption [7]. On the other hand, the expansion of digital economic activities propels the transition of industries into more sophisticated segments, giving rise to emerging sectors with low energy intensity, exemplified by distributed computing services and interconnected device networks. Simultaneously, it transforms traditional manufacturing through digital means and reduces carbon emissions using green technologies [8], thereby improving environmental quality and alleviating ecological pressures.

However, the digital economy's rapid growth may produce a counterproductive energy impact, partially offsetting its environmental benefits. In its early stages, the construction of digital infrastructure is characterized by high energy consumption, and large-scale fixed-asset investments can temporarily boost energy demand. Once the digital economy reaches a certain scale, network effects amplify technological spillovers. Yet rapid equipment replacement generates substantial electronic waste, and high-energy computing expansion may partially offset efficiency gains. Research by Tan et al. further indicates that unsustainable growth without green guidance risks triggering the Jevons Paradox—where digital service convenience stimulates end-user consumption, indirectly driving energy consumption across entire industrial chains. Feng's empirical study likewise draws attention to this issue, revealing that investments in fixed assets can negatively mediate how the digital economy interacts with energy intensity. This observation suggests that overly aggressive capital allocation may ultimately hinder progress in reducing carbon emissions.

In summary, the digital economy's impact on urban ecological resilience exhibits a nonlinear threshold characteristic. From a dynamic development perspective, its impact follows an “increasing marginal effect" trend: at lower development stages, environmental improvements are limited by infrastructure energy consumption constraints; however, once a critical development threshold is crossed, technological innovation and economies of scale synergize, leading to a significant leap in emission reduction efficiency. Consequently, we advance the third hypothesis:

Hypothesis 3: Urban ecological resilience responds to digital economic development in a nonlinear manner.

3. Data and methods

3.1. Sample selection and data sources

Considering data completeness and availability, this study employs panel data from 293 Chinese cities (2013–2022), with data for Hong Kong, Macau, and Taiwan temporarily unavailable. The DIFI, originating from the Beijing Research Center for Digital Finance, indexes inclusive digital finance, patent information is from the National IP Authority, and raw data for other indicators from the China Statistical Yearbook, China Urban Statistical Yearbook, China Urban Construction Statistical Yearbook, provincial/municipal statistical yearbooks, National Economic and Social Development Statistical Bulletin, the Global Statistical Data Analysis Platform (EPS) database, and China Economic Information Network. Partial missing values were imputed using linear interpolation.

3.2. Model specification

3.2.1. Benchmark regression model

To assess the influence of the digital economy on urban economic resilience and urban ecological resilience, and to test Hypothesis 1, this study constructs a panel fixed-effects model controlling for both city and year fixed effects. Considering significant fluctuations in data with different dimensions, logarithmic transformations were applied to certain variables. The benchmark model is set as follows:

$$econ\_res_{i,t} = \alpha_0 + \alpha_1 digital_{i,t} + \sum_2^8 \alpha_n Control_{nit} + \mu_i + \gamma_i + \varepsilon_{it} \tag{1}$$

$$eco_{i,t} = \beta_0 + \beta_1 digital_{i,t} + \sum_2^8 \beta_n Control_{nit} + \mu_i + \gamma_i + \varepsilon_{it} \tag{2}$$

Where $econ\_res_{i,t}$ signifies the economic resilience measure for city i during year t; $eco_{i,t}$ provides the ecological resilience measure for the i-th city during the t-th year; $digital_{i,t}$ is the digital economic development level index of the i city in the t year; $Control_{nit}$ is a series of control variables; μ_i is the individual fixed effect; γ_i is the time fixed effect; ε_{it} is the random disturbance term; α_0 *and* β_0 are the constant terms ; α_1 and α_n the regression coefficients.

