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Research on the Impact of the Digital Economy on China's New-Type Urbanization: Based on Spatial and Mediation Models

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Abstract: In the context of sustainable development, how the digital economy affects the development of new-type urbanization is a matter of concern. Based on the panel data of 30 provinces in China from 2011 to 2020, this article empirically explores the effect of the digital economy on the quality of new-type urbanization development. The results show the following. (1) The digital economy can significantly improve the development quality of new-type urbanization, which is still significantly valid after a series of robustness tests. (2) The mechanism analysis shows that the upgrading of industrial structures is an important transmission path for the digital economy to improve the quality of new-type urbanization development. (3) The spatial effect analysis shows that the development of the digital economy can not only significantly improve the quality of new-type urbanization development in this region, but also improve the quality of new-type urbanization development in surrounding areas through spillover effects. (4) The heterogeneity analysis shows that the development of the digital economy in the central and western provinces of China and in the big data pilot provinces plays a greater role in promoting the quality of new-type urbanization development. It is clear that the construction of new-type urbanization should fully consider the development trend of the digital economy, seize the policy and the technological dividends brought about by the digital economy, and explore more development opportunities.

Keywords: digital economy; new-type urbanization; industrial structure upgrading; mediating effects; spatial effects

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1. Introduction

Since the reform and the opening up of China, its high-speed economic growth has been accompanied by rapid urbanization [1,2]. From 1978 to 2021, China's urbanization rate grew from 17.9% to 64.72%, creating a historical miracle of urbanization development in the world. However, this speed-oriented traditional urbanization has brought many problems to China, such as inefficient factor allocation, widening the urban–rural gap, and significant deterioration of the urban environment, which seriously restricts sustainable economic development [3–5]. In this context, in order to effectively solve a series of problems brought about by traditional urbanization, both the Chinese Central Government and the local governments are trying to explore effective pathways for high-quality urban development. Among them, the National New-type Urbanization Plan (2014–2020) unveiled by the Chinese Central Government has revealed a new path for urbanization. Unlike the traditional economy-centered urbanization, the new-type urbanization emphasizes a people-oriented approach and pursues various development goals such as economic, social, cultural, and environmental considerations [6,7]. At the same time, as an emerging economy, China is experiencing information and communication technology revolutions. Among them, under the new round of information and communication technology revolutions, the digital economy has become a new form of economic development, which has had a profound impact on the population, economy, space, society, ecology, and other sectors in China [8–10]. According to the Chinese Academy of Information and Communication Research, the scale of China's digital economy industry has reached 39.2 trillion RMB in 2020, accounting for up to 38.6% of GDP, with a growth rate far exceeding the GDP growth rate. Different from the traditional economy, the digital economy, which takes information and communication technologies (ICT) as the key drivers, has promoted the profound changes in modes of social production and governance. Its inherent "green" attributes, such as lower marginal costs [11], lower resource consumption, and less environmental pollution, are consistent with the concepts of new-type urbanization development [12]. Therefore, during the window of opportunity for the development of the digital economy and the historic phase of changing urbanization patterns, how China can use the development of the digital economy to promote urbanization towards a new model of innovation-driven green development has become an important theoretical and practical issue worth exploring.

Although the new-type urbanization is a relatively Chinese concept, as environmental protection issues and sustainable development goals are discussed and researched globally, the new-type urbanization will become an important topic in the world in the future, and there is still a research gap in the discussion of the factors influencing the new-type urbanization. In fact, since the concept of new-type urbanization was put forward, academic circles have carried out multi-angle analyses and interpretations of the new-type urbanization's influencing factors [13,14]. Specifically, the research on the influencing factors of new-type urbanization can be summarized into the following two categories. The first type of research, from the perspective of economic growth, studies the impact mechanism of market agglomeration, human capital, opening up, financial development, and other factors on the development of new-type urbanization [15–18]. The second kind of research, from the perspective of environmental protection, studies the impact mechanism of energy structure, energy efficiency, environmental supervision, and other factors on the development of new-type urbanization [19–21]. On the other hand, the digital economy, as the new economic content of China's urbanization [22], will inevitably have an impact on the quality of new-type urbanization development. However, there are few empirical studies that accurately assess the impact of the digital economy on the quality of new-type urbanization development. Judging from the existing literature, scholars have mostly analyzed the impact of the digital economy on the sub-topics of new-type urbanization, such as the spatial allocation of factor resources, total factor productivity, urban environmental governance, and public service supply [23–26]. There are few studies on the overall impact of the digital economy on new-type urbanization from a macro perspective. With this mind, the research objectives of this paper can be divided into the following two aspects. The first is to broaden the research on the influencing factors of new-type urbanization. The second is to take China as an example to analyze the urbanization dividend brought by the development of the digital economy, so as to provide a policy reference for the urbanization transformation of other countries.

This paper deals with the following key questions: Has the digital economy supported by information technology improved the quality of China's new-type urbanization development? If this effect is confirmed, what is the mechanism of action behind it? How does the role of the digital economy in the development of new-type urbanization differ under its own characteristics and spatial laws? The study of the above questions has great significance for seizing the opportunities of digital economy development and the subsequent policy direction of new-type urbanization construction. Based on this, this paper first establishes a comprehensive evaluation index system for the digital economy and new-type urbanization. Then, after loading the data of 30 provinces in China from 2011 to 2020 into the system, the entropy weight method is used to calculate the comprehensive development level of the digital economy and new-type urbanization. Finally, the mediation effect model and the spatial econometric model are used to analyze the impact mechanism and spatial effect of the digital economy on the quality of new-type urbanization development.

The main findings of this paper are as follows. (1) The digital economy can significantly improve the development quality of new-type urbanization. (2) The upgrading of industrial structures is an important transmission path for the digital economy to improve the quality of new-type urbanization development. (3) The development of the digital economy can not only significantly improve the quality of new-type urbanization development in this region, but also improve the quality of new-type urbanization development in surrounding areas through spillover effects.

The possible key contributions of this paper are expressed in the following three points. (1) This paper measures the development level of the digital economy and new-type urbanization in China's provinces, providing quantitative standards for the government. (2) For the first time, this paper incorporates the digital economy and new-type urbanization into the same analytical framework, broadening the research perspective of new-type urbanization, and deeply analyzing the transmission mechanism of the digital economy on the quality of new-type urbanization development. (3) Based on the spatial dependence determined by the characteristics of the digital economy, this paper introduces spatial factors to examine the spatial spillover effect of the digital economy on the quality of new-type urbanization development.

The subsequent content is arranged as follows: Section 2 is a literature review and research hypothesis; Section 3 is a research design; Section 4 is an empirical test; Section 5 is a robustness test; and Section 6 provides the conclusion and the policy implications.

2. Literature Review and Research Hypotheses

In the context of China's urbanization transformation, the digital economy, as the new economic content of urbanization, is not only a new engine for urban function improvement, but also one of the important factors affecting the high-quality development of urban areas [27]. In fact, the development of the digital economy can not only directly affect the quality of urban development by virtue of its own characteristics and essence, but also indirectly promote high-quality urban development by promoting the industrial structure upgrading [28–30]. In addition, considering the "Metcalfe's Law" and "Network Effect" of the Internet in the digital economy [31], there may be a spatial spillover effect on the quality of urban development. Therefore, this paper will mainly analyze the impact of the digital economy on the quality of new-type urbanization development from three aspects: direct effect, indirect effect, and spatial effect, and propose corresponding research hypotheses.

