Digital technology, platform economy and manufacturing structure upgrading

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Abstract. Digital technology effectively drives the change of manufacturing production technology and business model, and becomes a key driver of manufacturing structural upgrading. Based on the provincial panel data of China from 2013 to 2020, the impact of digital technology on the upgrading of manufacturing structure and the mediating role of the platform economy are empirically analyzed using fixed-effect and mediating-effect models. The results show that digital technology has a positive impact on the rationalization and advanced manufacturing structure, but there is regional heterogeneity in its effect, showing that the upgrading of manufacturing structure is the fastest in the eastern region, followed by the central and western regions, and the slowest in the northeast region; further research finds that the platform economy has a mediating effect only in the stage of advanced manufacturing structure promoted by the technology, indicating that the economy, relying on digital technology, is more compatible with the higher ,The further study finds that the economy has a mediating effect only in the stage of advanced manufacturing structure driven by the technology.

Keywords: Digital Technology; Structural Upgrading of Manufacturing; Structural Rationalization; Structural Advanced; Platform Economy

1 Introduction

After decades of industrialization and rapid economic development, China's manufacturing industry is now in a steady growth stage and has been ranked as the world's top manufacturing country for many years. However, from the perspective of the global value chain, the overall level of China's manufacturing industry is still in the middle and low-end position[1], and there is still a gap between the digital foundation of intelligent manufacturing, core components and high-end software products and developed countries. As early as in the "Made in China 2025" action program, China has proposed to accelerate the deep integration of information technology and industrialization, intelligent manufacturing as the main direction of manufacturing development, focus on cracking the technology, process, material problems, and further promote the restructuring of the manufacturing industry, the "14th Five-Year Plan" again stressed the need

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to develop advanced, and applicable technologies Promote the optimization and upgrading of the whole industrial chain, create high-end and intelligent traditional industries, and accelerate the deep integration of digital economy and real economy. Thus, digital technology, as a core technology tool in the period of high-quality economic development, has the advantages of cultivating new factors, improving production efficiency and innovating digital products.[2] provides new momentum for the transformation and upgrading of the manufacturing industry. Therefore, based on the above background, and taking into account the long-term reality of uneven regional economic development in China, it is important to conduct an in-depth study on whether digital technology can sustainably promote the structural upgrading of the manufacturing industry, what its intrinsic influence mechanism is, and whether there is heterogeneous influence in each region.

2 Relevant Theoretical Foundations

2.1 Digital technology and manufacturing structure upgrading

Digital technology can be traced back to Solow's "productivity paradox"[3], which states that IT inputs are not significantly associated with productive efficiency. However, subsequently, a large body of literature has demonstrated the differential impact of IT on economic structure and regional comparative advantage at the national, provincial and enterprise levels, thus confirming the contribution of IT to productivity improvement[4,5]. At present, digital technology, as the core product of the new round of technological revolution, microscopically adjusts the structure of production factors, optimizes resource allocation and enhances enterprise competitiveness; macroscopically accelerates information flow, reduces transaction costs and innovates business models, and has become an important engine for developing knowledge, information and technology-intensive industrial structures. The upgrading of the manufacturing industry structure is a process of transforming the manufacturing industry structure from a low-level to a high-level form, manifested in the transformation of traditional manufacturing to high-quality and high value-added, as well as the emergence and development of high-tech manufacturing. From initially prioritizing the construction of heavy industry to adjusting the market factor structure to increase the proportion of light industry, to now using digital infrastructure to drive the flexible and intelligent development of the manufacturing industry, It can be seen that the upgrading of the manufacturing industry structure has gone through two stages: structural rationalization and upgrading. [6]. Among them, rationalization focuses on rational allocation of production factors and improvement of economic efficiency of manufacturing industry under the conditions of low level of consumption, resources and science and technology; advanced reflects the shift of industrial structure center of gravity to high technology industry, with high efficiency and high value-added as significant features, which is an advanced stage of industrialization development. Rationalization of the manufacturing industry is the precondition and foundation of advancedization, and advancedization is the inevitable result of dynamic and coordinated development of rationalized structure, and the biggest

difference between the two lies in the gap of technology level. As a result, this paper puts forward the following hypotheses.

