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Research on the Path to Improving Entrepreneurial Activity in Chinese Cities under the Background of Digital Economy

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Abstract

With the rapid development of digital technologies, the digital economy has become a crucial engine driving high-quality economic development. Against this backdrop, this study, covering 31 provinces, municipalities, and autonomous regions in China (excluding Hong Kong, Macao, and Taiwan) from 2013 to 2023, aims to systematically assess the level of digital economic development in each region by constructing a robust digital trade economic indicator system and empirically analyze its impact on innovation and entrepreneurship activity. This study not only focuses on direct factors such as digital infrastructure, digital innovation capabilities, and digital industry development, but also explores the role of indirect factors, such as the degree of government intervention, in promoting innovation and entrepreneurship through digital trade. This study aims to provide scientific evidence and practical guidance for policymakers, promoting the deep integration and coordinated development of the digital economy and innovation and entrepreneurship.

Keywords

Digital Economy; Entrepreneurial Activity; Government Intervention.

1. Introduction

Driven by the global wave of digitalization, the digital economy has become a crucial engine driving economic growth and stimulating innovation. With the rapid development of information technology and the widespread adoption of the internet, the digital trade economy, as a crucial component of the digital economy, is profoundly transforming traditional economic models and business ecosystems. The continuous improvement of digital infrastructure, the sustained growth of digital innovation capabilities, and the vigorous development of digital industries together form the cornerstones of its prosperity[1]. As the world's second-largest economy, China has made remarkable achievements in the digital economy in recent years[2]. Digital technologies have been widely applied across various industries, effectively promoting the optimization and upgrading of its economic structure and the vibrant development of innovation and entrepreneurship. However, significant differences exist across China's regions in the level of digital economic development. These differences are reflected not only in the coverage of digital infrastructure and the application of digital technologies, but also in the profound impact on the innovation and entrepreneurship environment and activity in each region[3]. Therefore, in-depth research on the mechanisms by which digital economic development influences innovation and entrepreneurship activity is of great significance for promoting balanced regional economic development and enhancing the country's overall innovation capacity. Against this backdrop, this study, covering 31 provinces, municipalities, and autonomous regions in China (excluding Hong Kong, Macao, and Taiwan) from 2013 to 2023, aims to systematically assess the level of digital economic development in each region by constructing a robust digital trade economic indicator system and empirically analyze its impact on innovation and entrepreneurship activity[4]. This study not only focuses on direct

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factors such as digital infrastructure, digital innovation capabilities, and digital industry development, but also explores the role of indirect factors, such as the degree of government intervention, in promoting innovation and entrepreneurship through digital trade. This research aims to provide scientific evidence and practical guidance for policymakers, promoting the deep integration and coordinated development of the digital economy and innovation and entrepreneurship[5].

2. Literature Review

2.1. Theoretical Basis and Evaluation Index System of Digital Economy

As an emerging economic form, the digital economy's theoretical foundations stem primarily from the intersection of information economics, network economics, and innovation economics. Information economics emphasizes how digital technology optimizes resource allocation by reducing information asymmetry, network economics focuses on the network effects and economies of scale of digital platforms, and innovation economics reveals the role of digital technology in reshaping innovation diffusion and the entrepreneurial ecosystem[6]. The integration of these three approaches provides a systematic theoretical framework for understanding how the digital economy empowers innovation and entrepreneurship.

Existing research generally adopts a multidimensional approach to constructing evaluation index systems. Zhang Hongling's research points out that "digital infrastructure, digital innovation capabilities, and digital industry development constitute the three pillars for measuring the level of digital economic development," which aligns with the internationally accepted digital economy measurement framework. Specifically, the digital infrastructure dimension primarily assesses hardware conditions such as broadband penetration and 5G base station density; the digital innovation capability dimension focuses on technological outputs such as R&D investment intensity and the number of patent authorizations; and the digital industry development dimension emphasizes market-oriented indicators such as e-commerce transaction volume and the proportion of digital service enterprises[7]. This multidimensional evaluation system can comprehensively reflect the comprehensive development level of a region's digital economy.