2.1. Direct Impact Mechanism of the Digital Economy on Quality of New-Type Urbanization Development

At present, there are relatively few studies directly exploring the impact mechanism between the digital economy and new-type urbanization. However, considering that the digital economy is a new form of economy that is endogenous to technological innovation and at the same time uses digital knowledge and information as key factors of production [32,33]. This paper intends to analyze the impact mechanism between the two from the perspective of information and communication technology (ICT).

Specifically, at the level of theoretical research, Caragliu et al. (2011) believe that the use of ICT in urban can not only improve the efficiency of urban functions and services, but also has the ability to improve the competitiveness of urban areas [34]. Yu (2016) argues that ICT can provide assurance for China's new-type urbanization by fostering new-type industries and transforming traditional industries [35]. Other scholars based on the analysis of the new economic growth theory found that the generation and development of ICT can improve the level of urban development by directly contributing to the growth of the local economy [36–39]. At the empirical research level, Wang et al. (2021) applies a geographically weighted regression (GWR) model and partial least squares structural equation modeling (PLS-SEM) to probe the effects of ICT on overall urbanization [40]. The results suggest that

ICT positively affects urbanization and directly improves urbanization levels and efficiency. Chatti & Majeed (2022) found that the application of ICT has a positive impact on improving the environmental quality of urban areas through empirical research on the developing and developed countries [41]. Further, from the actual situation, the digital economy supported by ICT can promote urbanization transformation through its role in new-type infrastructure development, public service delivery, and urban management services etc. [42,43]. Under this mechanism, not only the quality of life of urban residents has been significantly improved, but also the construction of urbanization has been developed in the direction of intelligence.

At the same time, in recent years, some scholars have discovered the positive effect of information and communication technology on urban green development. For example, Nguyen et al. (2020) believed that the development of ICT not only promoted the economic growth of G20 countries, but also improved the carbon productivity of these countries [44]. Lahouel et al. (2021) used a smooth transition regression (STR) model to verify the positive effect of the application of ICT on urban green economic growth [45]. It can be expected that, relying on technological innovations such as information, big data and cloud computing, the development of the digital economy can further unleash the role of technological empowerment, thereby improving the quality of new-type urbanization development. Based on this, this paper proposes the following hypothesis H1:

Hypothesis 1 (H1). *Under the condition that the existing literature fully affirms that information and communication technology play a positive effect on the level of urbanization development, this paper believes that promoting the development of the digital economy can improve the quality of China's new-type urbanization development.*

2.2. Indirect Impact Mechanism of the Digital Economy on the Quality of New-Type Urbanization Development

Under the concept of sustainable development, promoting the upgrading of industrial structures has become an important base point for building a new-type urbanization. Both the development experience of developed countries and the existing literature show that the rational flow of production factors and the increase of employment in the process of industrial structure upgrading play an important role in improving the quality of urbanization [46,47]. Specifically, the most basic manifestation of industrial structural upgrading is structural change and efficiency improvement. Among them, from the perspective of structural change, Murakami (2015) believed that the evolution of industrial structures was directly related to the development of urbanization, which could enable production factors to flow from rural areas to cities, thus promoting urban economic growth [48]. Further, Huff's (2011) research believes that the adjustment and evolution of industrial structures is conducive to attracting more open investment behavior, thus accelerating the process of land urbanization [49]. From the perspective of efficiency improvement, Zhou & Li (2021) believed that the improvement of production efficiency would promote the development of this industry and related industries, thus creating more jobs and indirectly accelerating the process of population urbanization [50]. It can be seen that the industrial structure upgrading plays an important role in promoting urban economic growth, accelerating the process of land urbanization, and expanding urban employment. These aspects are also the due meanings in the process of new-type urbanization construction, which can help overcome many difficulties in the traditional urbanization model.

On the other hand, the development of the digital economy also plays an important role in promoting the industrial structure upgrading [51]. First of all, from the perspective of digital industrialization, the digital economy with big data as the key factor of production can spawn many emerging industries, involving both manufacturing and service industries, which are related to many industries in the national economy [52,53]. Among them, emerging industries will gradually become the leading industries in the industrial system, and drive the transformation and upgrading of traditional industries through industrial linkages, technology diffusion, and other effects. Secondly, from the perspective of industrial digitalization, the digital economy supported by information technology can promote the digitalization and intelligent upgrading of traditional industries, and form a variety of new-type business forms such as smart agriculture and the industrial Internet of Things through innovation [54,55]. The emergence of new-type business forms has given more flexibility and possibility to the industrial ecosystem, making the boundary between industries gradually blurred, and the primary and secondary industries continue to extend and integrate into the tertiary industry. In general, relying on digital and information technology, enterprise entities can more easily access knowledge and information, master and accumulate emerging knowledge and skills faster, so as to promote technology upgrading and achieve industrial transformation and upgrading. Based on this, this paper proposes the following hypothesis H2:

Hypothesis 2 (H2). *Digital economy can improve the quality of new-type urbanization development by promoting industrial structure upgrading.*

2.3. Spatial Spillover Effects of the Digital Economy on the Quality of New-Type Urbanization Development

The digital economy, relying on the powerful modern information network, has broken the division and closure of different geographical space regions [28,31], not only promoted the quality of local urban development, but also produced spillover effects on the quality of urban development in adjacent areas [56]. Specifically, data, as a key factor of production, has the basic characteristics of integration, collaboration, and large amount of availability [57,58], and also has the technical-economic characteristics of non-competition, low replication cost, non-exclusivity, externality, and immediacy, etc. [59]. These characteristics enable data to strengthen the relationship and cooperation between enterprises in the region at the micro level; at the macro level, it can double the ability to create social value, thereby, improve the people's well-being of the local and neighboring areas. At the same time, the digital economy has weakened the attenuation law of technology spillover effect brought by geographical distance of various regions, greatly enhanced the inclusion of knowledge and information, and achieved cross-regional assistance and development [60,61]. This also provides a possible opportunity to narrow the development gap between urban areas. In addition, from the existing research, the digital economy also has certain spatial spillover effects on the economic development and ecological environment of surrounding urban areas [62–64]. Therefore, theoretically speaking, the impact of the digital economy on new-type urbanization also has spatial spillover effect. Based on this, this paper proposes the following hypothesis H3:

Hypothesis 3 (H3). *Digital economy can affect the quality of new-type urbanization of adjacent areas through spillover effect.*

According to the logical mechanism analyses and hypotheses above, the theoretical framework of the digital economy affecting the quality of new-type urbanization development is shown in Figure 1.

