RESEARCH-ARTICLE

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Analysis of the Impact of Digital Business Environment on the Development of Private Economy

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Abstract

The paper builds an evaluation index system for the digital business environment. It measures the development level of the digital business environment in Hubei Province. Using panel data from 12 cities in Hubei Province from 2013 to 2022, it analyzes how the digital business environment affects the development of private economy in Hubei Province. The results show that improving the digital business environment significantly promotes the development of private economy in Hubei Province. The heterogeneity analysis shows that factors like technology level, labor force size, and government support can affect how much the digital business environment helps the private economy.

CCS Concepts

• **Applied computing** → Enterprise computing .

Keywords

Digital Business Environment, Private Economy

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1 Introduction

In recent years, to create a more open and fair development environment for private enterprises, Hubei Province has introduced policies like the "Hubei Province Private Economy Development Promotion Measures" to support them. Private enterprises have been developing new business models and methods through technological innovation and business transformation, striving to seize growth opportunities[1]. However, under the complex and changing global economic situation and the deep adjustments in China's economic structure, private enterprises in Hubei still face many challenges. This paper will use empirical analysis to study how the digital business environment affects the development of the private economy. Based on the findings, it will provide practical suggestions for the growth of private enterprises in Hubei Province.

1.1 Research on the Evaluation Index System for Digital Business Environment

Liu Cheng and Xia Jiechang (2023) expanded the theoretical scope of the business environment from the traditional economy to the digital economy. They built a general analysis framework for the business environment in the digital economy era from the perspective of fair competition. They also provided policy suggestions for creating and improving a fair digital business environment[2]. Guo S, Yuan C, and Li X (2023) used ecosystem theory to develop evaluation indicators for the digital business environment. They measured the development level of China's digital business environment using panel data from 272 Chinese cities between 2011 and 2020, applying the entropy weight method[3]. Their study explored the sustainable development of the digital economy. Jin Doudou (2023) constructed an evaluation index system for the digital business environment based on three key dimensions: infrastructure, financial conditions, and market environment[4]. Liu Weitao (2023) analyzed updates to the World Bank's business environment evaluation system. They found that it now includes aspects related to digital technology, showing that such evaluation systems should be updated regularly to keep up with social progress[5]. Cao Jian, Tan Jialu, et al. (2023) emphasized the need to improve a business environment evaluation system with Chinese characteristics. They particularly highlighted the importance of creating a new first-level indicator for the digital business environment[6]. Liang Shengrong and Wang Wenjuan (2023) developed a digital business environment assessment system using provincial panel data from the Yangtze River Economic Belt. They analyzed its impact on consumption upgrading[7].

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1.2 Research on the Development of the Private Economy

Ren Yuanyuan (2023) believes that whether the private economy grows steadily affects the stability of the macroeconomy. She also points out that close and clean government-business relationships, as well as a good business environment, are key factors for the development of the private economy[8].

Ren Xiaomeng, Qian Tao, et al. (2022) argue that the private economy has entered a stage of high-quality development. However, due to changes in social conflicts, new trends in international competition, and the impact of digital technology, it faces both challenges and opportunities in reshaping its development methods, comparative advantages, and transformation drivers[9]. Wang Wei and Wu Zeyu (2023) analyze the current state of China's private economy. Based on their findings, they suggest ways to improve its development, including better government-business relations, wider market access, and reforms in government functions[10]. Wang Xia (2023) states that the condition of the private economy reflects the overall health of China's economy. She emphasizes the irreplaceable role of the private sector in China's economic growth[11]. Li Shuangjin (2023) focuses on exploring theories related to the private economy. From a theoretical perspective, he offers suggestions for achieving high-quality development of the private economy in the new era[12].

Wang Yaohui, Zhao Zhe, et al. (2023) acknowledge the importance of developing the private economy. They propose strategies to promote high-quality growth of Hubei's private sector, covering policies, production factors, and public services[13].