Hypothesis 1a, Digital technology can significantly contribute to the rationalization of manufacturing structures.

Hypothesis 1b, Digital technology can significantly contribute to the advanced structure of manufacturing.

2.2 The intermediary effect of platform economy

In addition to the direct impact of digital technology on the upgrading of manufacturing structure, it can also have indirect impact through other paths. It has been shown in the literature that the platform economy, supported by digital technology, highly relies on data acquisition and processing capabilities, flows at high speed through Internet channels, reduces intermediate links, matches more transaction parties and forms bilateral markets[7]. Based on the above network and scale effect, the platform economy has been growing and is gradually becoming the main industry in the digital economy era, which shows that digital technology is conducive to the formation of a platform economy ecosystem. In the background of industrial digitization, the platform economy accelerates the integration with traditional industries, and also becomes a new driving force of manufacturing structure adjustment with the advantages of high efficiency and low cost. The existing literature on platform economy and manufacturing structure upgrading is less, and its research results focus on platform economy boosting the transformation and upgrading of the manufacturing industry from manufacturing process, resource allocation, business model, industrial chain, etc., and forming a manufacturing industry that meets The direction of personalized and intelligent development of the industry with consumer demand as the core[8,9], which undoubtedly proves the positive influence of platform economy on the structural upgrading of the industry from the theoretical mechanism. Therefore, this paper puts forward the following hypothesis.

Hypothesis 2, Digital technology can indirectly promote the upgrading of manufacturing structure by facilitating the development of the platform economy.

3 Model and Data

3.1 Model building

According to hypothesis 1, this paper develops the following model to measure the direct relationship between digital technology and structural upgrading of the industry.

$$ln(msu_{it}) = \alpha_0 + \alpha_1 ln(dtl_{it}) + \alpha_2 \sum_{q=1}^{5} control_{it} + \lambda_{it} + \varepsilon_{it} \quad (1)$$

Where msu_{it} indicates the province i in t the level of structural upgrading of manufacturing in the time period; dtl_{it} denotes the core explanatory variable of the model, i.e., the level of digital technology; $control_{it}$ is the control variable of the model; λ_{it} is the province or point-in-time fixed effect; ε_{it} is the random disturbance term. Meanwhile, in order to narrow the absolute differences between data and reduce

the possibility of covariance and heteroskedasticity, the msu_{it} and dtl_{it} are smoothed and log-transformed.

In order to further study the intrinsic mechanism of digital technology affecting the structural upgrading of the industry, this paper, according to hypothesis 2, refers to the research method of Zhonglin Wen[10], introduces the platform economy into the model for mediating effect analysis and constructs the following equation.

$$ln(m_{it}) = \beta_0 + \beta_1\, ln(dtl_{it}) + \beta_2 \sum_{q=1}^{5} control_{it} + \lambda_{it} + \varepsilon_{it} \quad (2)$$

$$ln(msu_{it}) = \gamma_0 + \gamma_1 ln(dtl_{it}) + \gamma_2 ln(m_{it}) + \gamma_3 \sum_{q=1}^{5} control_{it} + \lambda_{it} + \varepsilon_{it} \quad (3)$$

Where m_{it} indicates the province i in t the level of economic development of the platform in the time period.