It's worth noting that the evaluation of the digital economy also needs to consider regional differences and its dynamic evolution. Fu Kaibao's research shows that the urban-rural digital divide leads to significant spatial heterogeneity in the impact of the digital economy on innovation and entrepreneurship[8]. Therefore, secondary indicators reflecting balanced development, such as digital inclusion and digital skills penetration, should be incorporated into the indicator design. Furthermore, with the rapid iteration of new technologies such as blockchain and artificial intelligence, the evaluation system should also be dynamically updated to accurately capture the continuous transformation of economic structures due to technological evolution[9].

From a methodological perspective, digital economy evaluation requires a balance of objective data and subjective perceptions. Qianqian Wan's team, using the CRITIC objective weighting method to construct the China Digital Economy Index, confirmed significant correlations between different indicators, necessitating the use of statistical methods to eliminate information overlap. Li Xin, on the other hand, emphasized the importance of soft factors such as organizational cognition during a company's digital transformation, suggesting that, in addition to hard indicators, qualitative evaluation factors such as entrepreneurs' digital literacy and policy awareness should also be incorporated.

Drawing on existing research, this paper constructs a digital economy evaluation system comprised of three tiers: foundational infrastructure (hardware infrastructure), capability (technological innovation), and application (industrial integration). This hierarchical structure

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not only reflects the phased characteristics of digital economic development but also reveals the differential impacts of different dimensions on innovation and entrepreneurship. This system provides a scientific measurement tool for subsequent empirical analysis and a diagnostic framework for policymakers to identify shortcomings in regional digital economic development.

2.2. Measurement Dimensions and Research Progress of Innovation and Entrepreneurship Activity

Measuring the level of innovation and entrepreneurship activity is an important tool for assessing the health of a regional innovation ecosystem. Existing research mainly constructs an evaluation system from three dimensions: innovation output, entrepreneurial behavior, and collaborative environment. In terms of innovation output, the number of patent authorizations, the number of high-tech enterprises, and the transaction volume of technology markets are core indicators. These indicators can directly reflect the market transformation efficiency of innovation results. In her research, Zhang Hongling pointed out that "the number of patent authorizations, especially the proportion of invention patents, is a key observation point for measuring the original innovation capabilities of a region." This view is generally recognized by the academic community. The entrepreneurial behavior dimension focuses on dynamic indicators such as the rate of new market entities and the number of gazelle enterprises cultivated. Among them, Xiong Bin's proposal that "the growth rate of gazelle enterprises can effectively capture the high-growth entrepreneurial characteristics spawned by the digital economy" provides a new perspective for entrepreneurship quality assessment.

In recent years, with the in-depth development of the digital economy, the measurement system for innovation and entrepreneurship activity has shown three significant evolutionary trends. First, the focus of measurement has shifted from simple quantitative indicators to quality and efficiency indicators, with more emphasis on the economic value transformation of innovative achievements and the survival cycle of entrepreneurial enterprises. For example, some studies have begun to introduce efficiency indicators such as "commercial value generated by unit R&D investment" and "three-year survival rate of entrepreneurial enterprises." Second, digital characteristic indicators have been incorporated into the evaluation framework, including indicators reflecting the degree of digital transformation such as cloud service utilization rate and data element transaction scale. These indicators can capture the deep transformation of innovation and entrepreneurship models by the digital economy. Third, spatial interaction indicators have received attention, revealing the spatial spillover effects of innovation and entrepreneurship activities by measuring the density of cross-regional technology cooperation networks and the frequency of talent flow[10].

In terms of research methods, the assessment of innovation and entrepreneurship activity exhibits a multidisciplinary approach. Traditional econometric methods, such as panel regression models, are still widely used to analyze the strength of influencing factors. Simultaneously, social network analysis is being applied to the topological structure of innovation collaboration networks, identifying the hubs of regions within them. Machine learning algorithms, by processing massive amounts of unstructured data (such as corporate registration documents and patent citation networks), can uncover hidden patterns that are difficult to capture using traditional statistical methods. This multi-methodological research paradigm significantly enhances the scientific nature and explanatory power of measurement results.