3.2.2. Mediating effect model

To test the mechanism of technological innovation (H2), a mediation model is established and analyzed through stepwise regression. This approach initially assesses the comprehensive impact of the digital economy on economic resilience, then regresses the digital economy on the technological innovation mediator, and finally includes both the digital economy and technological innovation in

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the model to assess their direct and mediating effects. The econometric model established accordingly is as follows:

$$M_{it} = \theta_0 + \theta_1 digital_{it} + \sum_2^8 \theta_n Control_{nit} + \mu_i + \gamma_i + \varepsilon_{it} \tag{3}$$

$$econ\_res_{it} = \pi_0 + \pi_1 digital_{it} + \omega M_{it} + \sum_2^8 \pi_n Control_{nit} + \mu_i + \gamma_i + \varepsilon_{it} \tag{4}$$

In the equation, M_{it} serves as the mediating variable; the remaining variables are identical to the baseline regression model (1). θ_0 and π_0 are the constant terms, while θ_1,θ_n,π_1 are all the regression coefficients.

3.3. Explanation and measurement of the variable

3.3.1. Dependent variables

(1) Economic Resilience (econ_res)

This study measures urban economic resilience following the method of Martin et al., constructing a resilience index by measuring the sensitivity of regional GDP to macroeconomic fluctuations, with centralisation adjustments applied. The specific calculation is detailed in Formula (5). This measurement method effectively reveals the relative robustness of regional economies following external shocks while capturing their dynamic performance during economic recovery cycles.

$$r_{it} = \frac{\Delta Y_{it} - \Delta E_{it}}{|\Delta E_{it}|} = \frac{\frac{Y_{it}-Y_{it-k}}{Y_{it-k}} - \frac{E_{it}-E_{it-k}}{E_{it-k}}}{\left|\frac{E_{it}-E_{it-k}}{E_{it-k}}\right|} \tag{5}$$

Where represents economic resilience, ΔY_{it} denotes the rate of change in regional economic performance, measuring variations in actual regional output; ΔE_{it} indicates the rate of change in the national economic performance mean, representing expected output shifts; and k is the temporal indicator set to 1.

(2) Ecological Resilience (eco)

The measurement of ecological resilience (eco) focuses on a city's comprehensive capacity to respond to ecological pressures or shocks. Building upon existing research [9] , this paper constructs an evaluation framework comprising three dimensions—state, pressure, and response—with three secondary indicators and fourteen tertiary indicators (Table 1). To integrate these disparate metrics, we adopt an established academic methodology: standardising data and applying entropy weighting to determine indicator weights [10] , ultimately synthesising a composite ecological resilience index for each city.

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Table 1. Comprehensive ecological resilience evaluation system

Primary Indicators	Secondary Indicators	Level 3 Indicators	Unit	Attribute
Ecological and Environmental Resilience Index (UERI)	State Resilience Index (UESI)	Individual Water Availability	m^3 /person	+
		Metropolitan Green Space Distribution	%	+
		Personal Park Access Across Urban Regions	ha/10,000 People	+
		Average Developed Space per Resident in City Zones	km^2 /10,000 people	+
	Stress Resilience Index (UEPI)	Industrial Wastewater Output per Person	t/person	-
		Industrial SO_2 Release per Individual	t/person	-
		Industrial particulate matter emissions per capita	t/person	-
		Per capita industrial nitrogen oxides	t/person	-
		$PM_{2.5}$ Annual average concentration	μg/m³	-
	Resilience Index (UEMI)	Industrial Sulfur Dioxide Removal	t	+
		Industrial Dust Removal Volume	t	+
		Domestic waste harmless treatment rate	%	+
		Centralized treatment rate at sewage treatment plants	%	+
		Industrial solid waste utilization rate	%	+

3.3.2. Explanatory variable: digital economy development level (digital)

Since a single variable is insufficient to capture the digital economy's full scope, we evaluate it from two dimensions—digital advancements in internet and financial technology, drawing on Liu et al. The internet dimension uses four metrics from Huang et al.: broadband and mobile phone subscribers per 100 people, share of IT sector employees, and per capita telecom revenue. The finance dimension incorporates the China's Digital Inclusion Finance Index from Peking University and Ant Group. A composite digital economy index is then formed by standardizing these five indicators and using principal component analysis for dimensionality reduction.