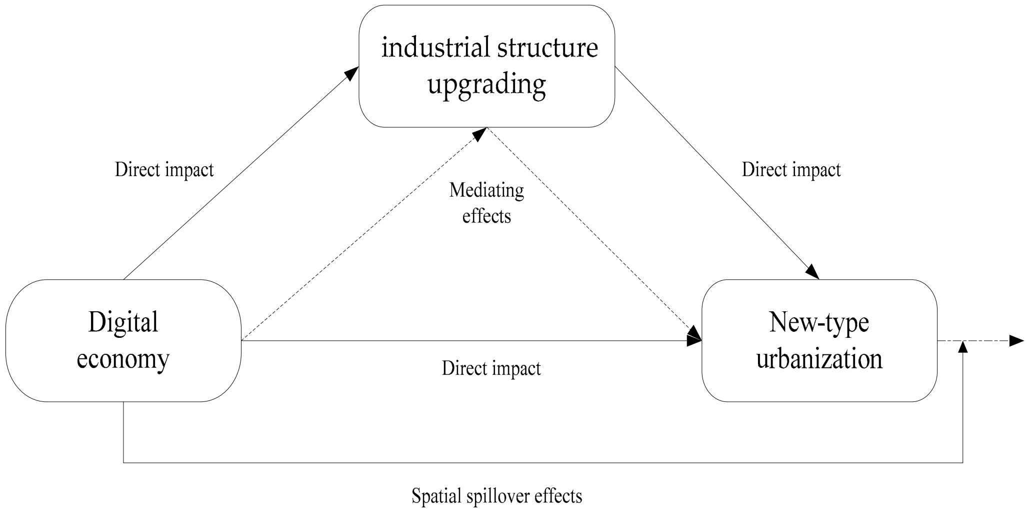

Figure 1. Conceptual framework.

3. Study Design

3.1. Econometric Models

In order to verify the above research assumptions, the following basic models are constructed for the direct transmission mechanism:

$$NUrb_{it} = \alpha_0 + \alpha_1 Dige_{it} + \alpha_j Control_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

In Equation (1), $NUrb_{it}$ represents the quality of new-type urbanization development in province i in period t. $Dige_{it}$ indicates the level of digital economy development in province i in period t. The vector $Control_{it}$ represents a set of control variables. Considering that the unobservable factors such as sudden events and economic cyclical fluctuations may exist in reality and affect the high-quality development of urban areas, the time fixed effect v_t is added to the model. Considering that the unobservable factors that do not vary with time may exist between different regions, the individual fixed effect μ_i is added; ε_{it} denotes the random disturbance term.

In addition to the total effect embodied in Equation (1), the digital economy may have an indirect effect on the quality of new-type urbanization development through some intermediary mechanisms. According to the hypothesis of the previous study, the digital economy may promote the quality of new-type urbanization development through the effect of industrial structure upgrading. Accordingly, this paper develops the following mediating effect model:

$$M_{it} = \beta_0 + \beta_1 Dige_{it} + \beta_j Control_{it} + \mu_i + v_t + \varepsilon_{it} \quad (2)$$

$$NUrb_{\text{it}} = \gamma_0 + \gamma_1 \text{Dige}_{\text{it}} + \gamma_2 M_{it} + \gamma_c Control_{\text{it}} + \mu_i + v_t + \varepsilon_{it} \quad (3)$$

In the above equations, Equation (2) represents the test of the digital economy (*Dige*) against the mediating variable (*M*): Equation (3) represents the test of the digital economy (*Dige*) and mediating variable (*M*) on the quality of new-type urbanization development (*NUrb*), where *M* denotes industrial structure upgrading (Ind) and the other variables are defined in the same way as in Equation (1). The specific steps are as follows: if the estimated coefficient α_1 of the digital economy (*Dige*) in Equation (1) is significantly positive, then there is a significant promotional role of the digital economy to the quality of new-type urbanization development (*NUrb*). Based on this, the regressions of Equations (2) and (3) are conducted, respectively. If the estimated coefficient β_1 in (2) and the estimated coefficient γ_2 in (3) are both significant and in line with the theoretical expectation, it means that the digital economy can influence the quality of new-type urbanization development through mediating factors.

Finally, to further discuss the spatial spillover effects of the digital economy on new-type urbanization development, the spatial interaction of these two and other control variables are introduced to Equation (1), which is further extended into a spatial panel econometric model:

$$\begin{aligned} NUrb_{it} = \alpha_0 + \rho NUrb_{it} + \varphi_1 WDige_{it} + \alpha_1 Dige_{it} + \varphi_j WControl_{it} \\ + \alpha_j control_{it} + \mu_i + \nu_t + \varepsilon_{it} \end{aligned} \tag{4}$$

where ρ represents the spatial autoregressive coefficient and W is the spatial weight matrix; φ_1 and φ_j represent the elasticity coefficients of the core explanatory variables as well as the spatial interaction terms of the control variables. Equation (4) is the spatial Doberman model (SDM), which includes the spatial interaction terms of explained variables and explanatory variables. To improve the robustness of the empirical results, this paper uses the neighborhood matrix ($W1$) and the economic geography matrix ($W2$) for regression, respectively.

3.2. Variable Definition

(1) The explained variable is the quality of new-type urbanization development (*NUrb*). Compared with traditional urbanization, China's new-type urbanization is characterized not only by a simple expansion of urban population and scale, but also by promoting people-oriented urbanization. Its core lies in sustainable, high-quality, and coordinated development. This is the key to the construction of new-type urbanization and also the standard for evaluating the quality of new-type urbanization. At present, there is no unified standard for measuring the quality of new-type urbanization development, and more scholars have introduced a multi-level index system to measure the quality of new-type urbanization development based on their understanding of it [13,65]. Therefore, based on the core connotation of new-type urbanization and the established research results, this paper selects 16 fundamental indicators from five dimensions: population, economy, society, ecological environment, and space, and establishes a comprehensive evaluation index system for the quality of new-type urbanization development as shown in Table 1.

Table 1. The comprehensive evaluation index system of the new-type urbanization level.

System Level	First-Level Indicators	Second-Level Indicators	Uint	Symbol
New-type Urbanization	Population Urbanization	Number of enrollments in higher education per 100,000 population	Person/ 100,000	+
		Proportion of urban population	%	+
		Population density of urban area	Person/km^2	-
	Economic Urbanization	Per capita GDP	Yuan/Person	+
		Proportion of tertiary industry to GDP	%	+
		Per capita disposable income of urban households	Yuan	+
		Per capita investment of urban fixed assets	Yuan	+
	Social Urbanization	Number of beds in medical facilities per 1000 population	Bed/1000	+
		Number of public transport vehicles per 10,000 population	Vehicle/ 10,000	+
		Per capita expenditure on education	Yuan	+
		Proportion of persons covered by urban basic endowment insurance to the total population	%	+

Table 1. *Cont.*

System Level	First-Level Indicators	Second-Level Indicators	Uint	Symbol
	Environmental Urbanization	Green coverage rate of completed areas	%	+
		Rate of harmless disposal of urban household garbage	%	+
		Per capita public green areas	m^2/Person	+
	Spatial urbanization	Per capita area of paved road	m^2/Person	+
		Proportion of built-up area to urban area	%	+

The methods for determining the weights of indicators in the evaluation index system usually include the expert scoring method, principal component analysis, factor analysis, and entropy weighting method, etc. Compared with other methods, the entropy weighting method determines the index weights by the utility of the entropy value of the information of each index, thus effectively avoiding the interference of human factors. In response, this paper adopts the entropy method to measure the quality of new-type urbanization development in each province of China, and the specific calculation steps are as follows.