1.3 Research on the Impact of the Digital Business Environment on the Development of the Private Economy

Ji Xiaoshu (2023) studied how Shenzhen, Hong Kong, and Singapore improved their business environments. The study showed that a better business environment can help private businesses grow[14]. Meisheng K (2021) looked at how private businesses can survive and grow in the big data era. The research discussed the current situation of private businesses, how big data affects them, and the strategies they can use[15]. Zhou Wenjun (2023) gave thoughts and suggestions on how private businesses can develop in the digital economy era, covering both big-picture and detailed aspects[16]. Le Chengyi and Liu Yan (2023) used empowerment theory and real cases of digital business environment improvements by governments. They studied both the hard and soft aspects of the digital business environment and analyzed how businesses can transform digitally. They concluded that improving China's digital business environment is important for helping businesses go digital[17]. Liu Fei (2023) believed digital technology can boost private businesses. The research also explored the challenges private businesses face in using digital technology and how they can overcome them[18]. Guo Jiayi (2024) pointed out that although private businesses in China are speeding up digital transformation, many still struggle because they lack strong digital foundations and skilled workers, leading to slow progress[19].

In summary, there are not many studies on how to evaluate the digital business environment, and the evaluation systems used by researchers are also different. Most researchers focus on how the digital economy or business environment affects the private economy, but few studies examine how the digital business environment influences the development of the private economy.This paper will build an evaluation system for the digital business environment based on factors like digital infrastructure, digital talent supply, digital markets, and government services. It will measure the development level of the digital business environment in Hubei Province. Using panel data from 12 cities in Hubei from 2013 to 2022, the paper will analyze how the digital business environment impacts the growth of the private economy in the region.

2 Theoretical Analysis of the Impact of Digital Business Environment on the Development of Private Economy

2.1 Defining the Concepts of Digital Business Environment and Private Economy

The digital business environment refers to using digital methods to improve the traditional business environment. These digital methods include digital technologies, digital tools, and the hardware and software conditions that support the growth of the digital economy. From this concept, we can see that digitalization plays a very important role in improving the business environment. Therefore, optimizing the digital business environment can help China's economy shift to digitalization and achieve high-quality development.

Private economy refers to all types of economic activities that are not state-owned or state-controlled. It includes state-managed private businesses, collective-owned enterprises, individual businesses, mixed-ownership private companies, and private tech firms.The private economy is a unique economic concept and form with Chinese characteristics.

2.2 The Role of the Digital Business Environment in the Development of the Private Economy

Optimizing the digital business environment brings more advanced digital technologies. Using digital technologies can greatly improve the work efficiency of private companies and reduce their costs. Digital technologies allow private companies to carry out economic activities without being limited by time and space. For example, they can use "Internet +", e-commerce platforms, and live streaming sales to conduct transactions. This improves transaction efficiency and lowers operating costs. Also, using digital technologies and tools can increase production efficiency within companies. It reduces the need for labor and capital investment.

Improving the digital business environment helps companies better use digital technology to find new consumer needs and preferences. This helps companies quickly spot business opportunities in the market. They can then use this demand to improve their industrial structure and adjust their business models.Also, using digital technology in production and operations speeds up the integration of resources in traditional industries. This increases the efficiency of resource allocation. It also provides new momentum for the transformation and upgrading of traditional industries.

Table 1: Digital Business Environment Evaluation Index System

Primary Indicator	Secondary indicator
Digital Infrastructure Construction(DD)	mobile phone end-of -year users(X_1)
	broadband internet subscribers(X_2)
Digital Talent Supply(DT)	resident population(X_3)
	educational expenditure(X_4)
	number of patents granted(X_5)
Digital Market Environment(DM)	total volume of postal and tele communications services(X_6)
	total retail sales of consumer goods(X_7)
	regional gross domestic product index(X_8)
	value-added of high-tech industries(X_9)
Governmental Environment	general public budget expenditure(X_{10})

Digital technology offers more possibilities for innovation in private enterprises.

From outside the company, a well-developed digital business environment helps create an open, inclusive, and shared market. Government policies are more transparent, applied more fairly, and easier to access. This encourages private enterprises to innovate. From inside the company, a good digital business environment supports the development and use of digital technology. Private enterprises can quickly update new products and improve their service models.

3 Empirical Analysis of the Impact of Digital Business Environment on the Development of the Private Economy

3.1 Evaluation of the Development Level of Digital Business Environment in Hubei Province

3.1.1 Construction of the Index System. This paper selects four main indicators: digital infrastructure construction, supply of digital talent, digital market environment, and government service environment. It also includes ten secondary indicators, such as year-end mobile phone users and internet broadband access users. Based on these, a comprehensive evaluation system for the digital business environment is built.

