Digital Technology and the Quality of Economic Growth: Based on Mediating Effects Model & Threshold Effects Model

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Abstract—In the context of the rapid development of digital economy, how to fully release the dividend of digital economy to promote the high-quality development of China, is an important issue of The Times.In this regard, this paper selects the provincial panel data from 2010 to 2018 in China, and uses the panel data model to conduct a multidimensional econometric analysis of the direct effect and transmission mechanism of digital economy affecting high-quality development in China.The results show that the digital economy significantly promotes the high-quality development of China and has the characteristics of increasing marginal change. But by region, the effect was significantly positive in the east and positive but not significant in the Midwest.Further research shows that consumption upgrading is an important transmission mechanism of digital economy affecting high-quality development. This paper provides important policy enlightenment for the high quality development of China.

Key words—digital economy; Consumption upgrading; High quality development; Mediating effect; Threshold regression

1 INTRODUCTION AND LITERATURE REVIEW

Since the reform and opening up, China's economy has made great achievements and achieved rapid GDP growth, but at the same time, it has also paid a heavy price, such as environmental pollution, uneven regional development, lack of economic growth momentum and so on. Therefore, taking the path of high-quality economic development under the new normal is a major strategic decision and deployment made by the Party and the government, and is the key to China's sustainable development.At the same time, in the context of the new round of scientific and technological revolution represented by 5G communication technology, digital economy, as the most active factor in China's economic development, is constantly integrated with various social and economic fields to promote consumption, investment and industrial upgrading. In 2016, the scale of China's digital economy was 22.4 trillion yuan, and in 2019, it

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reached 35.8 trillion yuan, accounting for 36.2% of GDP. In terms of comparable standards, the nominal growth was 15.6% year on year, far higher than THE GDP growth rate.As China government leader has pointed out, we should fully implement the new development philosophy, foster new growth drivers through informatization, and promote new development with new growth drivers.Then, as an even more important factor of production comparable to capital, labor and land, how does the digital economy affect the high-quality development of China's economy?What are the characteristics of heterogeneity in space?Furthermore, against the background of China's current emphasis on "internal circulation", can the digital economy promote consumption upgrading and thus boost high-quality economic development?The answers to these questions can further enrich relevant studies on digital economy and high-quality development, and provide constructive inspiration for relevant policy making.

As for how to promote high-quality economic development, scholars have conducted rich theoretical discussions and empirical tests from the perspectives of environmental regulation, innovation-driven development, haze control, development and agglomeration of producer services, and fiscal expenditure.For example, Yao-bin liu(2020) systemly investigate the mechanism of action of environmental regulation on economic growth quality, based on HDI partition and to the Chinese provincial panel data as the research object, found that environmental regulation on the quality of the regional economic development exists heterogeneity, high human development index areas have a positive influence, the low human development index region, on the other hand[1]. Bai Junhong et al. (2016) used China's provincial panel data to investigate the impact of innovation drive on the quality of regional economic growth, and found that the impact of innovation on the quality of economic growth has a significant regional heterogeneity, with a significant promoting effect in the eastern region and a significant negative effect in the western region[2]. Chen Shiyi et al. (2018) used labor productivity to measure the quality of economic development, systematically analyzed the internal mechanism of haze pollution affecting the quality of economic development, and found that haze pollution affects the quality of economic growth through urbanization and human capital, while environmental governance is conducive to improving the quality of economic growth[3]. Li Ping et al. (2017) found that a higher level of technological progress in producer services and a stronger ability to gather capital and labor factors can improve the overall total factor productivity of the macro economy, thus promoting the sustainable and high-quality growth of China's economy and becoming a new driving force for high-quality growth of China's economy under the new normal[4]. Zhan Xinyu (2016) empirically analyzed the impact of fiscal expenditure structure on the quality of economic growth, and found that productive, service and consumption expenditures had different effects on the quality of economic growth in different dimensions[5]. But these studies ignore an important factor in the digital economy.

There are few studies on the digital economy and its high-quality development. Zhang Hong et al. (2019) discussed how the digital economy can promote three reforms to realize the path of high-quality economic development from six aspects, including digital foundation, talent, technology, security, industry and format[6]. Zhao Tao et al. (2020) analyzed the influence effect and mechanism of digital economy boosting the high-quality development of urban economy, and found that entrepreneurial activity is an important mechanism variable.The data of prefecture-level cities and micro-enterprises are used for empirical research[7]. Ding Zhifan (2020) established the micro-meso-macro analysis framework and comprehensively and deeply analyzed the internal mechanism of digital economy boosting the high-quality economic

development[8]. Most of these studies are theoretical analysis, lack of empirical research and more in-depth channel or mechanism analysis.