Step 1: Standardize the raw data. Since the indicators in the new-type urbanization evaluation system constructed in this paper differ in terms of order of magnitude, dimension, and the positive and negative orientation of the indicators, the data need to be standardized. Equation (5) is used to standardize the positive indicators, and the larger the value, the greater its contribution to the system; Equation (6) is used to normalize the negative indicators, and the smaller the value the greater the contribution to the system. The specific data normalization methods are as follows:

$$x_{ij} = \frac{a_{ij} - \min\{a_{ij}\}}{\max\{a_{ij}\} - \min\{a_{ij}\}} (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n) \quad (5)$$

$$x_{ij} = \frac{\max\{a_{ij}\} - a_{ij}}{\max\{a_{ij}\} - \min\{a_{ij}\}} (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n) \quad (6)$$

where x_{ij} denotes the dimensionless result, $\max\{a_{ij}\}$ represents the maximum value of this indicator per year, $\min\{a_{ij}\}$ represents the minimum value of this indicator per year, a_{ij} denotes the standardized value. i means different provinces, j represents different indicators.

Step 2: Calculate the normalized weight of each indicator using the entropy method:

$$p_{ij} = \frac{x_{ij}}{\sum\limits_{i=1}^{m} x_{ij}} \quad (7)$$

Step 3: Calculate the entropy information:

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^{m} (p_{ij} \ln p_{ij}), e \in [0, 1] \quad (8)$$

Step 4: Calculating the coefficient of variation:

$$g_j = 1 - e_j \quad (9)$$

Step 5: Calculate the weights of each indicator:

$$w_j = \frac{g_j}{\sum\limits_{j=1}^{n} g_j} \quad (10)$$

Step 6: Calculate the composite score of the sample using a weighted summation method:

$$Nurb_i = \sum_{j=1}^{n} w_j x_{ij} \tag{11}$$

(2) The explanatory variable is the level of digital economy development (*Dige*). Referring to the indicator selection methods of the existing literature [28,66], as well as the digital economy-related indices released by authoritative institutions, such as the relevant data released by the China Academy of Information and Communication Research and Tencent Research Institute, and following the principles of relevance and data accessibility, this paper intends to select indicators to evaluate the development level of the digital economy from four aspects (See Table 2): digital industry, digital users, digital platforms, and digital innovation. Among them, the percentage of employment in information transmission, computer services, and the software industry is used to measure the digital industry; the number of Internet broadband access users per 100 of the population is used to measure the digital users; the number of domain names is used to measure the digital platforms; and the digital inclusive finance index is used to measure digital innovation. Finally, the entropy weight method is used to process the above indicators to obtain the final digital economy development level. The specific calculation method is the same as above.

Table 2. Digital Economy Development Indicator System.

System Level	First-Level Indicators	Second-Level Indicators	Uint	Symbol
Digital Economy	Digital Industry	Information transmission, computer services and software industry employees accounted for the proportion of urban units employed	%	+
	Digital Users	Number of Internet broadband access users per 100 population	User/100	+
	Digital Platform	Number of Domain names	10^4	+
	Digital Innovation	Digital Inclusive Finance Index	No	+

(3) The mediating variables are the industrial structure upgrading processes (*Ind*). Industrial structure upgrading is a complex dynamic evolutionary process. Through literature combing, in order to comprehensively reflect the overall status of upgrading among the three industries, this paper draws on the practices of Cha & Zuo (2017) and Li et al. (2020) [67,68]. First, the primary, secondary, and tertiary industries are given different weights; secondly, the proportion of the GDP of the three industries to the total output value is calculated, and finally, the weighted sum of the proportions of the three industries is calculated to characterize the industrial structure upgrading index (*Ind*). The specific measurement formula is as follows:

$$Ind = \sum_{t=1}^{3} \rho_t t, t = 1, 2, 3 \tag{12}$$

In Equation (12), Ind denotes industrial structure upgrading index, ρ_t denotes the share of industry t in GDP, t denotes the tth industry.

(4) The control variables more comprehensively analyze the impact mechanism of the digital economy on the quality of new-type urbanization development. The six control variables established in this paper are as follows. The level of financial development (*Fin*) is measured by using the balance of deposits and loans in each region as a percentage of regional GDP in calendar years. The level of external openness (*Open*) is measured by the ratio of total imports and exports to regional GDP, where total imports and exports are converted to RMB at the average exchange rate of the year. The level of Human

capital (*Hum*) uses the average years of education to portray the level of human capital in each region; calculated as $H_1 \times 6 + H_2 \times 9 + H_3 \times 12 + H_4 \times 16$, where H_1, H_2, H_3, and H_4 denote the proportion of the population aged six and above with four types of education in each region: elementary school, junior high school, senior high school, and college and higher. The level of government support (*Gov*) is measured using the ratio of government public finance expenditure to regional GDP. The level of regional consumption (*Con*) uses the retail sales of social consumer goods per capita in each region to express the consumption level of the corresponding region. The level of housing price (*Price*) uses the total sales price of commercial housing divided by the sales area of commercial housing to reflect the price level of commercial housing.

3.3. Data Sources and Descriptive Statistics

In order to ensure the continuity and availability of sample data and at the same time consider the development trend of the digital economy, this paper selects panel data of 30 Chinese provinces (excluding Tibet, Hong Kong, Macao, and Taiwan) from 2011 to 2020 for the study. The data used in this study are mainly from the China Statistical Yearbook, the China Population and Employment Statistical Yearbook, the China Environmental Statistical Yearbook, the China Science and Technology Statistical Yearbook, as well as the statistical yearbooks and statistical bulletins of each province, in which the Digital Inclusive Finance Index comes from the Internet Finance Research Center of Peking University. All variables are logarithmically treated in this paper to circumvent the problems of heteroskedasticity and nonlinearity caused by differences in the units of measurement of each variable. Table 3 shows the results of the descriptive statistics of the main variables. Specifically, Ln(*NUrb*) represents the quality of new-type urbanization development, and the mean value of this variable is −1.048, the standard deviation is 0.301, the minimum value is −2.063, and the maximum value is −0.33, indicating that the quality of new-type urbanization development varies greatly among different regions. Ln(*Dige*) represents the level of development of the digital economy, with a mean value of −1.423, a minimum value of −3.364, and a maximum value of −0.084, indicating that the level of digital economy development in the sample regions does have significant heterogeneous characteristics. In terms of control variables, there is some variability in each variable, but their values vary within the normal range, and there are no extreme values.

Table 3. Descriptive statistics of the variables.