Table 2. Comprehensive evaluation system for digital economic development levels

Primary Indicators	Second-Level Indicators	Tertiary Indicators	Unit	Attribute
Level of Digital Economy Development	Digital Advancements	Prevalence of high-speed internet connections per 100 inhabitants	Household	+
		Proportion of tech sector professionals in the urban workforce	%	+
		Average telecommunications consumption per person	10000 people	+
		Mobile phone penetration rate per capita	Household	+
	Financial Technology	China's Digital Inclusion Finance Index	—	+

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3.3.3. Mediating variable: technological innovation

This study leverages technology innovation as a bridge to unpack the intricate processes through which the digital economy fortifies urban areas against economic shocks. Considering that patent grants better reflect technological innovation in the commercialization of research outcomes, the log of patent grants at the prefecture-level city level is adopted to represent technological innovation.

3.3.4. Control variables

Given the numerous factors influencing economic and ecological resilience, and drawing on existing research, the following variables are introduced to control for potential biases arising from omitted important explanatory variables: ①Population density. This is quantified as the year-end population within a city's administrative boundaries divided by its corresponding land area, denoted as den; ②Foreign Direct Investment (FDI). Following international scholarly practice, we use the logarithm of actual FDI inflows, denoted as ln_fdi; ③Urban Scale. Measured by the logarithm of built-up area, denoted as ln_built; ④ Financial Development Level is measured by the logarithm of outstanding loans from financial institutions, denoted as ln_fin; ⑤Level of government intervention is represented by the ratio of public budget expenditure to GDP, denoted as gov; ⑥Level of human capital is derived from the share of employment accounted for by the education sector in total urban employment, denoted as human; ⑦Industrial structure is represented by the ratio of tertiary industry value-added to secondary industry value-added, denoted as isu. Table 3 presents the descriptive statistics for the variables.

Table 3. Descriptive statistics of variables

Variable Type	Variable Name	Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent variable	Economic Resilience	econ_res	2930	-0.002	0.545	-9.185	3.613
	Ecological Resilience	eco	2930	0.310	0.033	0.083	0.358
Explanatory Variable	Digital Economy	digital	2930	0.062	0.069	0.001	0.398
Control Variables	Population Density	ln_den	2930	5.738	0.925	1.792	7.905
	Foreign Direct Investment	ln_fdi	2908	-4.862	1.619	-13.472	-1.285
	Urban Expansion	ln_built	2928	4.610	0.874	0.693	7.405
	Financial Development	ln_fin	2930	16.692	1.170	13.560	20.688
	Government intervention	gov	2930	0.228	0.179	0.044	2.185
	Human Capital	human	2930	0.129	0.054	0.015	0.408
	Industrial Structure	ISU	2930	1.153	0.623	0.207	5.650
Mediating Variable	Technological Innovation	Technological Innovation	2930	8.121	1.798	1.099	12.583

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4. Results and discussion

4.1. Benchmark regression

Table 4. Robustness test results

Variable	Benchmark Regression		Excluding Special Years		Excluding Municipalities Directly Under Central Government		Replacing Core Explanatory Variables	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Digital Economy Level	-0.009***	0.605**	-0.010**	0.605**	-0.010**	0.841***		0.532*
	(0.004)	(0.257)	(0.005)	(0.257)	(0.004)	(0.222)		(0.279)
Digital Economy Squared	0.020***		0.021***		0.022***			
	(0.007)		(0.008)		(0.007)			
Inclusive Finance				-0.000		-0.000	0.000**	0.000***
				(0.001)		(0.001)	(0.000)	(0.000)
Inclusive Finance Square							-0.000***	
							(0.000)	
Constant term	0.313***	7.247***	0.313***	7.723***	0.310***	7.723***	-0.515	0.321***
	(0.023)	(2.261)	(0.023)	(2.238)	(0.023)	(2.238)	(0.318)	(0.017)
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES
City, time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Observation value	2906	2906	2615	2906	2866	2906	2880	2890
Adjusted R^2	0.991	0.252	0.989	0.162	0.990	0.162	0.988	-0.003

The test of Hypothesis 1 using Equation (1) demonstrates a significant positive relationship between digital economy development and urban economic resilience. As shown in Column (2) of Table 4, the estimated coefficient is significantly positive, supporting the hypothesis that digital economic development enhances economic resilience.

