The Influence of the Development of the E-Commerce Economy in the Digital Age on the Innovation of Regional Enterprises

Long Lin(✉), Jie Zhang, and Zengyu Wei

School of Management, Wuhan University of Technology, Wuhan, China
765166770@qq.com, 309459@whut.edu.cn

Abstract. In the context of the digital age and innovation-driven strategies, the rapid development of the e-commerce economy has had a significant impact on regional enterprise innovation. This paper collects the panel data of 30 provinces (municipalities and autonomous regions) in the country from 2013 to 2020 and uses the fixed effect model to test the e-commerce business from three aspects: Internet penetration rate, information transaction technology level, and enterprise information technology level using Stata software. The impact of economic development on regional enterprise innovation, and the possible location heterogeneity between eastern, central, and western regions of China was further studied. Finally, it was concluded that the development of the e-commerce economy in different regions had an impact on enterprise innovation. The degree of positive impact varies, and research implications are summarized from the corporate and government levels.

Keywords: E-commerce economy · Enterprise innovation · Fixed effect model · Stata software

1 Introduction

In the era of digital economy, the perfect combination of informatization and transportation convenience has created a group of emerging e-commerce enterprises with huge market potential. The operation mode shows the aggregation effect of "$1 + 1 > 2$", which effectively solves the short-board problem caused by factors such as distance. The rapid development of e-commerce enterprises and the promotion of operation models make the important role of informatization and transportation convenience in economic development and social progress increasingly apparent.

For enterprise innovation, the combination of informatization and transportation convenience has revolutionized the production methods of various industries, and it has profound practical significance to incorporate it into the regional enterprise R&D innovation influencing factor system. [11] At present, in terms of theoretical analysis, the research believes that the digital economy is conducive to strengthening the attention of innovation entities [14], integrating multi-faceted resources [2], and promote the high-quality development of the regional economy. In terms of empirical analysis, the research

Z. Zeng et al. (Eds.): ECIT 2022, AHE 11, pp. 449–458, 2023.
https://doi.org/10.2991/978-94-6463-005-3_44

believes that the digital economy can not only promote the improvement of regional innovation efficiency but also help to narrow the innovation differences between regions and promote the high-quality development of the regional economy [3].

The above research has an important reference function, but from the perspective of e-commerce economy, there is very little research on the impact of informatization and transportation convenience on regional innovation performance. Therefore, based on the panel data of 30 provinces (autonomous regions and municipalities) in China from 2013 to 2020, this paper examines the influence of the development status of e-commerce on the innovation capabilities of regional enterprises, and then reveals the linear relationship model between the two, to clarify the impact of the e-commerce economy. How development affects the innovation capabilities of regional enterprises, to provide reference and help for government departments to formulate digital economy development policies.

2 Theoretical Analysis and Research Assumptions

2.1 The Basic Influence of the Development of the E-Commerce Economy on the Innovation Ability of Regional Enterprises

This paper will start from the "research and development stage" and "results transformation stage" of regional enterprise innovation, based on the perspectives of information cost theory, innovation atmosphere, innovation diffusion theory, etc., to expound on the positive impact of e-commerce economic development in the digital age on the innovation ability of regional enterprises. Mechanism:

(1) Research and development stage

Information cost refers to the cost incurred by producers who need to classify and filter the information of different groups of people and different commodities after searching for possible innovative information. The regional innovation process is divided into the development period and the transformation period. The information cost of the former is borne by the innovation subject, and the latter is borne by the beneficiary group [5]. The development of the e-commerce economy enables enterprises to use big data and artificial intelligence to quickly classify and filter information, and use modern technology to efficiently summarize the identified information, thereby reducing the cost of information management and analysis.

(2) Achievement transformation stage

Under the e-commerce economy, the product innovation of enterprises takes producers as the main body, with producers, consumers, and other main bodies as network nodes to build a network, which is not limited by space distance and time, which greatly improves the speed of innovation diffusion. And through the agglomeration effect and diffusion effect of e-commerce, it has an impact on consumers, and it spreads using holiday promotions, new product trials, knowledge dissemination, etc., and enhances regional innovation capabilities [1].