Existing research has also revealed several bottlenecks that need to be overcome. On the one hand, the indicator system lacks dynamic adaptability, making it difficult to respond in real time to changes in innovation and entrepreneurship models caused by emerging technologies such as blockchain and AIGC. On the other hand, the problem of unified measurement standards

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caused by urban-rural differences and industrial heterogeneity has not been completely resolved. Luo Hongyan's research found that "the evaluation of entrepreneurial activity at the county level needs to add special indicators such as the penetration rate of agricultural products e-commerce, which suggests that the measurement system needs to be more flexible." In addition, the issue of indicator equivalence in international comparative studies is also worthy of attention. Differences between different countries in patent examination standards, enterprise classification rules, etc. may affect the credibility of cross-national comparison conclusions.

Future research needs to deepen exploration in three areas: first, building a dynamic and scalable indicator framework, adapting its modular design to the measurement needs of different technological development stages and regional characteristics; second, strengthening the integration of micro-foundation data, integrating multiple sources such as business registration, social security contributions, and tax returns, to improve measurement granularity and real-time performance; and third, exploring the application of digital twin technology in innovation and entrepreneurship monitoring, using virtual simulation to predict the effects of policy interventions. These advances will help establish a more accurate and sensitive monitoring system for innovation and entrepreneurship activity, providing a scientific basis for policymaking in the digital economy era[11].

3. Research Methods

3.1. Data Source and Processing Method

The research objects of this paper are 31 provinces, municipalities and autonomous regions in China except Hong Kong, Macao and Taiwan, with a time span of

From 2013 to 2023. When measuring the level of digital economic development in China's provincial level below, we will also construct a corresponding indicator system based on these three dimensions. The digital economy indicator system constructed in this article includes one first-level indicator, three second-level indicators, and ten third-level indicators.

Table 1. Construction of digital trade economic indicators

First-level indicators	Secondary indicators	Level 3 indicators	Symbol Expectations
Digital trade economy	Digital infrastructure	Long-distance optical cable lines (km)	+
		Broadband access ports (10,000)	+
		Number of Internet domain names (10,000)	+
	Digital innovation capabilities	R&D expenditure of industrial enterprises above designated size (10,000 yuan)	+
		Full-time equivalent of R&D personnel in industrial enterprises above designated size (person-years)	+
		Number of domestic invention patent applications authorized (items)	+
		Proportion of administrative villages with Internet broadband services (%)	+
		Mobile phone penetration rate (units/100 people)	+
	Development of digital industries	Total telecommunications business volume	
		Foreign trade income	

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3.2. Variable Selection and Data Description

Table 2. Main variables

Variable	index	definition
Explained variable	Innovation and entrepreneurship activity	Annual R&D expenditure in the region
Explanatory variables	Digital Trade	The above indicator system measurement
Control variables	Economic development level	GDP per capita
	Financial development level	Deposits and loans/GDP
	External dry degree	Import and export value of goods/GDP
Mechanism variables	Degree of government intervention	Fiscal expenditure/GDP

In this study, the explained variable is innovation and entrepreneurship activity, serving as the outcome variable whose causes need to be analyzed. The explanatory variable is digital trade, serving as the core causal variable and measured using the multidimensional indicator system constructed above (covering dimensions such as trade scale, infrastructure, and trade efficiency). Its core function is to verify its impact on innovation and entrepreneurship activity and the magnitude of its effect. The control variables include economic development level, financial development level, and degree of openness, measured by GDP per capita, the sum of deposits and loans/GDP, and the value of goods imports and exports/GDP, respectively. Although these variables are not core to the study, they do affect innovation and entrepreneurship activity. They are included to eliminate interference, avoid omitted variable bias, and ensure the accuracy of the impact of digital trade. For example, economic development level reflects regional economic strength, financial development level reflects the support capacity of financial markets, and degree of openness represents connections with international markets. The mechanism variable is the degree of government intervention, measured by fiscal expenditure/GDP. It serves as an intermediate path variable to reveal the bridge through which digital trade affects innovation and entrepreneurship activity. The mechanism logic assumes that digital trade may affect the degree of government intervention, thereby affecting innovation and entrepreneurship, by either prompting the government to increase relevant fiscal expenditures or forcing the government to optimize its expenditure structure.