	Variable	Obs	Mean	Std	Min	Max
Explained variable	Ln(*NUrb*)	300	−1.048	0.301	−2.063	−0.330
Explanatory variable	Ln(*Dige*)	300	−1.423	0.545	−3.364	−0.084
Mediating variable	Ln(*Ind*)	300	10.700	0.874	8.223	12.540
Control variable	Ln(*Fin*)	300	1.123	0.309	0.424	2.096
	Ln(*Open*)	300	−1.790	0.952	−4.875	0.437
	Ln(*Hum*)	300	2.216	0.092	2.011	2.548
	Ln(*Gov*)	300	9.380	0.422	8.410	10.440
	Ln(*Con*)	300	8.844	0.944	6.030	10.670
	Ln(*Price*)	300	8.829	0.483	8.086	10.540

In addition, to represent the correlation more visually between the digital economy and the quality of new-type urbanization development, we plotted a linear fit between the digital economy and the quality of new-type urbanization development (Figure 2). This shows an obvious positive correlation between the digital economy and the quality of new-type urbanization development, but does not fully reflect the real effect of the digital economy on the quality of new-type urbanization development. In other words, this only provides a preliminary judgment for hypothesis 1, which needs to rely on the following empirical tests if objective and valid conclusions are to be obtained.

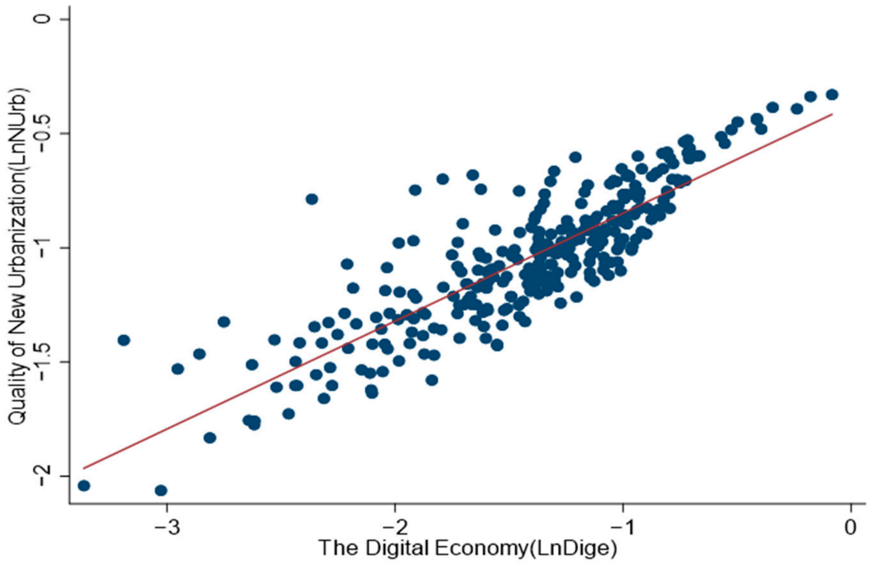

Figure 2. The correlation between the digital economy and quality of new-type urbanization development.

4. Empirical Test on the Impact of the Digital Economy on the Quality of New-Type Urbanization Development

4.1. Analysis of Basic Estimation Results

Before the benchmark regression, this paper first uses the Panel Granger Causality Test to test the causality between economic variables. The results are shown in Table 4. From the test results, changes in Ln*Dige* will cause changes in Ln*NUrb*, while changes in Ln*NUrb* will not cause changes in Ln*Dige*. This shows that the development of the digital economy can affect the development of new-type urbanization, while the development of new-type urbanization will not affect the development of the digital economy.

Table 4. Panel Granger Causality Test results.

Null Hypothesis	HPJ Wald Test	*p*-Value	Results
Ln*Dige* does not Granger-cause Ln*NUrb*	44.886	0.000	Rejection
Ln*NUrb* does not Granger-cause Ln*Dige*	1.517	0.468	Acceptance

Table 5 reports the results of the benchmark regression of the digital economy affecting the quality of new-type urbanization development under the panel two-way fixed effects model. In columns (1) and (2) of Table 5, the estimated coefficients of the core explanatory variable for the digital economic development level are significantly positive. This shows that the digital economy has a significant positive impact on the quality of new-type urbanization development, which supports hypothesis H1 in this paper. This result is also consistent with previous studies [29,40], indicating that the digital economy supported by information technology has played an important role in the modernization of urban governance, scientific urban construction, and convenient urban public services.

Table 5. Estimates of the impact of the digital economy on the quality of new-type urbanization development.

Variables	Ln(*NUrb*)	Ln(*NUrb*)	Ln(*Ind*)	Ln(*NUrb*)
	(1)	(2)	(3)	(4)
Ln(*Dige*)	0.329 *** (0.032)	0.221 *** (0.029)	0.096 *** (0.021)	0.198 *** (0.029)
Ln(*Ind*)				0.234 *** (0.084)
Ln(*Fin*)		0.134 *** (0.044)	−0.743 *** (0.033)	0.307 *** (0.076)
Ln(*Open*)		−0.039 ** (0.015)	−0.001 (0.011)	−0.038 ** (0.015)
Ln(*Hum*)		0.162 (0.217)	−0.192 (0.161)	0.207 (0.215)
Ln(*Gov*)		0.241 *** (0.055)	0.342 *** (0.041)	0.161 *** (0.061)
Ln(*Con*)		0.304 *** (0.035)	0.334 *** (0.026)	0.226 *** (0.044)
Ln(*Price*)		−0.100 * (0.051)	0.049 (0.038)	−0.111 ** (0.050)
constant	−0.628 *** (0.076)	−5.279 *** (0.837)	5.351 *** (0.619)	−6.530 *** (0.939)
Time	Y	Y	Y	Y
Province	Y	Y	Y	Y
Obs	300	300	300	300
R^2	0.905	0.937	0.979	0.939

Note: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

From the results of the control variables, there is a significant positive correlation between the level of financial development (*Fin*) and the quality of new-type urbanization development in each region. It shows that the improvement of the level of financial development can provide strong financial support for urban infrastructure construction, public service supply, urban industrial development, and structural adjustment, which is consistent with the findings of Xiong & Xu (2015) [17]. The coefficient of the level of external openness (*Open*) is significantly negative, indicating that foreign capital investment is not conducive to promoting the quality of urban development in the region, probably because the trade structure dominated by the processing trade will hinder the upgrading of the industrial structures and the transformation of the economic development mode, which is not conducive to a low-carbon and green sustainable development model. The level of human capital (*Hum*) variable is positive, but insignificant, indicating that the quality of the current workforce cannot meet the needs of high-quality urban development. The estimated coefficients of the government support level (*Gov*) and the residents' consumption level (*Con*) are both significantly positive, which indicates that the further increase of the government support level and the residents' consumption level has a positive contribution to the quality of new-type urbanization development, among which, the promotion effect of the government support level is expressed in the government's investment in urban public services such as education, science and technology, social security, and employment; the promotion effect of the residents' consumption level is expressed in the employment of labor caused by the demand of urban residents for accommodation, catering, and the development of the trade and circulation industry. However, for the level of housing price (*Price*), there is a significant negative relationship with the quality of new-type urbanization development, which implies that the rise in housing prices inhibits the inflow of the urban population, thus hindering the development of new-type urbanization.