Based on the above analysis, the following assumptions are put forward:

H_1: The development of the e-commerce economy has a positive impact on the innovation capabilities of regional enterprises.

2.2 Analysis of the Location Heterogeneity

Based on China's national conditions, due to the eastern region industrial foundation, technical ability, and industry development needs the guidance, therefore in the east electricity economy started earlier [7], experience is more, the regional capital and workforce allocation more reasonable, and the elements of the Midwest configuration developed degree is low, the release of electricity economic dividends not so good, It may lead to the difference in the influence degree of e-commerce economy on enterprises' innovation ability.

In addition, due to the differences in resource endowments and development stages in different regions, there are obvious heterogeneity characteristics in the regional distribution of both the development level of the e-commerce economy and the quality of economic development. [13] Therefore, the impact of the digital economy on the high-quality development of the urban economy may also be heterogeneous at the regional and urban levels, and it is necessary to conduct in-depth discussions on this.

Based on the above analysis, the following hypotheses are proposed:

H_2: The influence of the development of the e-commerce economy on the innovation ability of regional enterprises has location heterogeneity.

3 Study Design

3.1 Variable Definition and Measure

3.1.1 Explained Variable

The explained variable is the innovation level of regional enterprises. According to the previous analysis, the innovation process can be divided into "research and development stage" and "result transformation stage", so "regional innovation input" and "regional innovation output" are used as secondary indicators to measure the innovation level of regional enterprises.

Drawing on the research of Li Zheng et al. [4], the regional innovation investment is further subdivided into "regional innovation labor input" and "regional innovation capital investment", that is, the full-time equivalent of R&D personnel (rd_peopleno) and above-scale industrial enterprises in each province. Expenses of industrial enterprises to develop new products (newproduction_expense); regional innovation output is subdivided into "regional patent application output" and "regional new product sales output", that is, the number of patent applications (patent_no) and above-scale industrial enterprises in each province. New product sales revenue (newproduction_in) of industrial enterprises.

3.1.2 Core Explanatory Variables

The core explanatory variable is the economic development level of e-commerce. Referring to the researches of certain scholars [7, 12], this paper constructs a measurement system of e-commerce economic development level from the regional Internet penetration rate, informatization transaction technology level, and enterprise information technology level, and selects the number of Internet broadband access users in each province (in_no), express business income (exp_in), and the number of websites owned by the enterprise (web_no), as measurement indicators.

3.2 Model Construction

Considering that the focus of this paper is to examine the impact of e-commerce economic development level on regional enterprise innovation in terms of time and space, the fixed-effect model is selected, and the econometric model is constructed as follows concerning the research results of certain scholars [3, 4]:

$$pin_{it} = \beta_0 + \beta_1 exp_in_{it} + \beta_2 in_no_{it} + \beta_3 web\_no_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

In formula (1), the explanatory variable pin_{it} represents the innovation level of regional enterprises in province i in year t; the core explanatory variable exp_in_{it} represents the income level of express delivery business in province i in year t, and in_no_{it} represents the Internet access in province i in year t User level, web_no_{it} represents the number of companies in province i with company websites in year t; α_i represents the province fixed effect, ε_{it} represents the random disturbance term; β_0, β_1, β_2, β_3 are all the parameters to be estimated for the model.

3.3 Data Sources and Descriptive Statistics

The data used in the research mainly come from the National Bureau of Statistics and the websites of provincial governments. Because the indicators to measure the level of e-commerce economic development have been published since 2013, and because of the serious lack of relevant data in the Tibet Autonomous Region and China's Hong Kong, Macao, and Taiwan regions, this paper selects the panel of 30 provinces (cities, municipalities directly under the Central Government) in China from 2013 to 2020. Data as a research sample.