3.3. Empirical Model Setting

To verify the relationship between digital trade and innovation and entrepreneurship activity, this paper first established a static benchmark regression model of digital trade and innovation and entrepreneurship activity, and then used a fixed-effect model for verification:

$$Y_{it}=\beta_0+\beta_1 X_{it}+\beta_2 \text{Controls}_{it}+\alpha_i+\lambda_t+\varepsilon_{it} \qquad (1)$$

In (1), Y represents the innovation and entrepreneurship activity of province i in year t; X represents the digital trade index of province i in year t; Controls it is a set of control variables at the provincial level, including the level of economic development, the level of financial development, and the degree of external expansion; the model also includes province fixed effects αi and year fixed effects λt, as well as robust standard errors εit after robust adjustment.

ISSN: 2710-0723

3.4. Analysis of Empirical Results

3.4.1. Entropy Measurement

If the degree of dispersion of a particular evaluation indicator's data is greater, the information entropy of that indicator is lower, indicating that the indicator has more information within the indicator system and should have a higher weight. If the degree of dispersion of a particular evaluation indicator's data is smaller, the information entropy of that indicator is greater, and the information contained in that indicator is less, the weight should be lower. Using the objectively weighted entropy method to determine weights can effectively overcome information overlap between indicators and avoid the arbitrary and random nature of subjective weighting methods. To avoid interference from subjective factors, this paper uses the highly objective and accurate entropy weight method to determine the weights of each indicator.

The calculation steps of the entropy weight method are:

(1) Data standardization

Since the dimensions of the various indicators used in the data are different, it is necessary to perform dimensionless processing on the indicator data. SPSS is used to standardize the original data. The formula is as follows:

Positive indicators:

$$x'_{ij} = (x_{ij} - \bar{x})/s_j \tag{2}$$

Contrarian indicators:

$$\mathrm{x}'_{\mathrm{ij}} = (\bar{\mathrm{x}} - \mathrm{x}_{\mathrm{ij}})/\mathrm{s}_{\mathrm{j}} \tag{3}$$

Where, $x_{ij}$is the i-th sample, the original value of the j-th indicator, $x'_{ij}$is the standardized value, $\bar{x}$and $s_j$are the mean and standard deviation of the j-th indicator, respectively.

In the subsequent steps of the entropy method, the logarithm needs to be taken, and the normalized value needs to be shifted to make the value positive:

$$Z_{ij} = x'_{ij} + A \tag{4}$$

Where, $Z_{ij}$is the value after translation, and A is the translation amplitude.

(2) Calculate the information entropy of each indicator

Under the j-th indicator, the formula for calculating the proportion of the i-th data value $p_{ij}$is:

$$p_{ij} = Z_{ij}/\sum_{i=1}^{n} Z_{ij} \ (\mathrm{i} = 1,2,\dots,\mathrm{n};\ \ \mathrm{j} = 1,2,\dots,\mathrm{m}) \tag{5}$$

Where n is the number of samples and m is the number of indicators. The formula for calculating the indicator entropy $e_j$is:

$$e_j = -1/\ln n * \sum_{i=1}^{n} p_{ij} \ln p_{ij} \ (\mathrm{i} = 1,2,\dots,\mathrm{n};\ \ \mathrm{j} = 1,2,\dots,\mathrm{m}) \tag{6}$$

e_jRepresents the information entropy of the j-th indicator.

(3) Determine the weight of each indicator

ISSN: 2710-0723

The coefficient of variation of the j-th indicator $g_j$is:

$$g_j = 1 - e_j \tag{7}$$

The weight of the j-th indicator $w_j$is as follows:

$$w_j = g_j / \sum_{j=1}^{m} g_j \quad (j = 1,2, \dots, m) \tag{8}$$

(4) Calculation of comprehensive risk factorv_i

$$v_i = \sum_{j=1}^{m} w_j p_{ij} \tag{9}$$

3.4.2. Descriptive Analysis

Table 3. Descriptive statistics of variables

Name	Minimum	Maximum	average value	Standard deviation	median
Digital Trade	0.021	0.627	0.145	0.122	0.100
Innovation and entrepreneurship activity	17792.888	78186000.000	7930079.801	13800948.652	3135740.300
Economic development level	5692.330	48075.000	12608.339	8149.535	9670.690
Financial development level	1.664	8.131	3.465	1.200	3.244
External dry degree	0.008	1.342	0.247	0.262	0.137
Degree of government intervention	0.107	1.334	0.282	0.192	0.231