3.1.2 Score Calculation. The results in Table 2 show that from 2013 to 2022, the digital business environment scores of Hubei Province increased with fluctuations year by year, and the differences between cities were significant. Based on the scores of each city over the years, the average values were calculated and ranked. The cities were divided into three levels according to these averages.It can be seen that Wuhan's digital business environment score was above 2, placing it in the first level, far exceeding other prefecture-level cities and maintaining a leading position from 2013 to 2022. This indicates that Wuhan's digital business environment is the most advanced in Hubei Province, playing a driving and demonstrative role.Cities with digital business environment scores above 0.9 belong to the second level, including Xiangyang, Huanggang, Yichang, and Jingzhou. Among them, Xiangyang and Huanggang showed relatively stable development.Cities with scores below 0.9 fall into the third level, including Xiaogan, Shiyan, Huangshi, Jingmen, Xianning, Suizhou, and Ezhou. At this stage, the development of the digital business environment in these cities is relatively weak.

3.2 Empirical Analysis of the Impact of Digital Business Environment on the Private Economy in Hubei Province

3.2.1 Models and Variables. To analyze how the digital business environment affects the development of private economy in Hubei Province, this paper uses the following panel data regression model:

$$\ln PEit = C + \beta 1 DBEit + \beta 2 \ln FCAit + \beta 3 \ln FAIit + \beta 4 NSHit + \beta 5 \ln AGDPit + \beta 6 \ln D \quad (1)$$

In the above model, PE stands for the development level of the private economy. DBE stands for the digital business environment. FCA stands for the level of opening-up. FAI stands for the input of physical capital. NSH stands for the level of human capital. AGDP stands for the level of economic development. DIST stands for the level of technology. C is the constant term. β is the parameter to be estimated. ϵit is the random error term. i represents the region. t represents the year. ln means taking the natural logarithm of the variable.

3.2.2 Variable Selection and Data Explanation. Explained variable: Development level of the private economy (PE).This paper uses the added value of the private economy to measure the development level of the private economy in a region. The added value of the private economy is an important indicator to measure the economic performance of private enterprises. It can reflect the overall development level of the private economy. The unit is 100 million yuan.

Core explanatory variable: Digital Business Environment (DBE) development level. As mentioned earlier, we have built a related index system to measure the overall development level of the digital business environment in Hubei Province. The variable data is taken from the comprehensive scores shown in Table 2.

Control variables: ① Degree of Openness to the Outside World (FCA). Degree of openness to the outside world (FCA). When the level of openness is higher, private companies have more opportunities. Foreign investment and technical support bring funds and technology to private companies. This helps adjust industrial structure and improve economic structure. This paper uses the

Table 2: Measurement Results of the Digital Business Environment in Hubei Province

Year	Wuhan	Huang-shi	Shiyan	Jingzhou	Yichang	Xi-angyang	Ezhou	Jing-men	Xiao-gan	Huang-gang	Xian-ning	Suizhou
2013	2.57	0.56	0.66	0.85	0.87	0.96	0.39	0.57	0.76	0.87	0.54	0.49
2014	2.71	0.56	0.68	0.86	0.89	0.99	0.38	0.57	0.75	0.91	0.55	0.50
2015	2.98	0.52	0.67	0.92	0.93	1.07	0.36	0.60	0.77	0.96	0.54	0.48
2016	3.20	0.60	0.73	0.94	1.00	1.13	0.38	0.60	0.81	0.97	0.57	0.48
2017	3.48	0.61	0.62	0.97	0.84	1.17	0.40	0.61	0.81	1.02	0.55	0.47
2018	3.66	0.67	0.78	1.05	1.00	1.23	0.41	0.68	0.88	1.05	0.62	0.51
2019	4.00	0.75	0.84	1.09	1.09	1.20	0.41	0.69	0.92	1.14	0.66	0.53
2020	3.80	0.50	0.63	0.82	0.84	1.02	0.08	0.43	0.66	0.9	0.43	0.29
2021	4.60	0.93	0.92	1.15	1.30	1.48	0.54	0.76	1.06	1.29	0.80	0.62
2022	4.62	0.71	0.79	1.11	1.18	1.36	0.40	0.60	0.93	1.19	0.67	0.50
Mean	3.56	0.64	0.73	0.98	0.99	1.16	0.38	0.61	0.84	1.03	0.59	0.49

