

Research on the Impact of Digital Economy on Regional Innovation Capability

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Abstract: In this paper, an evaluation system of digital economy development level is constructed based on China's provincial panel data from 2011 to 2019, and ridge regression method is used to test whether digital economy development promotes innovative knowledge condensation and market transformation. The results show that the development of digital economy significantly promotes the knowledge condensation of innovation, but has no significant impact on the market transformation of innovation. Besides, the development of digital economy has significant heterogeneity in the innovation knowledge condensation and market transformation of the three regions. The suggestions are that precise measures should be taken in the three regions, labor and capital investment should be increased in basic and applied research and experimental development research.

Keywords: Regional innovation, Digital economy, Knowledge condensation, Market transformation, Ridge regression.

1. Introduction

Since reform and opening up, China's innovation level has been greatly improved. According to the 2021 Global Innovation Index Report released by the World Intellectual Property Organization (WIPO), China ranks 25th in innovation input and 7th in innovation output, showing a strong momentum of growth in its comprehensive innovation capacity. However, there are still problems such as "Valley of death" and "Darwin Sea". In order to achieve high-quality regional economic development, China should focus on commercializing and industrializing a large number of scientific and technological achievements in the direction of innovation-driven development.

At present, new generation of information technologies gradually have a close connection with social and economic fields. The development of digital economy undoubtedly provides a new channel for the transformation of China's scientific and technological achievements from samples to products to commodities. Based on this, this paper intends to use the research of Liu Shufeng et al(2019) to divide China's innovation process into two stages: knowledge condensation stage and market transformation stage.

2. Literature Review

Related to this paper is the role of digital economy on regional innovation. This kind of literature can be sorted out from both theoretical and empirical aspects. In terms of theory, Zhang Xinwei(2019) pointed out that under the condition of digital economy, the technological paradigm change will realize the evolution of innovation mode by promoting the transformation of industrial organization mode and accelerating the evolution of innovation organization mode. In terms of empirical analysis, Wen Jun et al.(2020) verified that digital economy can indeed improve regional innovation capability by analyzing data of 287 prefecture-level cities in China in 2015 and by means of ordinary least square method and robust standard error method. Hansen(2007) believed that the innovation process actually includes the generation, transformation and dissemination of innovation. Based on this, this paper intends to decompose the innovation process

and explore the impact of digital economy on the innovation process in detail.

3. Theoretical Analysis

3.1. Digital Economy and Knowledge Condensation Stage

First, the development of the digital economy has extended the breadth of innovation at the stage of knowledge condensation. The wide application of the new generation of information technology will alleviate the knowledge overlap among innovation subjects caused by poor communication, thus promoting the knowledge production and transfer of innovation subjects. Second, the development of digital economy deepens the innovation depth of knowledge condensation stage. Consumer demand for products is diversified, which forces each innovation subject to reduce the output of homogeneous innovation results in the knowledge condensation stage. Third, the development of digital economy can accelerate the speed of innovation and strengthen the precision of innovation. The development of digital economy can reduce the time to search for market demand, speed up the flow of innovation elements in the region, avoid the homogeneous output and ultimately improve the innovation output's quality at this stage.

3.2. Digital Economy and Market Transformation Stage

Shi Zhenquan(2020)believed that the main body of transformation of innovation results can form various information data including user data, transaction data, interactive communication data and task data through the business process of transformation of innovation results. Zhang Xinwei(2019) pointed out that the application of big data makes it possible to "accurately predict" consumer preferences. With new-generation information technologies, the problem of information asymmetry between innovation subjects and market demand is alleviated, and the precise matching between innovation achievements and market demand is also achieved, and the transfer and transformation accuracy of innovation achievements in the market transformation stage is finally improved.

4. Research Design

4.1. Cobb-douglas Production Function

The Cobb-Douglas production function is mainly used to measure the contribution rate of technological progress, capital and labor growth to output growth. Based on this, this paper constructs a model of the impact of digital economy development level on innovation from the dual perspectives of knowledge condensation and market transformation.

$$Y_i = A_{(t)} L_i^{\alpha_i} K_i^{\beta_i} \quad i = 1, 2 \quad (1)$$

$$K_{it} = E_{i(t-1)} + (1 - d) K_{i(t-1)} \quad (2)$$

Referring to the relevant research of Wu Yanbing(2008), it will be set in the following form:

$$A_{(t)} = A e^{f(DE, MAR, PGDP, IS, HR, URB, FTD) + \varepsilon} \quad (3)$$

$$f(DE, MAR, PGDP, IS, HR, URB, FTD) = \theta_1 LNDE + \theta_2 LNMAR + \theta_3 LNPGDP + \theta_4 LNIS + \theta_5 LNHHR + \theta_6 LNURB + \theta_7 LNFTD \quad (4)$$

$$LNY_i = D + \theta_1 LNDE + \theta_2 LNMAR + \theta_3 LNPGDP + \theta_4 LNIS + \theta_5 LNHHR + \theta_6 LNURB + \theta_7 LNFTD + \alpha_i LNL_i + \beta_i LNK_i + \varepsilon \quad i=1,2 \quad (5)$$

4.2. Data Sources and Descriptive Statistics

The paper selects panel data of 30 provinces, municipalities and autonomous regions in China (excluding Hong Kong, Macao, Taiwan and Tibet) from 2011 to 2019. Data from China Statistical Yearbook of Science and Technology, China Statistical Yearbook, Statistical Bulletin of national Economic and Social Development of each province, the Research Center of Digital Inclusive Finance of Peking University, the Report of China's Provincial Marketization Index. The descriptive statistics of each variable are shown in Table 1.