4.2. Analysis of the Transmission Channels

The previous paper theoretically analyzed the transmission mechanism of the impact of the digital economy on the quality of new-type urbanization development from the perspective of the industrial structure upgrading. In order to test the hypothesis of the transmission mechanism, the mediating effect model is selected for empirical testing in this paper, and the regression results are shown in Table 5. Specifically, on the basis of column (2) confirming that the digital economy has a positive impact on the quality of new-type urbanization development, column (3) verifies whether the digital economy is conducive to the upgrading of industrial structures. The results show that the regression coefficient of the digital economy is significantly positive at the level of 1%; that is, the development of the digital economy can promote the upgrading of industrial structures. Finally, when the mediating variable of industrial structure upgrading is put back into the regression equation of the impact of the digital economy on the quality of new-type urbanization development, the value of the regression coefficient of the core explanatory variable and the characteristics of significant changes can be observed. It is notable that the impact coefficient of the digital economy on the quality of new-type urbanization development in column (4) of Table 5 has decreased compared with column (2), but it is still significantly positive. This shows that the upgrading of industrial structures is the transmission mechanism of the digital economy to improve the quality of new-type urbanization development; therefore, the research hypothesis H2 has been proved.

4.3. Analysis of Spatial Spillover Effects

A spatial correlation between the digital economy and the quality of new-type urbanization development should be verified before conducting the spatial econometric analysis. This paper verifies the spatial autocorrelation of the main variables for each year under the neighborhood weight matrix (*W*1) and economic geography weight matrix (*W*2) using Moran's I index. As shown in Table 6, the Moran's I index for the level of digital economy development and the quality of new-type urbanization development from 2011 to 2020 were both significantly positive, indicating that the digital economy and the quality of new-type urbanization development in each region of China all have significant positive spatial autocorrelation, i.e., the phenomenon of spatial agglomeration. Furthermore, in order to determine the specific form of estimation of the spatial econometric model, this paper follows the test idea of Elhorst (2014) and conducts the Hausman test, LM test, and SDM model simplification test (LR test, Wald test) in turn [69], and finally chooses the spatial Durbin model (SDM) controlling for spatio–temporal dual fixed effects, as shown in Table 7.

Table 6. Moran's I of the digital economy and the quality of new-type urbanization development from 2011 to 2020.

Year	**Ln(*Dige*)**		**Ln(*NUrb*)**	
	***W*1**	***W*2**	***W*1**	***W*2**
2011	0.215 ** (2.103)	0.260 *** (2.734)	0.482 *** (4.227)	0.429 *** (4.174)
2012	0.238 ** (2.318)	0.309 *** (3.226)	0.480 *** (4.193)	0.440 *** (4.262)
2013	0.166 * (1.714)	0.257 *** (2.755)	0.459 *** (4.021)	0.436 *** (4.221)
2014	0.204 ** (2.057)	0.258 *** (2.776)	0.430 *** (3.788)	0.461 *** (4.449)

Table 6. *Cont.*

Year	Ln(*Dige*)		Ln(*NUrb*)	
	***W*1**	***W*2**	***W*1**	***W*2**
2015	0.197 ** (2.013)	0.271 *** (2.922)	0.430 *** (3.794)	0.452 *** (4.378)
2016	0.230 ** (2.247)	0.294 *** (3.079)	0.420 *** (3.721)	0.460 *** (4.464)
2017	0.278 *** (2.650)	0.312 *** (3.236)	0.428 *** (3.788)	0.448 *** (4.352)
2018	0.300 *** (2.877)	0.326 *** (3.413)	0.431 *** (3.819)	0.440 *** (4.291)
2019	0.279 *** (2.732)	0.318 *** (3.375)	0.427 *** (3.800)	0.438 *** (4.289)
2020	0.243 ** (2.468)	0.307 ** (3.337)	0.466 *** (4.129)	0.445 *** (4.356)

Note: z-statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Test results related to selection.

Inspection	Null Hypothesis	*W*1		*W*2	
		Significance	**Result**	**Significance**	**Result**
LM test	SEM model	23.838 ***	SDM model	5.404 **	SDM model
	SEM model(steady)	1.136		6.638 **	
	SAR model	48.721 ***		28.930 ***	
	SAR model(steady)	26.018 ***		30.164 ***	
Hausman test	Random effect	41.71 ***	Fixed effect	45.06 ***	Fixed effect
	Individual fixation is better than both fixation	34.36 ***	Both	42.36 ***	Both
	Time fixation is better than both fixation	442.55 ***		409.98 ***	
Wald test	SEM model is better than SDM model	37.93 ***	SDM model	40.19 ***	SDM model
	SAR model is better than SDM model	28.08 ***	SDM model	27.21 ***	SDM model
LR test	SEM model is better than SDM model	36.98 ***	SDM model	38.20 ***	SDM model
	SAR model is better than SDM model	26.70 ***	SDM model	26.85 ***	SDM model

Note: ** $p < 0.05$, *** $p < 0.01$.

Table 8 reports the regression results for the spatial Durbin model (SDM), and to compare the robustness of the estimates, the spatial lag model (SAR) with spatio–temporal dual fixed effects were also listed in this paper as a control. In columns (1) and (2), the spatial autoregressive coefficient ρ was significantly positive, and the coefficients of the spatial interaction terms between the digital economy with the neighborhood and economic geography matrices were positive and passed the 1% confidence level. This indicates that there is not only an exogenous digital economy interaction effect in the sample provinces spatially, but also an endogenous interaction effect of new-type urbanization development quality improvement. In addition, the direct spillover and the total effects of the impact of the digital economy on the quality of new-type urbanization development were positive at the 1% significance level whether the neighborhood weight matrix or the economic geography weight matrix were used. This indicates that not only the development of the digital economy in this province will promote the high-quality development of towns in this province, but also the development of the digital economy in other provinces adjacent to this province can promote the quality of new-type urbanization development in this province, i.e., there is a spatial spillover effect of the development of the digital economy. Thus, research hypothesis H3 is tested.

Table 8. Regression results of the spatial model of the digital economy's impact on the quality of new-type urbanization development.

Model Setting	**SDM**		**SAR**	
Variables	***W*1**	***W*2**	***W*1**	***W*2**
	(1)	**(2)**	**(3)**	**(4)**
ρ	0.330 *** (0.073)	0.307 *** (0.088)	0.410 *** (0.053)	0.403 *** (0.073)
Ln(*Dige*)	0.180 *** (0.025)	0.144 *** (0.027)	0.170 *** (0.025)	0.167 *** (0.027)
$W \times$ Ln(*Dige*)	0.137 *** (0.049)	0.288 *** (0.075)		
Direct	0.197 *** (0.025)	0.169 *** (0.027)	0.178 *** (0.025)	0.174 *** (0.027)
Indirect	0.270 *** (0.056)	0.455 *** (0.099)	0.107 *** (0.022)	0.103 *** (0.026)
Total	0.467 *** (0.068)	0.624 *** (0.104)	0.285 *** (0.041)	0.277 *** (0.043)
Controls	Y	Y	Y	Y
Year	Y	Y	Y	Y
Province	Y	Y	Y	Y
Log-L	520.8702	508.0727	507.0195	494.6464
Obs	300	300	300	300
R^2	0.910	0.903	0.914	0.914

Note: Standard errors in parentheses; *** $p < 0.01$.