If the coefficient of model (1) α_1 is significantly positive, it proves that the level of digital technology directly affects the upgrading of manufacturing structure. Hypothesis 1 is valid, and the test of mediating effect can be continued; if the coefficient of model (2) β_1 If the coefficient of model (2) is significantly positive, it means that the technology has a significant effect on the mediating variable platform economy; further test the coefficient of model (3) γ_1 and γ_2 if γ_1 is positive and significant, the γ_2 and the coefficient of model (2) β_1 At least one of them is not significant, then proceed to Bootstrap method to test $\beta_1 \times \gamma_2$ whether they are significantly different from 0. If $\beta_1 \times \gamma_2$ is significantly different from 0, then compared $\beta_1 \times \gamma_2$ with γ_1 the sign difference of the same sign, there is a partial mediating effect and hypothesis 2 holds; if different sign, there is a masking effect and hypothesis 2 does not hold. In the mediating effect model, the α_1 is the total effect of digital technology on the structural upgrading of manufacturing, and β_1 is the effect of the technology on the platform economy, and γ_2 is the effect of the economy on the upgrading after controlling for the effect of the core explanatory variable digital technology γ_1 is the direct effect of the technology on the upgrading of manufacturing structure after controlling for the effect of the mediating variable platform economy, and $\beta_1 \times \gamma_2$ is the indirect effect of the technology on the structural upgrading of the manufacturing industry through the mediating variable.

3.2 Selection of indicators

1) Explanatory variable: the level of manufacturing structure upgrading. The upgrading of manufacturing structure includes two dimensions of industrial structure optimization and value addition, which is the transformation of industrial structure from low-level to high-level form. This paper draws on the research results of Gan Chunhui et al. (2011)[11] to measure the upgrading level of manufacturing structure from two dimensions of rationalization and advanced manufacturing structure, so as to reflect the upgrading process of the structure more comprehensively and objectively.

Rationalization of manufacturing industry structure. The rationalization of manufacturing structure reflects the rational allocation and coordinated integration of production factors, supply and demand quantity and structure of each industry within the industry. Therefore, this paper selects the Thiel index to measure the gap of the gross

product of each segment of manufacturing industry, and the calculation method is shown as follows[12].

$$mir = \sum_{i=1}^{n} \left(\frac{y_i}{y}\right) \ln \left(\frac{y_i/l_i}{y/l}\right) \quad (4)$$

Where mir denotes the Thiel index, and$y$ is the total manufacturing output, and l is the number of people employed in the manufacturing industry, and i is the manufacturing industry segment, and n is the total number of manufacturing industry segments. Since Thiel's index represents the difference in output value, the smaller the Thiel's index is, the smaller the difference between manufacturing segments, and vice versa, the larger the difference.

Advanced manufacturing structure. Advanced manufacturing structure means that the advantageous proportion of industrial structure is gradually transferred from medium and low-technology level to high-technology level, and it is based on the rationalization of the structure to continuously improve the economic efficiency of the manufacturing industry. Therefore, this paper divides the manufacturing industry into two parts: high-tech industry and low- and medium-tech industry, and measures the advanced level of manufacturing industry by the ratio of business income of the high-tech industry to business income of the low- and the industry, and selects pharmaceutical manufacturing, electronic and communication equipment manufacturing, computer and office equipment manufacturing, medical instrumentation and apparatus manufacturing, and railroad, ship, aerospace and other transportation equipment manufacturing as the five industries to measure the high-tech industries, and the medium and low-tech industries from the Classification and Coding of National Economic Industries (GB/T 4754-2017).

2) Core explanatory variable: the level of digital technology. Digital technology, represented by information technology such as IoT and ICT, connects upstream and downstream industries and users in clusters, and controls the whole process of enterprise production and operation through data and information mining, analysis and optimization, so as to achieve the goal of improving quality and increasing efficiency and value of manufacturing industry[13]. Therefore, this paper constructs an index system from five levels: Internet of Things, ICT technology, data collection and flow, data and information mining and analysis, and digital security, and calculates the level of digital technology using the entropy weight method, as shown in Table 1.