Table 1. Descriptive statistics of variables

Variable types	Variable symbol	Sample size	Mean	Standard deviation	The minimum	The maximum
Explained Variable	PN	270	10.006	1.429	6.219	13.176
	TC	270	13.828	1.761	8.642	17.858
Core Explanatory Variable	DE	270	-1.443	1.129	-4.605	0.010
	BC	270	14.284	1.181	11.456	17.184
	BL	270	9.705	0.931	7.315	11.958
	EC	270	15.838	1.349	12.523	18.380
	EL	270	10.847	1.285	7.729	13.479
Control Variables	MAR	270	1.854	0.317	0.864	2.408
	PGDP	270	10.757	0.442	9.691	12.011
	IS	270	0.167	0.380	-0.640	1.655
	HR	270	-2.074	0.400	-2.925	-0.683
	URB	270	4.046	0.202	3.556	4.495
	FTD	270	2.784	0.966	0.128	4.982

Table 2. Ridge regression results in knowledge condensation stage

	LNPN			
	All $k = 0.10$ (1)	East $k = 0.01$ (2)	Center $k = 0.19$ (3)	West $k = 0.01$ (4)
<i>LNDE</i>	0.142** (5.670)	0.092* (2.478)	0.121** (2.732)	0.053 (0.965)
<i>LNBL</i>	0.475** (14.529)	0.739** (6.576)	0.413** (4.115)	0.070 (0.508)
<i>LNBC</i>	0.281** (10.698)	0.131 (1.297)	0.032 (0.518)	0.615** (6.619)
Control	Yes	Yes	Yes	Yes
Constant	-8.328** (-7.702)	-0.952 (-0.317)	-4.320 (-1.403)	-5.221* (-2.137)
Obs	270	99	72	99
Adjusted R ²	0.897	0.942	0.682	0.921
F	261.954**	178.529**	17.914**	128.594**

Note: * P < 0.05 ** P < 0.01 are t values in parentheses.

5. Results Analysis

5.1. In Knowledge Condensation Stage

Ridge regression results of knowledge condensation stage are shown in Table 2. As can be seen from the ridge regression results of column (1), the development level of digital

economy has a significant positive impact on innovation in this stage, and the investment of basic and applied research capital and personnel also shows a significant positive impact. This indicates that the level of development of digital economy and the investment of personnel and capital in basic and applied research are conducive to the formation of

knowledge results. Columns (2) to (4) in Table 2 are the results of regional heterogeneity analysis. (This article refers to the standard of the National Bureau of Statistics to divide the eastern and western regions) The results show that regional heterogeneity exists and is prominent in the knowledge condensation stage.

5.2. In Market Transformation Stage

Ridge regression results in the market transformation stage are shown in Table 3. As can be seen from the ridge regression results in column (1), the development level of digital

economy has a positive but insignificant impact on innovation in this stage, which indicates that the development of digital economy currently mainly affects innovation output in the stage of knowledge condensation, and has no significant effect on the promotion of innovation in the stage of market transformation. As can be seen from the regression results of column (1), the input of R&D researchers and R&D capital has a significant positive impact on the commercialization and industrialization of innovation outputs. As can be seen from Columns (2) to (4), regional heterogeneity also exists and is prominent in the market transformation stage.

Table 3. Ridge regression results in market transformation stage

	<i>LNTC</i>			
	ALL $k = 0.46$ (1)	East $k = 0.01$ (2)	Center $k = 0.11$ (3)	West $k = 0.99$ (4)
<i>LNDE</i>	0.055 (1.532)	0.001 (0.036)	-0.146* (-2.453)	0.114* (2.231)
<i>LNEL</i>	0.328** (15.479)	0.192 (1.804)	-0.092 (-0.983)	0.365** (9.082)
<i>LNEC</i>	0.416** (19.074)	1.160** (13.222)	0.548** (4.884)	0.388** (9.573)
Control	Yes	Yes	Yes	Yes
Constant	0.142 (0.133)	-16.686** (-5.301)	-17.768** (-4.259)	2.924 (1.288)
Obs	270	99	72	99
Adjusted R ²	0.694	0.964	0.773	0.449
F	68.628**	289.105**	27.928**	9.889**

Note: * $P < 0.05$ ** $P < 0.01$ are t values in parentheses.

6. Conclusions and Suggestions

Based on the above theoretical and empirical analysis, the development of digital economy not only has different impacts on the knowledge condensation stage and the market transformation stage of China's innovation at the national level, but also has obvious regional heterogeneity. Based on the above conclusions, the paper puts forward the following policy suggestions: first, comprehensively promote the development of digital economy, promote digital inclusion, and bridge the regional difference in innovation capacity caused by the digital divide. Second, further increase labor and capital input in basic and applied research and experimental development research to ensure adequate intellectual support and capital supply in the knowledge condensation stage and market transformation stage of innovation.

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