To test Hypothesis 3 regarding the nonlinear effect, we estimate Equation (2). As indicated in Table 4, Column (1), the inclusion of the squared term for the digital economy corroborates a statistically significant nonlinear pattern. The linear term coefficient is negative at the 5% level, suggesting an initial suppressive effect on ecological resilience. By comparison, the coefficient for the squared term is 0.020 and reaches statistical significance at the 1% threshold. This implies that as the digital economy develops further, its initial inhibitory influence shifts toward a promoting effect, forming a U-shaped relationship. This supports Hypothesis 3, confirming a threshold effect rather than a simple linear association.

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4.2. Robustness tests

4.2.1. Excluding samples from exceptional years

The selected sample data spans from 2013 to 2022. The year 2020 exhibited significant fluctuations in various indicators due to the impact of the COVID-19 pandemic. To eliminate the macro-level effects of the pandemic, this study excludes the special year of 2020 and conducts regression analysis using the remaining years' sample data to test the robustness of the empirical results.

Economic resilience findings are presented in Column 4 of Table 4. After excluding the 2020 sample, the coefficient indicating digital economy effects on economic sustainability reaches statistical significance at the 5% level of confidence, demonstrating strong alignment with the baseline model estimates. This demonstrates the digital economy's beneficial reinforcement of economic resilience remains valid in the pre-pandemic sample. Ecological Resilience Test Results Column (3) of Table 4 shows that after excluding 2020, the digital economy's primary coefficient shows a negative value, while the coefficient for the second-order term is notably positive and retains its statistical significance, with signs consistent with the benchmark regression. This indicates that the U-shaped relationship between the digital economy and ecological resilience holds across different subsamples, further supporting the robustness of Hypothesis 3.

4.2.2. Excluding central government-controlled municipalities

Considering the significant socioeconomic and environmental differences may introduce estimation biases, we conducted robustness tests by excluding the four municipalities of Beijing, Shanghai, Chongqing, and Tianjin, following the methodology of Zhou et al.

According to Column (6) in Table 4, the findings on economic resilience show that after factoring out cities that are directly governed by the central authorities, the digital economy shows a highly significant ($p<0.01$) positive correlation with economic resilience, consistent with the benchmark results. Regarding ecological resilience, Column (5) of Table 4 indicates that after excluding the municipalities, the digital economy's linear coefficient proves significant at $p<0.05$ with a negative value.The significance level and directional sign of the squared term's coefficient remain unchanged, meeting the 1% significance threshold. This further validates that the U-shaped impact of the digital economy on ecological resilience holds true across different city types.

4.2.3. Substituting core explanatory variables

This study employs principal component analysis to assess digital economic advancement. To assess the robustness of the findings, the Peking University's Index of Digital Financial Inclusion is selected as the core explanatory variable for regression analysis, replacing the constructed composite digital economy indicator.

Column (8) of Table 4 confirms that the positive impact of the digital economy on economic resilience remains significant following the substitution of the core variable. Column (7) shows that the primary and squared terms of the digital inclusive finance index retain signs consistent with the benchmark model, confirming the robust U-shaped relationship. The smaller coefficient magnitude indicates a weaker effect, suggesting that the comprehensive digital economy index is a more representative measure than the single finance index.

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4.2.4. Endogeneity treatment

Although factors influencing economic resilience and ecological resilience were controlled for as much as possible, endogeneity issues may still exist. Therefore, this paper adopts the method proposed by Gong and Tan, utilizing 1984's per-capita postal facility distribution as an instrumental variable [11]. For panel data analysis implementation, adopting Nunn and Qian's methodology [12], we constructed interactive elements between each city's 1984 number of post offices per 100 people and its internet user count from the previous year. These interaction terms serve as instrumental variables for measuring each city's level of digital economic development. Additionally, since only 281 prefecture-level cities had data on post offices per 100 people in 1984, the sample size is limited to 281 cities.