Data source: Compiled with SPSS 23.0

actual amount of foreign capital utilized to measure the level of openness, with the unit being 100 million yuan. ② Investment in Physical Capital (FAI). Investment in physical capital, such as upgrading equipment and expanding factories, can directly increase the production capacity and efficiency of private enterprises. This helps them scale up production, gain more market share, improve competitiveness, and achieve better economic results. In this study, we use total fixed asset investment in society to measure physical capital investment, with the unit being 100 million yuan. ③ Level of Human Capital (NSH). Human capital is very important for the growth of private companies. High-level human capital can improve a company's ability to develop technology. It can also make the company more competitive in the market. Besides, it helps to better organize management and make operations more efficient. At the same time, it can create a positive company culture.In this paper, we measure the level of human capital by the ratio of college students to the city's population. A higher ratio means a higher level of human capital. The unit is %. ④ Level of Economic Development (AGDP). The higher the level of economic development, the more opportunities and resources private businesses may get. When a country or region's economic development level rises, it means there will be more market demand, better infrastructure, and more advanced technology. This helps private businesses grow.This paper uses GDP per capita to measure the level of economic development, in yuan per person. ⑤ Level of Technological Development (DIST). Technological progress helps private companies innovate, improves production efficiency, and strengthens market competitiveness. Technological innovation supports private companies in achieving automated and smart production, optimizing industrial structure, and expanding development space. This paper uses the total number of patents by the end of the year to measure the level of technological development, with the unit being "item."

Data Explanation: The original data for these variables all come from sources like the Regional Statistical Yearbook, the EPS data platform, the CNKI database, and the Hubei Provincial Bureau of Statistics.

3.2.3 Descriptive Statistics. The descriptive statistical results for each variable are shown in Table 3.

3.2.4 Multicollinearity Test. This paper uses the Variance Inflation Factor (VIF) method. It combines the correlation coefficient matrix and the VIF method to fully check if there is correlation or multicollinearity between variables. Table 4 shows all variables have VIF values below 10. This means there is no serious multicollinearity problem in the regression model. So, the regression analysis can continue.

3.2.5 Empirical Analysis Results. This paper uses the Hausman test to decide whether to use a fixed-effects model or a random-effects model. In the Hausman test, the null hypothesis is that the random-effects model should be used. According to Table 5, the result shows P=0.037<0.05. Therefore, we reject the null hypothesis at the 5% significance level and choose the fixed-effects model.

This paper first runs a regression between the explained variable (private sector development level) and the core explanatory variable (digital business environment development level). Then it gradually adds control variables: openness level, physical capital input, human capital level, economic development level, and technological development level. The regression results are shown in Table 6. Column (1) in the table shows the regression of digital business environment on private sector development. The result is significantly positive. This means improving the digital business environment positively affects private sector development. Without control variables, when the digital business environment improves by 1 unit, private sector development increases by 0.718%.When control variables are added step by step, the coefficient of digital business environment on private sector development remains significantly positive. After adding all control variables, the specific analysis results of each explanatory variable are as follows:

Digital Business Environment Development Level: The regression results show this variable has a positive effect on private sector development. An improved digital business environment significantly helps private sector growth.Looking at the coefficient value, at the 1% significance level, every 1-unit increase in the digital business environment leads to a 0.251% rise in private sector

Table 3: Descriptive Statistical Results

Variable	Sample Size	Average Value	Standard Deviation	Minimum	Maximum
PE	120	1673	1697	391.3	11177
DBE	120	1.007	0.838	0.08	4.62
FCA	120	5.784	15.40	0.045	81.70
FAI	120	2503	1969	571.7	10474
NSH	120	1.916	2.167	0.239	9.456
AGDP	120	78685	29203	23582	145545
DIST	120	6018	13220	221	89298

Data source: Organized according to STATA16.0

Table 4: Variance Inflation Factor

	VIF	1/VIF	
DBE	9.72	0.103	
lnFAI	6.017	0.166	
NSH	5.711	0.175	
lnDIST	4.705	0.213	
lnFCA	2.575	0.388	
lnAGDP	1.583	0.632	
Mean VIF	5.05		0

Data source: Organized according to STATA16.0

Table 5: Hausman Test Results

Chi-square test value	13.4
P-value	0.037

Data source: Organized according to STATA16.0

development.A better digital business environment helps in three ways: reduces business costs, encourages business upgrades, increases innovation.These factors all contribute to improved private sector development.