4.4. Further Expansion: Regional Heterogeneity

Firstly, the heterogeneity analysis of the eastern provinces and the central and western provinces is considered. In fact, due to the different resource endowments and development stages, there are apparent heterogeneous characteristics in the regional distribution, whether considering the level of the digital economy development or the quality of new-type urbanization development. Therefore, this paper divides the 30 sample provinces into two parts: eastern (11 provinces) and central-western (19 provinces), and the results are shown in columns (1) and (2) of Table 9. These results show that the impact of the digital economy on the quality of new-type urbanization development is not significant in the eastern region, while it has a significant contribution in the central and western regions. This may be because the digital economy infrastructure environments in the eastern region are relatively perfect and have already benefited from digital construction, so the marginal benefits of the digital economy to promote the quality of new-type urbanization development are relatively small. Relatively speaking, the foundation of digital development in the central and western regions is not as good as in the eastern regions, but it can benefit from the relevant national macro-control policies and rich local resources, thus, it has a good latecomer advantage. At the same time, along with the accelerated construction of the digital economy in the central and western regions, the dividends released have effectively promoted the quality of urban development in the region, which provides the possibility for the central and western regions to cross the digital divide, cultivate new digital dynamics, and achieve sustainable urban development.

Table 9. Regional heterogeneity tests for the impact of the digital economy on the quality of new-type urbanization development.

Varibles	Eastern Regions	Midwest Regions	Pilot Regions	Non-Pilot Regions
	(1)	(2)	(3)	(4)
Ln(*Dige*)	0.045 (0.034)	0.101 ** (0.040)	0.425 *** (0.060)	0.198 *** (0.031)
Controls	Y	Y	Y	Y
constant	−2.151 ** (0.850)	−7.544 *** (1.187)	−5.900 *** (1.565)	−3.555 *** (1.092)
Time	Y	Y	Y	Y
Province	Y	Y	Y	Y
Obs	110	190	90	210
R^2	0.953	0.962	0.955	0.948

Note: Standard errors in parentheses; ** $p < 0.05$, *** $p < 0.01$.

Secondly, the heterogeneity analysis of pilot provinces and non-pilot provinces in the big data comprehensive pilot area, is considered. Examining the impact of the digital economy on the quality of new-type urbanization development in pilot and non-pilot provinces is of practical significance for assessing the value of piloting a comprehensive pilot area of big data in China and improving the quality of new-type urbanization development in the region. In 2015–2016, in order to promote the development of the digital economy, Tianjin, Hebei, Henan, Inner Mongolia, Liaoning, Shanghai, Guangdong, Chongqing, and Guizhou in China were successively approved by the State Council to be established as cross-regional Big Data Comprehensive Pilot Zones. In view of this, this paper divides the sample data into two sub-sample systems of pilot provinces (Tianjin, Hebei, Henan, Inner Mongolia, Liaoning, Shanghai, Guangdong, Chongqing, and Guizhou) and non-pilot provinces (the remaining 21 provinces across the country) in the Big Data Comprehensive Pilot Zones, and uses a two-way fixed-effects panel model to conduct separate econometric tests (see columns (3) and (4) of Table 9). It is noted that the impact of the digital economy on the quality of new-type urbanization development is significantly positive in both pilot and non-pilot provinces, and the coefficient is much higher in pilot provinces than in non-pilot provinces. This indicates that the digital industry in the pilot provinces has an outstanding ability to serve the development of new-type urbanization in the region, and the country has taken these provinces as demonstration areas for the development of the digital economy, which can provide better "reform samples" for the development of the digital economy in non-pilot provinces.

5. Robustness Tests

In order to ensure the accuracy and reliability of the above research results, this paper conducted robustness tests from four aspects, according to the following process.

First, adjust the sample size. This takes into consideration that the four municipalities directly under the central government of Beijing, Shanghai, Tianjin, and Chongqing have higher administrative levels and their political and economic resources are richer, resulting in a much higher level of digital economy development than the other provinces. In order to ensure the robustness of the results, the above four unique regional samples are excluded here to study the effect of the digital economy on the quality of new-type urbanization development. As shown in column (1) of Table 10, the regression process is repeated after excluding the sample of special regions, and the results show that neither the significance nor the direction of the sign of the coefficient of the digital economic development level has changed substantially, which is consistent with the above.

Table 10. Model robustness test.

Variables	Adjustment of Sample Size	Substitution of Core Explanatory Variables	Adding Control Variables	Replace Tool Variables	
	(1)	(2)	(3)	First Stage (4)	Second Stage (5)
Ln(*Dige*)	0.226 *** (0.033)	0.118 *** (0.012)	0.247 *** (0.028)		0.284 *** (0.047)
IV				0.570 *** (0.039)	
Controls	Y	Y	Y	Y	Y
Ln(*Er*)			0.021 (0.016)		
Ln(*Estr*)			0.033 ** (0.015)		
Ln(*Effi*)			0.133 ** (0.047)		
Constant	−5.587 *** (0.994)	−5.225 *** (0.781)	−4.037 *** (0.852)	0.402 *** (1.119)	−4.036 *** (0.746)
Time	Y	Y	Y	Y	Y
Province	Y	Y	Y	Y	Y
Obs	260	300	300	270	270
R^2	0.945	0.945	0.943	0.989	0.976
Kleibergen-Paaprk LM statistic				24.543 [0.000]	
Kleibergen-Paaprk Wald F statistic				218.78 {16.38}	

Note: ** $p < 0.05$, *** $p < 0.01$; Standard errors in parentheses; *p*-values for statistical tests are in medium brackets; critical values for the Stock–Yogo weak instrumental variable test at the 10% level are in curly brackets.

Second, replace the core explanatory variables. Different approaches have also been adopted in the existing studies regarding the construction of an indicator system for the digital economy development level. Here, the comprehensive index of the digital economy development level is reconstructed based on principal component analysis to test the impact of the digital economy on the quality of new-type urbanization development. The results are shown in column (2) of Table 10. Among them, the coefficient of the impact of the digital economy on the quality of new-type urbanization development was 0.118, which passed the significance test at the 1% level. This suggests that the empowering effect of the digital economy on the high-quality development of towns and cities has not changed fundamentally, proving the findings of the previous study.

Third, add control variables. This mitigates the impact of missing variables on the research and improves the robustness of the estimation results. Based on the original control variables, this paper adds environmental factor variables such as energy efficiency (*EFFI*), energy consumption structure (*ESTR*), and environmental regulation intensity (*ER*). The specific estimation results are shown in column (3) of Table 10. The results show that the regression coefficient of the digital economy development level is consistent with the benchmark regression model in significance and sign direction after adding the control variables of the environmental factors.