Table 1. Digital technology level index system

Tier 1 Indicators	Secondary indicators	Tertiary indicators
Digital Technology Level	Internet of Things	Number of domain names (million)
	ICT Technology	Total telecom business (billion yuan)
		Internet broadband access ports (billion yuan)
	Data Acquisition and Flow	Software product revenue (billion yuan)

	Data information mining and analysis	Annual revenue of information technology services (billion yuan)
	Digital Security	Embedded system software revenue (billion yuan)

3) Mediating variable: the level of platform economy development. The platform economy is a new industry developed with the improvement of digital technology level, which is conducive to promoting manufacturing production efficiency and resource integration. In this paper, referring to the findings of Ji Yuanyuan et al.[14], with the Internet infrastructure construction as the carrier, a large number of products and services are provided through the scale of platform transactions, and considering the huge financial investment and transportation guarantee in the process of platform economy development, the level of the development is measured at three levels of goods and services provided by e-commerce, financial support and logistics guarantee, respectively, as shown in Table 2.

Table 2. Platform economic development level index system

Tier 1 Indicators	Secondary indicators	Tertiary indicators
Platform economic development level	Goods and services provided by electronic commerce	Number of e-commerce platform enterprises (a)
		E-commerce sales (billion yuan)
		E-commerce procurement volume (billion yuan)
	Financial Support	Digital Inclusive Finance Index
	Logistics Guarantee	Number of parcels (million)

4) Control variables. In order to minimize the bias of measurement results due to omitted variables, the following variables are selected for control: Foreign trade dependence (dft), measured by the ratio of import and export trade to regional GDP; foreign investment level (lfi), measured by the ratio of foreign direct investment to regional GDP; human capital level (tcl), measured by the number of population and the number of years of education per capita; government support (gs), measured by the product of internal expenditure on R&D funds and regional GDP; innovation investment (tin), measured by the product of internal expenditure on R&D funds and regional GDP. (tcl), measured by the product of population and years of education per capita; government support (gs), measured by the ratio of local general budget expenditure to regional GDP; and innovation investment (tin), measured by the ratio of internal expenditure on R&D to regional GDP.

3.3 Source of data

Limited by data availability, this paper selects panel data of 30 provinces in China (excluding Tibet and Hong Kong, Macao and Taiwan) from 2013 to 2020 to empirically investigate the effect and inherent mechanism of the impact of digital technology on

the transformation and upgrading of manufacturing industry. The digital inclusive finance index of the platform economic development level is obtained from the "Peking University Digital Inclusive Finance Index (2011-2020)" released by the Digital Finance Research Center of Peking University, and other data are obtained from the China Statistical Yearbook, the China High Technology Industry Statistical Yearbook and the China Electronic Information Industry The descriptive statistics of each variable are shown in Table 3.

Table 3. Descriptive statistics of variables

Variables	Indicator Meaning	Average value	Standard deviation	Minimum value	Maximum value
lnmir	Rationalization of manufacturing structure	-1.9512	0.7502	-4.6052	-0.0305
lnmih	Advanced manufacturing structure	-2.2662	0.8935	-5.6557	-0.5164
lndtl	Digital technology development level	6.4560	1.0630	3.5519	9.0201
lnm	Platform economic development level	6.8190	1.1144	3.8576	9.4533
dft	Foreign trade dependence	0.2527	0.2684	0.0077	1.3480
lfi	Foreign investment level	0.0215	0.0242	0.0001	0.1706
tcl	Human Capital Level	0.0901	0.0626	0.0176	0.4121
gs	Government Support	0.2546	0.1034	0.1190	0.6430
tin	Innovation input	0.0107	0.0057	0.0017	0.0230

4 Empirical Analysis

4.1 Basic regression results

Based on the above research design, this paper first tests the direct impact of digital technology on manufacturing transformation and upgrading, and finally selects a fixed-effects model based on the Hausman test results, while all estimation results control for provincial factors. The regression results are shown in Table 4.