As can be seen from the above table, the value range of the digital trade index is 0.021-0.627, the average is 0.145, the standard deviation is 0.122, the median is 0.100, the ratio of the standard deviation to the average is about 0.841, and the average is higher than the median. The overall level of digital trade development in the sample is relatively low, but the degree of digital trade development in some samples is significantly higher, with certain regional or individual differences. The value differences of innovation and entrepreneurship activity are extremely significant, with the minimum value being only 17792.888 and the maximum value being as high as 78186000.000, a difference of more than 4383 times. The average value is 7930079. .801, the standard deviation is 13800948.652, the standard deviation is much larger than the mean, and the median (3135740.300) is significantly lower than the mean. The innovation and entrepreneurship activity in the sample shows a strong imbalance. A few samples show extremely high innovation and entrepreneurship vitality, while the activity of most samples is at a relatively low level. The value range of economic development level (measured by per capita GDP) is 5692.330-48075.000, with an average of 12608.339, a standard deviation of 8149.535, and a median of 9670.690. The mean is higher than the median, and the standard deviation is similar to the mean. The ratio of the means is about 0.646. There is a certain gap in the economic development level among the samples, but it is more moderate than the innovation and entrepreneurship activity. The economic development level of some samples is significantly ahead of the overall average level; the value range of the financial development level is 1.664-8.131, the average is 3.465, the standard deviation is 1.200, and the median is 3.244. The average and the median are relatively close, and the standard deviation is relatively small. The overall fluctuation of the financial development level in the sample is low,

ISSN: 2710-0723

and the financial development level of most samples is concentrated at a medium level; the value range of the degree of openness to the outside world is 0.008-1.342, with an average of 0 .247, the standard deviation is 0.262, and the median is 0.137. The standard deviation is slightly higher than the average, and the average is higher than the median. There are certain differences in the degree of openness among samples. The level of openness of a few samples is higher, which pulls up the overall average. The value range of the degree of government intervention is 0.107-1.334, the average is 0.282, the standard deviation is 0.192, and the median is 0.231. The average is higher than the median. The ratio of the standard deviation to the average is about 0.681, reflecting that there are certain differences in the intensity of government intervention in the economy among the samples. The degree of government intervention in some samples is significantly higher than the overall average.

3.4.3. Correlation Analysis

Table 4. Correlation analysis

	Innovation and entrepreneurship activity	Digital Trade	Economic development level	Financial development level	External dry degree	Degree of government intervention
Innovation and entrepreneurship activity	1					
Digital Trade	0.814***	1				
Economic development level	0.391***	0.596***	1			
Financial development level	0.113*	0.434***	0.628***	1		
External dry degree	0.643***	0.617***	0.862***	0.531***	1	
Degree of government intervention	-0.329***	-0.546***	-0.254***	0.400***	-0.314***	1