Fourth, replace the tool variables. The regions with a higher quality of new-type urbanization development may be more advanced in technological innovation and new-type infrastructure construction, and thus, have higher levels of digital economy development, leading to the problem of endogeneity in which the explanatory variables are mutually causal with the explanatory variables. Therefore, in order to overcome the potential endogeneity problem, this paper selects one period lag of the core explanatory variables as the instrumental variable (IV) and re-estimates them using a two-stage least squares (2SLS), as shown in columns (3) and (4) of Table 10. After replacing the instrumental variable, the coefficient of the effect of the digital economy on quality of new-type urbanization development was 0.284, and it passes the significance test at the 1% level. This suggests that the results of this paper remain robust after considering the endogeneity of the core variables, i.e., digital economy development is conducive to improving the quality of new-type urbanization development. In addition, correlation tests for the instrumental variables showed that the Kleibergen–Paap rk Wald F statistic was greater than the critical value (at the 10% level) of the Stock–Yogo weak instrumental variable test, indicating that there was no weak instrumental variable identification problem. The p-value of the LM statistic for Kleibergen–Paap rk was 0.000, indicating that there was no under-identification of the instrumental variables. Overall, the above tests illustrate the reasonable selection of instrumental variables in this paper.

6. Conclusions and Policy Implications

6.1. Main Conclusions

The unprecedented rate of urbanization requires smarter ways to manage the accompanying challenges in urban areas [70]. The digital economy gives us an opportunity to solve tangled and wicked problems inherited in the rapid urbanization. In this regard, this paper theoretically analyzes the intrinsic mechanism of the digital economy affecting the quality of new-type urbanization development, and constructs a data-available index of the digital economy and new-type urbanization. In the empirical study, the panel data of 30 provinces in China from 2011 to 2020 were used as the research sample, and the panel fixed-effects model, mediated-effects model, and spatial econometric model were used to explore the impact of the digital economy on the quality of new-type urbanization development in terms of the direct effect mechanism, indirect effect mechanism, and spatial spillover effect. The results show the following. (1) The digital economy could significantly improve the quality of China's new-type urbanization development. Furthermore, by conducting robustness tests such as replacing the core explanatory variables, changing the sample size, increasing control variables, and introducing tool variables, the above findings still hold. (2) In addition to the direct effect, the digital economy can also indirectly influence the quality of new-type urbanization development by promoting industrial structure upgrading. (3) The digital economy not only has a positive effect on the quality of new-type urbanization development in the region, but also has a spatial spillover effect on the quality of new-type urbanization development in neighboring regions. (4) There was heterogeneity in the impact of the digital economy on the quality of new-type urbanization development, which is more significant and positive in the central and western regions and the comprehensive experimental region of big data.

6.2. Policy Implications

In response to the above findings and combined with the theoretical analysis, this paper proposes the following policy implications:

1. Increase the construction of digital infrastructure and improve the development of a digital economy. The digital economy has a positive effect on the quality of new-type urbanization development, while there is also still much room for improvement in the development level of China's digital economy at this stage. First, in the process of digital economy development in the future, we should further increase the construction of new-type infrastructures such as the 5G network, data centers, industrial Internet, and the Internet of Things, and strengthen the investment in R&D of basic digital technology and short-board technology, and continuously enrich, expand and innovate the scenario application of digital technology. Second, the

new-type infrastructure is different from the old infrastructure in that most of it is a product of business operations. Therefore, the new-type infrastructure, except for projects such as 5G base stations and public big data centers, should allow the decisive role of the market in resource allocation to be fully developed. For example, different market players are encouraged to use market mechanisms to cooperate in order to broaden the sources of funding for new-type infrastructure investments. Finally, the guidance and support function of the government in the process of digital economy development should be effectively utilized. The relationship between the government and the market should be clarified for the construction of new-type infrastructures, as it has an important role in promoting the construction of new-type infrastructures involving public information. Therefore, formulating corresponding policies for digital economy development and guiding social capital to invest in core aspects and key areas of the digital economy infrastructure is the next step for the government's efforts.

2. Vigorously promote digital industrialization and industrial digitization, and promote industrial structure upgrading. The industrial structure upgrading not only plays an important "intermediary effect" in the process of the digital economy promoting the development of new-type urbanization, but also provides powerful dynamic energy for the development of new-type urbanization by itself. Therefore, the advantages of digital technology should be used to strengthen digital industrialization and industrial digitization. Specifically, on the one hand, we should grow digital information and related industries, build digital economy industry chains and clusters, vigorously develop a technology-based digital economy, and fully release the huge potential of data as an important market element. On the other hand, we should strengthen the digital transformation of traditional industries, enhance the digitalization and intelligence level of advantageous industries, deepen the integration of digital technology in industrial vertical segments, and guide enterprises to actively expand the application space of digital technology to stimulate new market demand with richer application scenarios, so as to lay the foundation of consumption for industrial structure upgrading.
3. Continuously promote integrated regional development and bridge the digital development divide. Digital economy development has spatial spillover effects; the radiation effect of areas with better digital economy development on neighboring areas should be developed fully to promote regional integrated development. To this end, local governments should abandon the idea of local departmentalism, smooth the flow of digital elements between regions, expand the spatial radius of the digital economy dividend overflow, and let more market players and urban residents enjoy the dividends of digital development. At the same time, attention should be paid to international cooperation and more outstanding digital enterprises should be guided to go out and contribute Chinese wisdom to the development of the global digital economy and the construction of the governance system. Accordingly, Chinese enterprises can also fully learn from advanced foreign technology and management concepts.
4. Develop a dynamic and differentiated digital economy development strategy. Due to the differences in resource endowment and economic development levels among regions in China, the digital development gap between the central and western regions and the eastern regions is still relatively prominent. Thus, there is a need to develop digital economy development strategies tailored to local conditions in order to bridge the digital economy development gap between regions. Specifically, the eastern region should give full advantage to its good digital economies of scale, focus on building a modern digital industry ecosystem, promote digital industrialization and industrial digitization as a grip, and better promote the demonstration effect and radiation effect on the surrounding areas. The central and western regions should accelerate the construction of information infrastructure, continuously expand the

coverage of the digital economy, develop relevant talent policies, and enhance the digital talent resource pool. In addition, the development of big data pilot work should continue to be promoted to strengthen the digital economy to enhance the quality of new-type urbanization development. At present, the demonstration area of the big data comprehensive pilot area has formed a replicable and promotable reform experience, providing a useful reference and strong support for the development of China's overall digital economy. Therefore, the provinces that have been set up as pilot zones need to continue to maintain the development direction of the big data strategy, step up the construction and improvement of the relevant laws and regulations, and represent a good "model area" to take the lead. The provinces not established as pilot zones need to combine their actual conditions, including the level of economic development, the ability to gather resources, the differences in the institutional environments, and the deployment of big data strategic planning.

6.3. Research Deficiencies and Prospects

It should be noted that the study in this paper also has some limitations. First, it is limited by the availability of data. This paper only uses a panel dataset of 30 Chinese provinces from 2011 to 2020 for the empirical study, and future studies can be considered to use prefectural and municipal level or micro-enterprise data to obtain more specific conclusions. Second, there is a lack of unified standards for measuring the development quality of new-type urbanization. Although 16 subdivision indicators are selected to measure the development quality of new-type urbanization in each province, due to the broad definition of new-type urbanization and the difficulty of measuring some indicators, it is difficult to comprehensively consider the influencing factors of new-type urbanization in the research process. Therefore, how to accurately measure the development quality of new-type urbanization is still a future issue that needs to be addressed. Finally, this paper only verifies the impact of the digital economy on the development quality of new-type urbanization from the path of promoting industrial structure upgrading, and the examination and identification of other impact paths still need to be continued in subsequent research.

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