Table 4. Basic regression results of digital technology on structural upgrading of manufacturing

Variables	Rationalization		Advanced	
	(1)	(2)	(3)	(4)
lndtl	0.1514***	0.1781***	0.2390***	0.2288***
	(3.26)	(3.28)	(9.92)	(8.26)
dft		0.5104		0.4101
		(0.93)		(1.47)

lfi		-4.2805 (-1.54)		1.4039 (0.99)
tcl		1.3458 (0.98)		-2.1090** (-3.02)
gs		1.1694 (0.85)		-1.6286** (-2.33)
tin		-11.3561 (-0.45)		12.5058 (0.98)
_cons	-2.8178*** (-7.36)	-3.9512 (-4.69)	-2.6166*** (-13.18)	-1.9922 (-4.64)
N	240	240	240	240
R^2	0.6977	0.7064	0.9428	0.9462
Provincial fixed effects	Yes	Yes	Yes	Yes

*Note, ***, **, * denote significant at 1%, 5%, and 10% levels, respectively, and the t-values in parentheses are the same below.*

Column (1) in Table 4 is the result of the direct effect of digital technology level on the rationalization of manufacturing structure, and the regression coefficient is 0.1514, which is significantly positive at the 1% level, indicating that digital technology effectively promotes the rationalization of the structure. Column (2) reflects that the effect of digital technology on the rationalization of manufacturing structure is still significantly positive after the inclusion of control variables, which verifies that hypothesis 1a holds. Columns (3) and (4) are the results of the direct effect of digital technology level on the advanced manufacturing structure with and without control variables, and the regression coefficients are 0.2390 and 0.2288 respectively, both of which are significantly positive at the 1% level, indicating that digital technology is conducive to improving the advanced manufacturing structure, which verifies the validity of hypothesis 1b. Combining the data in each column of Table 4, it can be found that the promotion effect of digital technology on the advancedization of the industry is greater than the rationalization of the manufacturing industry, reflecting the long-term nature of the technology influencing the upgrading of manufacturing structure, which is more suitable for higher-level manufacturing production methods, business models and product forms, which may be related to the higher requirements of the technology on high-tech environment such as platform-based infrastructure construction and digital governance capability.

4.2 Regional heterogeneity analysis

Considering the differences in economic development rate, resource endowment and geographical location among regions in China, the impact of digital technology on the upgrading of manufacturing structure in each region may vary. This paper further divides 30 provinces into eastern, northeastern, central and western regions based on the documents related to the regional division of China's economy, and again tests the direct effect of digital technology on the upgrading of manufacturing structure, and the regression results are shown in Tables 5 and 6.

Table 5. Regional heterogeneity analysis of rationalization of manufacturing structure

Variables	East	Northeast	West	Middle
lndtl	-0.0283	0.5741*	0.2224**	0.2357
	(-0.35)	(1.85)	(2.11)	(1.38)
dft	0.4790	11.2301***	-0.4212	-7.5416
	(1.09)	(4.05)	(-0.16)	(-1.34)
lfi	1.8090	3.5296	-6.0474	8.8160
	(0.83)	(0.48)	(-0.28)	(0.30)
tcl	-1.1644	-2.4046	5.3810	3.8808
	(-0.77)	(-0.83)	(1.62)	(1.01)
gs	-5.4657**	0.1283	4.4543	-3.0187
	(-2.42)	(0.04)	(1.51)	(-0.57)
tin	-27.2017	-227.4482**	101.7147	-20.2105
	(-1.20)	(-3.26)	(1.21)	(-0.25)
_cons	-0.0594	-5.9350**	-6.4217***	-2.4485
	(-0.06)	(-2.92)	(-5.07)	(-1.54)
N	80	24	88	48
R^2	-0.9142	0.5513	0.9605	0.7817
Provincial fixed effects	Yes	Yes	Yes	Yes