* p<0.1 ** p<0.05 *** p<0.01

As can be seen from the above table, innovation and entrepreneurship activity has a significant correlation with all explanatory variables, control variables and mechanism variables. It is highly positively correlated with the core explanatory variable digital trade (correlation coefficient = 0.814, p < 0.01). The higher the level of digital trade development, the higher the innovation and entrepreneurship activity of the samples. This preliminarily verifies the theoretical hypothesis that there is a positive correlation between the two. It is positively correlated with the level of economic development (correlation coefficient = 0.391, p < 0.01), the level of financial development (correlation coefficient = 0.113, p < 0.1) and the degree of opening up to the outside world (correlation coefficient = 0.643, p < 0.01), and is positively correlated with the degree of opening up to the outside world. The strength of the correlation is second only to digital trade, reflecting that the improvement of economic strength, the improvement of financial markets and the deepening of foreign exchanges can all provide support for innovation and entrepreneurship activities. Although the correlation of financial development level is significant, the strength is weak (only passing the 10% significance level test), because there are structural differences in the support of financial resources for innovation and entrepreneurship (such as a preference for mature enterprises rather than start-ups); it is significantly negatively correlated with the mechanism variable of government intervention (correlation coefficient = -0.329, p < 0.01). Excessive government intervention may have an inhibitory effect on the vitality of innovation and entrepreneurship, providing preliminary empirical evidence for the "mediating effect of government intervention level" in subsequent mechanism tests. From the perspective of the intercorrelation between variables, digital trade also has a significant correlation with other control variables: it is moderately to highly positively correlated with the level of economic development (correlation coefficient = 0.596, p < 0.01) and the degree of opening up to the outside world (correlation coefficient = 0.617, p < 0.01), indicating that samples with developed economies and high degrees of opening up to the outside world have a better foundation for the development of digital trade; it is moderately positively correlated with the level of financial development (correlation coefficient = 0.434, p < 0.01), reflecting that the financial market plays a supporting role in the infrastructure construction, cross-border transaction settlement and other aspects of digital trade; it is highly negatively correlated with the degree of government intervention (correlation coefficient = -0.546, p < 0.01), indicating that government intervention indirectly affects the development of digital trade by affecting the efficiency of market resource allocation. The degree of openness to the outside world is most strongly correlated with the level of economic development (correlation coefficient = 0.862, p < 0.01), and potential multicollinearity issues need to be addressed in subsequent empirical analysis. The level of financial development is moderately positively correlated with the degree of government intervention (correlation coefficient = 0.400, p < 0.01), which may be due to the government's participation in the allocation of financial resources through fiscal policies, regulatory guidance, etc., while the level of economic development is weakly negatively correlated with the degree of government intervention (correlation coefficient = -0.254, p < 0.01), which is in line with the general rule that "the higher the maturity of economic development, the lower the demand for government intervention."

3.4.4. Benchmark Regression

Table 5. Benchmark regression

item	Innovation and entrepreneurship activity
intercept	-1.839 (-0.807)
Digital Trade	2.227*** (6.504)
Economic development level	1.680*** (7.205)
Financial development level	0.098** (2.062)
External dry degree	2.192*** (9.720)
R^2	0.213
Sample size	225
F	54.568***

As shown in the table above, the R^2 value of the regression equation is 0.213, indicating that the four variables-digital trade, economic development, financial development, and degree of openness-collectively explain 21.3% of the variance in innovation and entrepreneurship activity. The model has a reasonable explanatory power. The overall test statistic for the regression equation is 54.568 (p<0.01), indicating that the overall linear relationship in the model is significant and that there is no overall failure of fit. Controlling for economic development, financial development, and degree of openness, the core explanatory variable, digital trade, has a significant positive impact on innovation and entrepreneurship activity.

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Specifically, the regression coefficient for digital trade is 2.227, which is statistically significant at the 1% level (t-value = 6.504). This indicates that, ceteris paribus, for every 1-unit increase in digital trade development, innovation and entrepreneurship activity increases by 2.227 units. This fully confirms the positive driving effect of digital trade on innovation and entrepreneurship, consistent with the conclusion of a high positive correlation between the two in the previous correlation analysis. From the perspective of control variables, the positive impact of economic development level on innovation and entrepreneurship activity is also significant and strong, with a regression coefficient of 1.680 (t value = 7.205, p < 0.01). The improvement of regional economic strength can provide more complete industrial supporting facilities, consumer markets and factor support for innovation and entrepreneurship, and is an important foundation for promoting the improvement of innovation and entrepreneurship activity. The degree of opening up to the outside world has a strong positive driving effect on innovation and entrepreneurship activity, with a regression coefficient of 2.192 (t value = 9.720, p < 0.01), reflecting that a higher level of opening up to the outside world can promote the flow of innovation factors such as technology, talents, and capital between regional and international markets, and inject external impetus into innovation and entrepreneurship activities. The positive impact of financial development level on innovation and entrepreneurship activity is significant at the 5% statistical level (regression coefficient = 0.098, t value = 2.062), but its impact is weaker than other variables. This is because financial resources are more inclined to mature enterprises with lower risks during the allocation process, and the support for start-up innovation entities is relatively limited, resulting in a relatively mild driving effect on innovation and entrepreneurship activity. In summary, digital trade has a significant positive impact on innovation and entrepreneurship activity.

3.4.5. Robustness Test

According to the purpose of this study and taking into account the stability of the model, this time we adopt the method of changing the sample interval to conduct a robustness test, which is 2017-2022. The specific results are shown below.