Degree of Openness to the Outside World: From the regression coefficient sign, a higher degree of openness leads to a higher level of private economic development. However, the regression coefficient is not significant, which means that increasing openness does not significantly boost private economic development. This may be because while greater openness creates more opportunities for private enterprises, most foreign investment and technical support goes to large private enterprises. As a result, small and medium-sized private enterprises may not benefit much.

Physical Capital Investment: The positive regression coefficient shows that investment in physical capital has a positive effect on the development of private enterprises. Based on the regression coefficient, at the 1% significance level, a 1% increase in physical capital investment leads to a 0.837% rise in the development level of private enterprises. Increasing physical capital investment can expand production scale, improve production capacity and efficiency, and thus help private enterprises gain more market share, enhance competitiveness, and achieve better economic results.

Human Capital Level: From the sign of the regression coefficient, we can see that the level of human capital has a positive effect on the development of the private economy. Based on the value of the regression coefficient, at the 5% significance level, a 1% increase in human capital leads to a significant 0.222% rise in private economic development.This can be explained as follows: A high level of human capital improves a company's ability to innovate, optimizes its management structure, and increases operational efficiency. As a result, it helps the private economy grow.

Economic Development Level: From the regression coefficient sign, the economic development level has a negative impact on the development of private economy, and the coefficient value is not significant. The reason may be that economic development in Hubei Province is uneven. Wuhan has a far better economy than other areas. As economic growth increases, market competition becomes fiercer. At the same time, production costs rise and the pressure for technological innovation grows. These factors all create challenges for private economic development.

Technological Development Level: From the regression coefficient signs, we can see that the level of technological development has a positive effect on the development of the private economy, and the regression coefficient is significant. At the 10% significance level, if the total number of patents at the end of the year increases by 1, the development level of the private economy will rise by 0.062%. This shows that improving technological development helps the private economy upgrade and promotes its growth.

Table 6: Empirical Regression Results

	(1)lnPE	(2)lnPE	(3)lnPE	(4)lnPE	(5)lnPE	(6)lnPE
DBE	0.718**	0.712**	0.177**	0.303***	0.301***	0.251***
	(2.281)	(2.296)	(2.646)	(3.543)	(4.006)	(3.259)
lnFCA		-0.078	0.009	-0.001	-0.001	0.017
		(-1.412)	(0.198)	(-0.016)	(-0.025)	(0.423)
lnFAI			1.042***	0.871***	0.891***	0.837***
			(7.497)	(12.351)	(5.132)	(4.652)
NSH				0.260**	0.261**	0.222**
				(2.682)	(2.545)	(2.227)
lnAGDP					-0.033	-0.095
					(-0.162)	(-0.450)
lnDIST						0.062*
						(1.822)
cons	6.409***	6.441***	-0.991	-0.307	-0.092	0.645
	(20.231)	(20.424)	(-0.906)	(-0.416)	(-0.101)	(0.674)
N	120	120	120	120	20	120
R2	0.236	0.253	0.638	0.673	0.673	0.679

Note: The values in parentheses are t-values calculated based on standard errors, "cons" represents the constant term, N is the sample size, and R^2 is the coefficient of determination indicating the goodness of fit of the regression equation (the same below).

Data source: Organized according to STATA16.0

4 Conclusions

The paper builds a comprehensive evaluation index system with four dimensions: digital infrastructure, digital talent supply, digital market, and government service environment. Then, it uses principal component analysis to measure the digital business environment in Hubei Province. The study also uses panel data from 12 cities in Hubei from 2013 to 2022 and applies Stata software to analyze how the digital business environment affects the development of the private economy in Hubei.After adding control variables step by step, the regression results still show that the digital business environment has a positive and significant effect on the private economy. This means improving the digital business environment can strongly boost private economic growth.At the same time, physical capital investment, human capital level, and technological development all have significant positive effects on private economic growth. The heterogeneity analysis also finds that factors like technological development, labor force size, and government support influence how much the digital business environment helps the private economy.

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