According to Table 5, it can be seen that there are differences in the influence of digital technology on the rationalization of manufacturing structure in different economic regions. Among them, the level of digital technology in the eastern region has begun to inhibit the development of rationalization of manufacturing structure, and the regression coefficient is not significant; although the digital technology in the central region has promoted the rationalization of the structure, the effect is not significant; the improvement of the level of the technology in the northeast and west regions fully promotes the rationalization of the structure, and the role of the technology is more obvious in the northeast region. The reason for the above regional differences may be that the economic level in the eastern and central regions is more developed and the level of digital technology is developing rapidly, while rationalization, as the primary stage of upgrading the manufacturing structure, is different from the actual situation that the manufacturing industry in the developed regions has evolved to the advanced direction, so the direct effect of the technology on the rationalization of the manufacturing industry in the eastern and central regions does not have a positive significant effect, especially in the economic and In contrast, the economic development level of northeast and western regions is more backward, and the transformation of traditional old industrial bases in northeast and the undertaking of manufacturing transfer from east and central regions by western provinces need the empowerment of the technology, so the technology has a significant effect on the rationalization of manufacturing in the Northeast and West has a positive incentive effect.

Table 6. Regional heterogeneity analysis of manufacturing advanced

Variables	East	Northeast	West	Middle
lndtl	0.1190*	-0.1184	0.3030***	0.2139***

	(1.99)	(-0.58)	(6.35)	(3.87)
dft	0.2839	0.9404	-2.3363*	-3.8706**
	(0.87)	(0.52)	(-1.98)	(-2.12)
lfi	1.9811	1.3663	10.5719	-3.2875
	(1.22)	(0.28)	(1.10)	(-2.05)
tcl	-0.8521	-3.2017	-1.7349	-2.5523**
	(-0.75)	(-1.68)	(-1.15)	(-2.05)
gs	-0.0734	-0.9993	0.8602	-2.1061
	(-0.04)	(-0.53)	(0.64)	(-1.22)
tin	6.9636	-15.1034	23.8552	0.1446
	(0.41)	(-0.33)	(0.63)	(0.01)
_cons	-1.7993**	-1.1967	-5.3066***	-2.1183***
	(-2.58)	(-0.89)	(-9.27)	(-4.11)
N	80	24	88	48
R^2	0.9142	0.5513	0.9605	0.7817
Provincial fixed effects	Yes	Yes	Yes	Yes

Table 6 shows the regression results of the effect of digital technology on the advancedization of manufacturing in each region. Except for the northeast region, digital technology has a positive and significant effect on the advanced manufacturing industry in the other three regions, but the regression coefficients are different. Specifically, the effect of digital technology is the largest in the western region, the second largest in the central region, and the smallest in the eastern region, mainly because the technology is continuously adjusting the industrial structure of each region. On the one hand, the eastern region has been the pioneer region of economic development by virtue of its resource environment and policy support, and its manufacturing industry gradually enters the late stage of industrialization development, and the economic growth rate becomes more and more steady and slow, so the effect of digital technology on manufacturing On the other hand, with the construction of "One Belt and One Road" and the Yangtze River Economic Belt gradually forming a new development pattern, the advanced manufacturing industry in the central and western regions is developing rapidly, and the tilting of economic policies to the central and northwestern regions also brings more dividends, so the effect of digital technology on the advanced structure of manufacturing industry in the central and western regions is most prominent. Therefore, digital technology has the most prominent role in promoting the advanced manufacturing structure in the central and western regions. In the northeast region, the regression coefficient of digital technology on the advancedization of manufacturing structure is negative and not significant, implying that although the development of the northeast region has rebounded to some extent and large-scale technological changes have been carried out in various manufacturing industries, the manufacturing structure of the northeast region has still not reached the advancedization stage due to the constraints of relatively lagging transformation and upgrading of manufacturing industry and insufficient investment in human capital and innovation, which in turn leads to the heterogeneous influence of digital technology and the heterogeneous impact of advanced.