And in the digital economy to promote consumption upgrading, and consumption upgrading to promote economic growth, the relevant research is relatively rich.Chen Xiaoxia (2020), based on the urban panel data from 2011 to 2018 in China, empirically tested and confirmed that digital inclusive finance can promote consumption upgrading, and the underlying mechanism is the income mechanism, and the effect is more significant in less developed regions and regions with high level of digital inclusive finance[9]. Zhang Lei (2020) used the provincial panel data from 2013 to 2019 to test the mechanism of action between the popularization of the Internet and consumption upgrading, and found that the Internet promoted the consumption upgrading in China[10]. Xue Junmin et al. (2019) used the "Five Concepts" to construct the panel data of provinces and empirically analyzed the boosting effect and dialectical relationship of consumption upgrading on high-quality development[11]. Ding Jiao (2016) pointed out that the consumption structure of residents is unbalanced at the regional level, thus showing obvious heterogeneity to economic growth [12]. But these studies fail to integrate digital economy, consumption upgrading and high-quality development into a unified analytical framework.

Through reviewing the literature, it is found that there is a lack of relevant research, especially empirical research, on how the digital economy promotes high-quality development.In this article, we will in the empirical research digital economy booster quality and economic development, on the basis of the digital economy, the upgrading of consumption and high quality development into a complete analysis framework, explore the consumption upgrade this important role and mechanism of intervening variable, and carry on the analysis of the heterogeneity, for China's abundant empirical evidence for the development of high quality.

2 RESEARCH DESIGN

2.1 Model setting

In order to investigate the impact of digital economy on the quality of economic development, the following regression model is constructed in this paper:

$$highq_{i,t} = \alpha + \beta \times digit_{i,t} + \sum_{k=1}^{K} \left(\gamma \times x^{k}{}_{i,t} \right) + u_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

In Formula (1), *highq* represents the quality of economic development, *digit* represents the digital economy, *x* represents a set of control variables, including industrial structure, foreign direct investment, innovation capacity, environmental regulation, urbanization level and government intervention. α is constant, β and γ are coefficient of each variable, respectively, *i* is on behalf of the province, *t* is on behalf of the year, respectively, and u,$\lambda$and ε are individual effect, time effect and random disturbance.

In order to test the possible action mechanism of consumption upgrading in promoting high-quality economic development in digital economy, the following regression model is further constructed:

$$cons_{i,t} = \alpha + \beta_1 \times digit_{i,t} + \sum_{k=1}^{K}\left(\gamma \times x_{i,t}^{k}\right) + u_i + \lambda_t + \varepsilon_{i,t} \quad (2)$$

$$highq_{i,t} = \alpha + \eta_1 \times digit_{i,t} + \eta_2 \times cons_{it} + \sum_{k=1}^{K}\left(\gamma \times x^{k}{}_{i,t}\right) + u_i + \lambda_t + \varepsilon_{i,t} \quad (3)$$

In Equations (2) and (3), $cons$is consumption upgrade.The specific test process is as follows: on the basis of the significance test of the coefficient β of regression model (1), the existence of the mediation effect can be judged by the significance of the regression coefficient β_1,$\eta_1$and η_2. If β_1,$\eta_1$and η_2 are both significant, then consumption upgrade is an important intermediate transmission mechanism.

2.2 Variable selection

2.2.1 Explained variable: Quality of economic development ($highq$)

Compared with measuring the quality of economic development as the efficiency of economic growth with a single index, currently more scholars use the multi-index comprehensive evaluation system to measure the quality of economic development in a more comprehensive way.By referring to the practices of most scholars and considering the comparability and stability of digital economy in the quality of economic development, this paper calculates the quality index of economic development by using entropy weight method from a multidimensional evaluation system consisting of five secondary indicators, namely, economic benefit, technological innovation, industrial structure, ecological environment and residents' life.

2.2.2 Core explanatory variables: digital economy level ($digit$)

With digital infrastructure, digital business scale, digital devices and digital pratt &whitney four financial indicators to measure regional level of digital economy, the digital infrastructure with Internet penetration characterization, digital operations to express delivery business, digital equipment application is represented by the mobile phone penetration is measured, for pratt & Whitney financial index, comes from digital financial research center of Peking University.Through principal component analysis, the dimensionality reduction of the data of the above four indexes after standardization is processed to obtain the development level index of digital economy.

2.2.3 Consumption structure ($cons$)

It is represented by the proportion of the total expenditure of transportation and communication, education, culture, entertainment and medical care in the consumption expenditure.