Table 1 shows the results of descriptive statistics. The results show that the standard deviations of the express delivery business income and the number of websites owned by enterprises in each region are 2,995,214 and 18,030.23 respectively, which are relatively large as a whole, indicating that the level of informatization transactions technology in different regions and the level of enterprise information technology are quite different, and the standard for the number of Internet access users The difference is 877.8635, indicating that there is no significant difference in the level of Internet penetration among different regions in China.

3.4 Selection of Processing Software

Since this paper deals with panel data and needs to use the fixed-effect model for regression analysis, after comprehensive consideration of data management function, statistical analysis function, operation flexibility, user-friendliness, and openness, the final choice of Stata software for data processing and analysis.

Table 1. Descriptive statistics of variables.

Variable	Name	Mean	Std. Dev.	Min	Max
Explained Variable	The full-time equivalent of R&D personnel	96732.06	132266.3	1157	700017
	Expenses for developing new products	4473377	6520931	62146	4.13e+07
	Number of patent applications	28213.34	45202.79	305	305665
	New product sales revenue	6.13e+07	8.29e+07	85659	4.43e+08
Explanatory Variables	Number of Internet Access Users	1103.295	877.8635	54.9	3890
	Express business income	1598592	2995214	11903.46	2.18e+07
	Number of websites owned by the company	17820.83	18030.23	886	85688

4 Empirical Results and Analysis

4.1 Basic Effect Test

Based on the 2013–2020 Chinese provincial panel data, this paper uses Stata software based on model (1) to test the basic effects between variables.

Table 2 and Table 3 are the regression results of "regional enterprise innovation input" and "regional enterprise innovation output" based on model (1). It can be seen from the table that in the quadratic regression, there is a significant relationship between the explanatory variables and the explained variables, indicating that the model construction is reasonable; the adjusted R^2 is around 0.9, indicating that the fitting effect is good, and the obtained results are highly reliable; three The coefficients of the indicators are all positive, indicating that the development of the e-commerce economy has a positive impact on the input and output of regional enterprise innovation.

It can be seen from Table 2 that for the number of R&D personnel and the investment in developing new products, the P-values of express business income are 0.015 and 0.023 respectively, the P-values of the number of Internet access users are 0.055 and 0.041, respectively, and the P-values of the number of websites owned by enterprises are respectively are 0.047 and 0.106. Therefore, the value of P of express business income is significant at the 5% level in both regressions, the value of P of the number of Internet access users is around 0.05, and the number of websites owned by enterprises is significant at the 5% level to the number of R&D personnel. However, the investment in new product funds is only significant at the 10% level, and the difference is large.

Table 2. The impact of the development of the e-commerce economy on the innovation investment of regional enterprises.

Index	rd_peopleno			newproduction_expense		
	Coef.	value of T	value of P	Coef.	value of T	value of P
exp_in	0.0091586	2.63	0.015	8.108402	2.41	0.023
in_no	11.34501	2.16	0.055	16145.23	2.14	0.041
web_no	2.675171	2.35	0.047	2332.502	1.87	0.096
_cons	21900.59	1.62	0.177	−1.10e+07	−1.28	0.236
Prob > F	0.0000			0.0000		
R-sq(overall)	0.9042			0.9266		

Table 3. The influence of the development of the e-commerce economy on the innovation output of regional enterprises

Index	patent_no			newproduction_in		
	Coef.	value of T	value of P	Coef.	value of T	value of P
exp_in	0.0062563	2.21	0.035	0.7999203	2.70	0.012
in_no	7.84758	1.98	0.075	1221.511	2.04	0.058
web_no	1.694982	2.30	0.040	260.8857	2.11	0.044
_cons	−20652.16	−1.08	0.289	−2802256	−1.38	0.180
Prob > F	0.0000			0.0000		
R-sq(overall)	0.8992			0.9239		

The above results show that the level of informatization transactions has a strong positive impact on enterprise innovation investment, followed by the regional Internet penetration rate, and the impact of enterprise digitization on enterprise innovation varies with investment in different aspects.