Table 6. Robustness test

Item	Innovation and entrepreneurship activity
intercept	-7.604*** (-3.587)
Digital Trade	1.815*** (4.856)
L Economic development level	2.235*** (10.274)
Financial development level	0.216*** (4.370)
External dry degree	3.003*** (7.914)
R^2	0.715
Sample size	125
F	60.081***

As shown in the table above, digital trade shows a significant correlation at the 0.01 level (t=4.857, p=0.000<0.01), with a regression coefficient of 1.814 > 0, indicating a significant positive impact on innovation and entrepreneurship activity. Economic development level also shows a significant correlation at the 0.01 level (t=10.274, p=0.000<0.01), with a regression

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coefficient of 2.235 > 0, indicating a significant positive impact on innovation and entrepreneurship activity. Financial development level also shows a significant correlation at the 0.01 level (t=4.370, p=0.000<0.01), with a regression coefficient of 0.216 > 0, indicating a significant positive impact on innovation and entrepreneurship activity. As for the degree of outward expansion, it shows a significance at the 0.01 level (t=7.914, p=0.000<0.01), and the regression coefficient value is 3.003>0, indicating that the degree of outward expansion has a significant positive impact on the activity of innovation and entrepreneurship. In summary, after changing the sample interval, the significance of the coefficients of the core explanatory variables of the model is consistent with the main regression, and the model passes the robustness test.

3.4.6. Mechanism Inspection

Table 7. Mechanism analysis

	Innovation and entrepreneurship activity	Degree of government intervention	Innovation and entrepreneurship activity
constant	-1.839 (-0.807)	1.049*** (11.423)	29.643*** (19.176)
Economic development level	2.227*** (6.504)	-0.101*** (-9.695)	-1.433*** (-8.596)
Financial development level	1.680*** (7.205)	0.047*** (17.052)	0.015 (0.270)
External dry degree	0.098** (2.062)	-0.014 (-0.755)	3.315*** (13.437)
Digital Trade	2.192*** (9.720)	-0.207*** (-8.269)	4.472*** (11.718)
Degree of government intervention			-12.138*** (-13.499)
N	225	225	225
R^2	0.213	0.721	0.892
F	54.568***	77.029***	362.275***
* p <0.1 ** p <0.05 *** p <0.01 *The* t value is in brackets			

As shown in the table above, the independent variable, digital trade, has a significant correlation with innovation and entrepreneurship activity. Based on the mediation theory, we found that the significance of the independent variable, digital trade, in the second model is less than the 0.05 level. We reject the null hypothesis and conclude that c in Y=cX+e1 is significant, indicating that the independent variable, digital trade, has a significant effect on the dependent variable, innovation and entrepreneurship activity. This demonstrates that digital trade can directly predict innovation and entrepreneurship activity. Secondly, we tested the regression equation for the independent variable, digital trade, on the mediating variable, government intervention. Based on the coefficient table above, we found that the significance of the independent variable, digital trade, on the mediating variable, government intervention, is less than the 0.05 level. This leads to a rejection of the null hypothesis, concluding that digital trade can predict the mediating variable, government intervention. We then tested the relationship between the mediating variable, government intervention, and the dependent variable, innovation and entrepreneurship activity. This study concluded that the significance of the mediating variable, government intervention, on the dependent variable, is less than the 0.05 level, indicating that the mediating variable, government intervention, has a significant impact on the dependent variable, innovation and entrepreneurship activity. In summary, we find that there is a

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mediating effect in the model, that is, when the independent variable digital trade has a significant impact on innovation and entrepreneurship activity, the degree of government intervention plays a mediating role.

4. Conclusion and Policy Recommendations

This study systematically analyzes provincial-level panel data from China from 2013 to 2023, confirming that the development of the digital economy significantly promotes regional innovation and entrepreneurship activity . Based on the empirical findings, the following policy recommendations are proposed: First, a differentiated digital infrastructure investment strategy should be implemented, targeting network coverage shortcomings in central and western regions and focusing on increasing the penetration rate of new infrastructure such as 5G base stations and data centers. For example, fiscal subsidies can be used to guide social capital to participate in county-level digital infrastructure construction and narrow the urban-rural digital divide. Second, the digital talent training system should be improved, with cutting-edge technology modules such as data analysis and artificial intelligence added to university courses. At the same time, joint university-enterprise laboratories should be established to promote knowledge transfer. The "Digital Craftsman" training program implemented in one province increased the supply of skilled personnel by 40% within two years, which is worthy of reference and promotion.