2.2.4 Control variables

According to related research, in order to avoid the bias of omitted variables, this paper also selected a set of control variables, specifically as follows: industrial structure (ind). Characterized by the ratio of tertiary industry output value to GDP; foreign direct investment (fdi). Expressed in terms of the actual use of foreign direct investment as a percentage of GDP; technological innovation (inn). Use the logarithm of the number of patent applications granted in each region to characterize; environmental regulations (er). This article measures the intensity of environmental regulation based on the logarithm of the total investment in regional industrial pollution control. Urbanization level (urb). Measured by the proportion of urban population in total population. Government revenue (gr). The macro-control of the local government on the market also plays an important role in the quality of economic development. This article uses the logarithm of local public fiscal revenue to measure.

2.3 Data sources and descriptive statistics

Considering the availability and completeness of the data, this paper selects the provincial panel data of 30 provinces and autonomous regions from 2010 to 2018, except Xizang, Hong Kong, Macao and Taiwan, as samples from the historical China Statistical Yearbook, China Environmental Statistical Yearbook and The Research Center for Digital Economy of Peking University. In order to reduce the possible heteroscedasisness and better interpret the results, the logarithm of the absolute number of variables was taken with the proportion remaining unchanged. Descriptive statistics of related variables are shown in Table 1.

Table 1 Descriptive statistics of each variable

Variables	***Obs.***	***Mean***	***SD***	***Min***	***Max***
highq	270	1.03	0.23	0.54	1.79
digit	270	5.22	2.41	0.58	15.07
cons	270	0.586	0.053	0.708	0.432
ind	270	0.46	0.08	0.19	0.59
fdi	270	0.02	0.02	0.00	0.08
inn	270	4.19	0.65	2.42	5.52
er	270	22.44	21.09	0.40	141.60
urban	270	0.45	0.10	0.25	0.70
gr	270	0.23	0.11	0.08	0.63

3 ANALYSIS OF EMPIRICAL RESULTS

3.1 Baseline regression results

Table 2 reports the regression results of the panel model of digital economy promoting high-quality economic development, using the bidirectional fixed estimation method. Model (1) only adds the core explanatory variables to the digital economy, while model (2) adds all the control

variables. It can be seen from the estimation results of model (1) and model (2) that the digital economy has a significant promoting effect on high-quality development, and has a strong robustness. In addition, from the regression coefficient of control variables, the influence of industrial structure is positive but not significant, indicating that China's extensive economic structure has not been fundamentally changed. Foreign direct investment is significantly negative, indicating that China's opening to the outside world has not only gained the spillover effect of capital and technology, but also paid a large price, such as the aggravation of environmental pollution, widening income gap and other practical problems. The positive effect of technological innovation is obvious, which means that innovation and entrepreneurship and high-quality development complement each other. Environmental regulation, urbanization and government intervention also have a significant positive impact on high-quality development. Therefore, strengthening environmental regulation, accelerating urbanization and giving full play to the macro-control role of the government are also necessary to promote high-quality development.

Table 2 Shows the baseline regression results of digital economy promoting high-quality economic development

variable	**highq**	
	(1)	***(2)***
$digit$	0.0853 * * * (8.35)	0.0721 * * * (3.38)
ind		0.00150 (0.60)
fdi		1.400 * * * (4.02)
inn		0.206 * * * (3.99)
er		0.00118 * * * (2.97)
urb		0.123 * * (2.36)
gr		0.224 * * * (3.21)
Province fixed	YES	YES
Year fixed	YES	YES
Constant term	0.607 * * * (11.39)	0.0869 (0.46)
N	270	270

Note: *, **, and *** respectively represent significance levels of 10%, 5%, and 1%. T values are in brackets, as shown in the table below.

3.2 Heterogeneity test

Considering the large difference in resource endowment and economic development level among different regions in China, the country is divided into the eastern region and the central and western regions for sample regression, and the relevant results are shown in Table 3. As can be seen from model (1) and model (2), the impact of digital economy on high-quality development is significantly positive in the eastern region, while positive but not significant in

the central and western regions.The reason behind this may be that there is a digital divide between different regions in China. The eastern region has a high level of digitization and can well integrate with traditional industries and all aspects of social life. Such integration makes the digital economy play a good role in the high-quality development of renting. On the other hand, in the central and western regions, the development of digital economy is still not high enough, slow and integrated with the economy and society, so its impact on high-quality development is not significant.