Comprehensive Table 5 and Table 6 can find that the upgrading of manufacturing structure in the northeast region is still in the rationalization stage, and the manufacturing industry in the central and western regions is evolving from the rationalization stage

to the advanced stage, and according to the relevant regression coefficient, it can be seen that the evolution of the western region is slightly faster than that of the central region, while the manufacturing structure in the eastern region has reached the advanced stage, which is consistent with the current situation of regional imbalance in the national economic development, but with the This is consistent with the current situation of regional imbalance of national economic development, but with the continuous enhancement of coordination of economic development, the manufacturing structure of each region has shown a trend of equalization, and the development gap will be further reduced, so as to jointly promote the steady upgrading of national manufacturing structure.

4.3 Testing the mediating effect of platform economy

In order to test the intrinsic mechanism of digital technology influencing the structural upgrading of the manufacturing industry, this paper introduces the platform economic development level indicators based on the basic regression model, and the results are shown in Table 7.

Table 7. Analysis of the mediating effect of platform economy

Variables	(5) lnm	Rationalization (6) lnmir	Advanced (7) lnmih
lnm		-0.1537	0.0075
		(-1.13)	(0.11)
lndtl	0.4092***	0.2410***	0.2257***
	(14.61)	(3.1)	(5.68)
Control variables	Yes	Yes	Yes
Prob>F	0.0000	0.0000	0.0000
Bootstrap Mediated Effects Test		Not significant	Significant
R^2	0.9647	0.7082	0.9462
Provincial fixed effects	Yes	Yes	Yes

Column (5) in Table 7 shows that the coefficient of the effect of digital technology on the platform economy is 0.4092, which is positively significant at the 1% level, indicating that the technology facilitates the scale of supply and demand transactions between multiple parties driven by digital governance and network collaboration, forming a new economic relationship based on platform support, thus promoting the rapid development of the economy. Column (6) represents the results of the mediating effect of the platform economy in the process of digital technology influencing the rationalization of manufacturing structure. According to the theoretical basis of the previous model, it is known that the regression coefficient of the technology is significantly positive, and the coefficient of platform economy is negative and insignificant, but the results of Bootstrap test indicate that the indirect effect of the economy is significant, and the direct effect is insignificant, and the indirect effect is different from the direct effect, which indicates that the platform economy has a masking effect on the

rationalization of manufacturing structure. Column (7) shows the results of the mediating effect of the platform economy on the influence of digital technology on the advanced manufacturing structure, in which the regression coefficient of digital technology is significantly positive at the 1% level, and the regression coefficient of the platform economy is positive but insignificant, and the direct and indirect effects of the platform economy are significant in the Bootstrap test, and the indirect effect is the same sign as the direct effect. The total effect of digital technology on the advance of manufacturing structure is 0.2288, the direct effect is 0.2257.The influence coefficient of digital technology has decreased, indicating that there is a partial intermediary effect of platform economy, and its indirect effect is 0.0031, implying that in the process of digital technology promoting the advanced of manufacturing structure, the indirect effect of platform economy as an intermediary variable accounts for 1.35%, specifically, for every change of digital technology 1%, the degree of positive influence on the upgrading of manufacturing structure through the direct effect is 22.57%, and the speed of platform economy development is promoted by 40.92% through the indirect effect, which in turn affects the level of advanced manufacturing structure by 0.31%.

The above results show that there is no mediating effect of digital technology on the rationalization of manufacturing structure and a partial mediating effect on the advancedization of manufacturing structure, i.e., digital technology can indirectly promote the upgrade of advanced manufacturing structures by improving the level of economic development of the platform, and hypothesis 2 is partially valid. The results of the intermediary effect test also fit the conclusion of the basic regression model that the promotion effect of digital technology on the advancedization of manufacturing structure is higher than that on the rationalization of manufacturing, which shows that digital technology, as the latest product of the technological revolution, is more inclined to technology-driven upgrading of manufacturing structure, and advancedization is the development process of the manufacturing structure rising from rationalization to a higher level, coalescing with a higher demand for emerging technologies, while the platform economy is based on The platform economy is based on digital technology and has the characteristics of cross-integration and value reshaping[8], so there is a basis for coordination among the three, thus forming a transmission mechanism of promoting the advanced manufacturing structure by digital technology with the platform economy as the intermediary.