Third, optimize the digital industry ecosystem, support platform companies in opening up their technology tools and data resources, and reduce the costs of digital transformation for small and medium-sized enterprises. This can be reflected in the "industrial brain" model of coastal regions, integrating industry chain resources through industrial internet platforms. Fourth, innovate policy regulation methods, shifting from direct intervention to fostering an environment and establishing an inclusive and prudent regulatory framework. Specifically, mechanisms for evaluating policy effectiveness can be established to dynamically adjust intervention efforts and avoid a one-size-fits-all approach. Finally, strengthen regional coordinated development, establish cross-provincial and municipal data sharing and talent mobility mechanisms, and amplify the spatial spillover effects of the digital economy. For example, the "digital passport" system implemented in the Yangtze River Delta region has achieved cross-regional mutual recognition of scientific and technological innovation resources, significantly improving the efficiency of innovation factor allocation.

The implementation of these recommendations requires collaboration among government, businesses, and society. Government departments should prioritize top-level design and institutional development, market players should proactively embrace digital transformation, and educational institutions should focus on cultivating interdisciplinary talent suited to the digital economy. Through a systematic policy mix, it is hoped that the digital economy's potential for empowering innovation and entrepreneurship will be fully unleashed, injecting new momentum into high-quality economic development. Future research can further track the effectiveness of policy implementation and provide a basis for dynamic and optimized decision-making.

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References

[1] Luo Hongyan, Yang Li, Yang Ruilan, et al. Digital economy, innovation and entrepreneurship activity and urban economic resilience [J]. Journal of Management, 2025, 38(02): 148-158.

[2] Di Jia, Sun Pengfei, Yuan Chunhui, et al. Digital economic development drives entrepreneurial activity: a quasi-natural experiment based on the National Big Data Comprehensive Experimental Zone [J]. Research on Quantitative and Technical Economics, 2025, 42(01): 157-177.

[3] Su Pei, He Daxing. The impact of digital economic development on employment: an analysis based on panel data of 279 prefecture-level cities [J]. Shanghai Economic Research, 2024, (10): 53-74.

[4] Xiong Bin, Wang Zhiwei. Research on the impact of the digital economy "double pilot" policy on entrepreneurial activity - from the perspective of effective government and effective market collaboration [J]. Modern Finance (Journal of Tianjin University of Finance and Economics), 2024, 44(06): 36-53.

[5] Gao Xia, Li Xingjie. Research on the impact of digital economy on urban entrepreneurial activity: the regulatory role of entrepreneurial environment [J]. Journal of Dalian University of Technology (Social Science Edition), 2024, 45(01): 42-51.

[6] Chen Hailong, Li Yang. Research on the spatial spillover effect of digital economic development on entrepreneurial activity[J]. Statistics and Information Forum, 2023, 38(05): 41-52.

[7] Hui Xianbo. Digital economy, entrepreneurial activity and common prosperity: evidence from smart city construction [J]. Contemporary Economic Management, 2023, 45(05): 18-24.

[8] Zhao Xiaoyang, Yi Changjun. Has the development of digital economy increased the entrepreneurial activity in cities? [J]. Modern Finance (Journal of Tianjin University of Finance and Economics), 2022, 42(11): 19-31.

[9] Li Zhi, He Haomiao. Research on the impact of digital economy on entrepreneurial activity: An empirical analysis based on provincial panel data and spatial Durbin model [J]. Price Theory and Practice, 2021, (09): 18-22.

[10] Jiang Nan, Li Pengyuan, Ou Zhonghui. Intellectual property protection, digital economy and regional entrepreneurial activity [J]. China Soft Science, 2021, (10): 171-181.

[11] Zhao Tao, Zhang Zhi, Liang Shangkun. Digital economy, entrepreneurial activity and high-quality development: empirical evidence from Chinese cities [J]. Management World, 2020, 36(10): 65-76.