Table 3 Regional heterogeneity test of digital economy promoting high-quality development

variable	**The eastern region**	**The Midwest**
	(1)	***(2)***
digit	0.0825***	0.319
	(6.85)	(1.36)
Control variables	YES	YES
Province fixed	YES	YES
Year fixed	YES	YES
Constant term	0.624 * * *	0.496
	(6.85)	(6.28)
N	90	180

3.3 Mediation effect analysis

In order to verify the transmission mechanism of consumption upgrading in the digital economy affecting high-quality development, this paper uses the mediating effect model for empirical test, and the regression results are shown in Table 4. On the basis of model (1), which verifies that digital economy has a direct positive impact on high-quality development, model (2) empirically tests that digital economy can simultaneously promote consumption upgrading. Finally, in the model (3), which contains two explanatory variables of digital economy and consumption upgrade, the influence coefficient of digital economy on high-quality development is lower than that of model (1), which proves that consumption upgrade is the intermediate transmission mechanism for digital economy to promote high-quality development. The reason behind this may be that, on the one hand, the extensive application of digital economy enables consumers to better connect online and offline in their personalized pursuit and expands the depth and breadth of consumer services, which is conducive to consumption upgrading. On the other hand, consumption upgrading can promote economic growth by promoting consumption demand, promote modern service industry to realize benign interaction of high-quality economic development, and boost high-quality development by relying on supply-side reform and technological innovation.

Table 4 Test of mediating effect of digital economy in promoting high-quality economic development

variable	**highq**	**cons**	**highq**
	(1)	***(2)***	***(3)***
digit	0.0721***	0.718 * * *	0.052 * * *
	(8.35)	(4.36)	(3.38)
cons			0.0343 * * *
			(2.97)

Control variables	YES	YES	YES
Province fixed	YES	YES	YES
Year fixed	YES	YES	YES
Constant term	0.529 * * * (7.89)		0.07985 (0.52)
N	270	270	270

3.4 Threshold effect analysis

Considering the incremental economic network effect of digital economy, this paper will further verify the incremental "marginal effect" by using the threshold effect model. Firstly, the existence of threshold effect was tested based on Hansen's (1999) method. After repeated sampling with bootstrap for 500 times, it was found that the digital economy passed the significance test of a single threshold, while consumption upgrade passed the double threshold test. Then, the threshold model regression was carried out, and the results were shown in Table (5). It can be seen from model (1) that the role of digital economy in promoting high-quality development is continuously enhanced, and there is also an increasing marginal effect. To be specific, when the digital economy crosses a single threshold value and consumption upgrading crosses two thresholds respectively, the influence coefficient of the digital economy on high-quality development keeps increasing. It can be seen that the influence of the digital economy on high-quality development has a marginal increasing effect.

Table 5 Threshold effect test of digital economy and consumption upgrade

variable		**Threshold variable**	
		(1) highq	***(2) cons***
The threshold value	q1	9.683	0.516
	q2		0.658
$digit \cdot I(Th \leq q_1)$		0.0682*** (6.38)	0.638 * * * (4.76)
$digit \cdot I(q_1 \leq Th \leq q_2)$		0.0746 * * * (4.296)	0.705 * * * (2.96)
$digit \cdot I(Th \geq q_2)$			0.747 * * * (3.56)
Control variables		YES	YES
N		270	270

4 CONCLUSIONS AND COUNTERMEASURES

On April 1, 2020, China government pointed out that "seize industry digitalization, digital opportunity given by the industrialization, speed up the 5 g network, data center, the new infrastructure, grasping the layout and digital economy, life and health, new materials, and other strategic emerging industries, the future industry, vigorously promote scientific and technological innovation, strive to expand new growth point, form the development of new

kinetic energy".This paper uses provincial panel data from 2010 to 2018 in China, and uses fixed effect model, intermediary effect model and threshold effect model to verify the typical fact and response mechanism of digital economy boosting China's high-quality development from multiple perspectives. The main conclusions are as follows: First, from a national perspective, the digital economy promotes the high-quality development of China's economy and has a marginal incremental network impact effect. However, by region, the impact of digital economy on high-quality development is significantly positive in the eastern region, while the impact coefficient is positive but not significant in the central and western regions. Secondly, digital economy can promote high-quality development by influencing consumption upgrading, so consumption upgrading based on digital economy has important practical significance.

The conclusions of this paper have the following policy implications: First of all, the construction of digital China should be strengthened, the development and application of 5G commercial use and big data and artificial intelligence should be vigorously accelerated, and the dividends of China's digital economy should be consolidated by increasing investment in information technology fields such as the Internet. Second, more efforts should be made to build and invest in the digital economy in the central and western regions, so as to give full play to the dividends of the digital economy and promote and accelerate the high-quality economic and social development in the underdeveloped regions. Third, through the development of digital economy, we should fully accelerate consumption upgrading, unleash consumption potential, and promote China's internal economic cycle and high-quality economic development under the new situation.

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