It can be seen from Table 3 that for the number of patent applications and the sales revenue of new products, the P-values of express delivery business income are 0.035 and 0.012, both of which are significant at the 5% level; the P-values of the number of Internet access users are 0.075 and 0.058, respectively, both It is significant at the 10% level; the P values of the number of websites owned by enterprises are 0.040 and 0.044, both at the 5% level.

The above results show that the level of informatization transactions and the level of enterprise digitization have a strong positive impact on the innovation output of enterprises, while the impact of the regional Internet penetration rate is slightly less than the two.

According to the analysis results, the information transactions brought about by the development of the e-commerce economy in the digital age have the most significant role in promoting the innovation of regional enterprises. Thus, Hypothesis 1 is confirmed.

4.2 Locational Heterogeneity Analysis

To prove the effect of regional heterogeneity, this paper divides 30 provinces (autonomous regions and municipalities) into eastern, central, and western regions for regional heterogeneity regression, and selects the development of new products and new product sales revenue. As explained variables, the results are shown in Table 4 and Table 5.

Table 4. Location heterogeneity regression results (1)

newproduction_expense	East Region		Central Region		Western Region	
	Coef.	value of T (value of P)	Coef.	value of T (value of P)	Coef.	value of T (value of P)
exp_in	0.478	1.57 (0.148)	0.976	1.72 (0.083)	2.104	15.46 (0.000)
in_no	2910.993	2.25 (0.048)	1077.677	1.45 (0.164)	−546.040	−5.86 (0.000)
web_no	396.378	3.01 (0.013)	153.947	3.14 (0.016)	13.384	0.12 (0.189)
_cons	−9320684	−2.28 (0.046)	−1086909	−1.25 (0.251)	627711.4	1.65 (0.133)

Table 5. Location heterogeneity regression results (2)

newproduction_in	East Region		Central Region		Western Region	
	Coef.	value of T (value of P)	Coef.	value of T (value of P)	Coef.	value of T (value of P)
exp_in	4.439	1.30 (0.222)	29.677	3.98 (0.005)	18.878	5.30 (0.000)
in_no	36687.14	2.44 (0.035)	−7075.773	−1.31 (0.179)	−5488	−2.74 (0.023)
web_no	3674.307	2.54 (0.029)	3396.647	5.39 (0.001)	226.946	0.31 (0.761)
_cons	−6.51e+07	−1.44 (0.179)	−1.59e+07	−1.54 (0.169)	9396723	2.05 (0.070)

It can be seen from Table 2 that for the number of R&D personnel and the investment in developing new products, the P-values of express business income are 0.015 and 0.023, which are both significant at the 5% level; the P-values of the number of Internet access users are 0.055 and 0.041, respectively; The P values of the number of websites owned by enterprises are 0.047 and 0.106 respectively, which are significant at the 5% level for the number of R&D personnel, but only at the 10% level for the investment in new products.

The reason for the above situation may be that the transportation convenience in the eastern region is relatively high, and the digital economy started early, so it is less affected by the income of the express delivery business. There is still room for improvement in the digitalization of enterprises and enterprises, so it has a positive impact on the innovation ability of enterprises; while the transportation convenience in the central and western regions needs to be improved, especially in the western region, so the impact of the level of informatization transactions on enterprise innovation is relatively It is more significant for the other two indicators. Hypothesis 2 is confirmed.

5 Conclusions and Implications

5.1 Research Conclusions

Based on the panel data of 30 provinces (municipalities and autonomous regions) in our country from 2013 to 2020, this paper constructs a model of the impact of the development of the e-commerce economy in the digital age on the innovation capabilities of regional enterprises. The basic influence effect was analyzed, and the fixed effect model was used to verify it, which further verified the influence of location heterogeneity on the above relationship.