This research applies a two-stage instrumental variables (2SLS) method to to address endogeneity concerns. The results appear in Table 5, for the initial analysis phase, the instrumental variable shows statistical significance at the 1% level. Moreover, Kleibergen-Paap's rk LM test and Wald F test both pass the conventional significance thresholds, rejecting the null hypotheses of underidentification and weak identification, which validates the strength of the instrument. The second-stage estimates affirm that the digital economy substantially strengthens economic resilience, while producing a negative effect in relation to ecological resilience, confirming that the core findings remain robust after controlling for endogeneity.

Table 5. Endogeneity treatment

	First Stage (iv2)	ECO	ECON_RES
	(1)	(2)	(3)
Instrument Variables	0.000***		
	(0.000)		
Digital Economy Level		-0.025***	0.674***
		(0.008)	(0.253)
Control Variables	YES	YES	YES
City, time fixed effects	YES	YES	YES
N	1771	1771	1771
r^2	0.447	0.095	0.062

4.3. Test results for the mediating effect

To further probe the mechanism by which urban economic resilience is shaped by the digital economy, and to empirically test Hypothesis 2, this study constructs a mediation effect model for empirical verification. Table 5 presents mediation outcomes for technological innovation.

In column (2) of Table 6, we can clearly see that there's a strikingly positive correlation between the digital economy and technological advancements, with a regression coefficient that is statistically significant at the 1% threshold. Column (3) indicates that the coefficient of the digital economy is smaller than that in column (1), indicating that technological innovation plays a partial mediating role.

To validate the reliability of the mediating effect, this study further conducts a Sobel test. The results show that the Sobel Z-value is 2.36 and significant, with an indirect effect value of 0.0352. This reveals the mediated impact of digital economic development on economic adaptability.

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through technological innovation accounts for 6.14% of the total effect, confirming a partial mediating effect. In summary,Technological innovation serves as a crucial transmission channel through which the digital economy influences economic resilience.

Table 6. Mediating effect test results

Variable	(1)Economic Resilience	Technological Innovation	
		(2)Technological Innovation	(3)Economic Resilience
Digital Economy	0.452***	0.538***	0.416**
	(0.161)	(0.150)	(0.163)
Technological Innovation			0.065***
Constant term	-1.771***	-8.906***	-1.188***
	(0.209)	(0.225)	(0.281)
Control Variables	YES	YES	YES
Indirect effect		[0.0352]	
Standard Error of Indirect Effect		[0.0149]	
Soble Z		2.3615 (Z = 2.36)	
Indirect effect proportion		6.14%	
Control Variables	YES	YES	YES
City and time fixed effects	YES	YES	YES
Number of cities	2906	2906	2906
R^2	0.047	0.751	0.050

5. Conclusions and implications

This research constructs a dual-aspect analytical framework based on a balanced panel of 293 Chinese cities at or above the prefectural administrative tier, with annual data from 2013 to 2022. By applying two-way fixed effects, mediation effect, and instrumental variable models, it systematically investigates the differential impacts of the digital economy on urban resilience. The empirical evidence demonstrates that the digital economy directly strengthens urban economic resilience and also exerts an indirect positive influence by stimulating technological innovation. Concurrently, its impact on ecological resilience exhibits a pronounced U-shaped nonlinear characteristic, being initially by factors such as infrastructure energy consumption and rebound effects, but ultimately transforming into a positive promotional effect as digital technologies mature and industrial structures upgrade.

Based on these findings, the following policy recommendations are proposed: First, adopt differentiated strategies to coordinate digital economy development with resilient city construction. Government departments should fully recognize the double-edged sword effect of the digital economy on economic and ecological sustainability and implement categorized guidance. Second, strengthen the intermediary role of technological innovation to drive resilience enhancement through digital empowerment. Increase R&D investment in critical digital technologies, encourage the integration of digital and green technologies, and support industry-academia-research collaboration among enterprises, universities, and research institutions to accelerate the commercialization of green patent outcomes.

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Generally, this research delves into the complex interplay mechanisms by which digital economy growth affects urban resilience, offering new evidence to interpret the "digital paradox." The findings offer valuable insights for policymakers aiming to navigate the trade-offs between development and security, as well as between economic growth and ecological conservation, in the ongoing process of digital transformation.

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