4.4 Endogeneity and robustness tests

Considering that the technological demand for structural upgrading of the manufacturing industry may reverse the impact on the level of digital technology, in order to prevent endogeneity problems such as mutual causality and omitted variables in the regression model, this paper draws on the method of Huang Qunhui et al.[15] and selects the interaction term between the number of fixed-line telephones per 100 people in 1984 and the number of Internet broadband access subscribers in the previous year in each province as the instrumental variable of the level of digital technology. Meanwhile, in order to ensure the accuracy of the empirical results, considering the time lag effect of digital technology on the structural upgrading of the manufacturing industry,

this paper adopts two ways of robustness testing, replacing the explanatory variable with new product sales revenue and using one period lag of digital technology as the core explanatory variable, respectively, and the regression results are shown in Table 8.

Table 8. Endogeneity and stability tests

Variables	Rationalization		Advanced		Substitution of explanatory variables		
	Tool Variables	One period behind	Tool Variables	One period behind	lnmsu	lnm	lnmsu
lndtl	0.2055***		0.2591***		0.3207***	0.4092***	0.2492***
	(2.93)		(8.29)		(9.99)	(14.61)	(5.47)
l.lndtl		0.1990*** (2.90)		0.2166*** (6.36)			
lnm							0.1748** (2.20)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7060	0.6908	0.9459	0.9521	0.9764	0.9647	0.9769
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

From the results in Table 8, it can be seen that the impact of digital technology on rationalization and advanced manufacturing structure is always significantly positive, whether by introducing instrumental variables, lagging the core explanatory variables by one period, or replacing the explanatory variables, which is consistent with the basic regression results in Table 4; after replacing the explanatory variables and re-running the mediating effect test, it is found that the coefficients are positive, and the significance does not change significantly, indicating that the platform economy There is still a mediating effect in the process of digital technology promoting the upgrading of manufacturing structure, and the results of the original baseline regression model and the mediating effect model are robust.

5 Conclusions

Based on the panel data of 30 provinces in China from 2013 to 2020, this paper analyzes the influence role of digital technology on the structural upgrading of the manufacturing industry and its internal transmission mechanism by using fixed-effect and mediated-effect models, and the results show that: First, digital technology can effectively promote the upgrading of manufacturing structure, and the empowering effect of digital technology in the advanced stage of the manufacturing structure is higher than that in

the rationalization stage of structure, indicating that digital technology has a long-term and sustainable impact on the upgrading of manufacturing structure. Second, there is regional heterogeneity in the influence of digital technology on the upgrading of manufacturing structure, which is mainly due to the unbalanced economic development of various regions in China. In the stage of rationalization of manufacturing structure, digital technology significantly promotes the development of northeast and central and western regions and inhibits the development of eastern regions; in the stage of advanced manufacturing structure, digital technology favors the development of eastern and central and western regions and discourages the development of northeast regions. Third, the platform economy is an important intermediary mechanism for digital technology to promote the advanced manufacturing structure, but the intermediary effect on the rationalization of manufacturing structure is not significant. It can be seen that the platform economy, as a form of digital industrial organization, has a stronger role in promoting the advanced stage of the information- and technology-intensive manufacturing industry. Based on this, in the process of upgrading the manufacturing structure, we should focus on improving the construction of digital technology and platform economy infrastructure, expanding the depth and breadth of its application; increasing the digital cultivation in economically underdeveloped regions such as the northeast and west, giving full play to the conduction role of platform economy, gradually transferring some manufacturing industries in the east and central regions to the northeast and west regions, and improving the national economic disparity; at the same time, boosting the upgrading of the manufacturing structure by efficiently using domestic and foreign financial support and establishing incentive mechanisms for talent innovation.

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