The research conclusions are as follows: First, the development of the e-commerce economy can actively promote the innovation of regional enterprises by improving the penetration rate of regional Internet, the level of information-based transactions, and the level of enterprise digitization. Second, electricity economic development on the influence of different regional innovation ability has the regional heterogeneity, among them, the eastern region is mainly affected by Internet penetration and the level of enterprise digital, the central region is mainly affected by the computerized trading level and the level of enterprise digital, the western region is affected by information trading level is most significant.

5.2 Research Implications

Based on the above research conclusions, this paper draws the following inspirations:

First, accelerate the development of the e-commerce economy, promote innovation diffusion, and increase regional innovation output. Enterprises should, according to their own needs and in combination with the current development trend of the e-commerce economy, choose the breakthroughs that are most conducive to breaking the innovation bottleneck and increasing innovation output.

Second, governments in different regions should issue corresponding policies to guide and motivate local enterprises based on the economic development of their

provinces. For example, the eastern region should pay attention to increasing the Internet penetration rate, the central region should strengthen the digitalization process of enterprises, and the western region should increase its efforts to improve the level of informatization transactions.

Third, focus on creating an atmosphere of innovation. Local government departments need to increase the financial support for scientific research, expand the scale of the e-commerce market, improve the basic guarantee of e-commerce, and enhance the sustainable development capacity of e-commerce, so as to reduce the cost of information, thereby reducing the cost of regional innovation, and provide good innovation for enterprises. Atmosphere and motivation.

Acknowledgements. This paper is supported by the National innovation and entrepreneurship training program for college students (No. 3120400002147).

References

1. Basu S, Fernald JG (2008) Information and communications technology as a general purpose technology: evidence from U.S. industry data. Econ Rev 8(2):46–173
2. Chen X (2018) Analysis of technology integration and application innovation trends in the era of digital economy. J Central South Univ (Soc Sci Ed) 24(05):1–8
3. Han X, Song W, Li B (2019) Can the Internet become a new driving force for improving regional innovation efficiency in China? China Ind Econ 7:119–136
4. Li J, Zhao X, Zheng L (2021) The impact of the opening of high-speed rail on enterprise innovation: an empirical analysis based on the micro-data of listed companies. China Econ Issues 1:142–155
5. Jia W, Cai L (2011) Analysis of innovation resistance based on induced institutional change and information cost theory. Bus Times 34:75–76
6. Li Z, Yang S (2018) Fiscal decentralization, government innovation preference and regional innovation efficiency. Manage World 34(12):29–42
7. Ma Z, Ning C (2020) Digital economy, factor allocation and manufacturing quality upgrade. Econ Syst Reform 3:24–30
8. Jun J, Yan Z, Cheng Y (2019) Improvement of digital economy and regional innovation capability. Explor Econ Issues 11:112–124
9. Xia Y, Wang H, Zhang F et al (2018) Research on the impact of digital economy on China's economic growth and non-agricultural employment: based on input occupation output model. Proc Chin Acad Sci 7:707–716
10. Xiong L, Cai C (2020) The impact of digital economy on the improvement of regional innovation capabilities: an empirical study based on the Yangtze River Delta urban agglomeration. East China Econ Manag 34(12):1–8
11. Xu D, Han B (2016) Research on regional innovation performance and spatial spillover effect under the e-commerce model. Sci Res Manag v.37 251(11):107–118. https://doi.org/10.19571/j.cnki.1000-2995.2016.11.013
12. Yan J, Ji W, Zhu L (2021) Digital economy, government intervention and regional innovation capability. Innov Technol 21(12):29–39

13. Zhao T, Zhang Z, Liang S (2020) Digital economy, entrepreneurial activity and high-quality development: empirical evidence from Chinese cities. Manage World 36(10):65–76
14. Zubchyk O, Kireev D (2019) Development of digital economy as an element of the social development strategy in Ukraine. Int J Econ Financ Issues 9(6):151–155