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How Digital Transformation Affect the Competitiveness of Enterprises of Petroleum Corporation

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Abstract: Petroleum enterprises play an important fundamental role in our national economy. In the context of the rapid development of the digital economy, digital transformation is an effective way for enterprises to use digital information technology and digital platforms to enhance traditional power, promote information technology and business innovation, improve corporate performance, and seek lasting competitive advantages. Based on the concepts of digital transformation, dynamic capability and enterprise competitiveness and relevant theoretical basis, this paper constructs A theoretical model of digital transformation and enterprise competitiveness of petroleum enterprises with 1052 samples of 98 oil enterprises listed on Shanghai and Shenzhen A-shares from 2007 to 2021. Content analysis and crawler technology were used to calculate the degree of digital transformation, factor analysis was used to calculate the enterprise competitiveness index, and statistical analysis software STATA15.1 was used to analyze the impact of digital transformation on the competitiveness of petroleum enterprises and the regulatory role of knowledge transfer ability in this process. The results show that the digital transformation of petroleum enterprises is positively correlated with the competitiveness of petroleum enterprises. Knowledge transfer ability plays a moderating role in the relationship between digital transformation and competitiveness of petroleum enterprises. This paper discusses the mechanism between the digital transformation of petroleum enterprises and the competitiveness of enterprises, which helps petroleum enterprises to actively promote digital transformation, enhance their emphasis on technological innovation and patent research, and provide new ideas for petroleum enterprises to promote digital transformation and enhance their competitiveness.

Keywords: Petroleum enterprises, Digital transformation, Knowledge transfer ability, Competitiveness of Enterprises.

1. Research Background

Digital transformation refers to the use of digital information technology and digital platform to promote the transformation of enterprises from traditional industrial operation to the era of digital economy, change and upgrade the traditional driving force of enterprises, promote the innovation of information technology and business, so as to improve enterprise performance and seek lasting competitive advantages, which is the ultimate goal of enterprise digital transformation [1]. In January 2022, The State Council issued the 14th Five-Year Plan for the Development of the Digital Economy, pointing out that it is necessary to "accelerate the digital transformation of the energy sector", "promote the digital upgrading of energy production, transportation, storage, sales, use and other links, and implement equipment in fields such as oil and gas fields and oil and gas storage". Promote the construction of digital platforms based on supply and demand, production services, supervision and management, and improve the intelligence level of energy systems. In addition to the support of the government, the rapid development of China's digital economy and social recognition have also forced small and medium-sized enterprises to actively choose digital transformation methods, such as the digital transformation of the manufacturing industry, to achieve digital and intelligent, get rid of the limitations of manual production, and promote the production transformation of enterprises. New digital forms such as live broadcasting, online office and online learning brought about by the epidemic have been subtly integrated into social production and life, forcing enterprises to adapt to the trend of the digital economy era, accelerate the transformation of digital operation mode, improve production efficiency, and maintain long-term market competitiveness. It is foreseeable that the digital transformation of oil companies is about to enter a new stage of development.

Since the beginning of the 21st century, Chinese petroleum enterprises have become the world's second largest resource consumption and production main body. It is a comprehensive heavy industry integrating oil and gas geological exploration, oil and gas field development, oil and gas exploitation, oil and gas refining and processing, oil and gas transportation, storage and transportation, and plays an important fundamental role in the national economy. However, compared with oil companies in developed countries, Chinese oil companies are still in a "big but not strong" situation. The lack of innovation power of core technology leads to the stagnation of innovation technology, which leads to the internalization of economy, and Chinese oil enterprises as a whole are at the end of the world value chain. With the outbreak of the novel coronavirus outbreak in 2019 and the outbreak of the Russia-Ukraine war, Chinese oil companies are facing enormous competitive pressure. Seriously affect the sustainability of economic growth, and then the competitive environment is more unstable, and the competitive situation is more difficult to predict.

In the past, Porter's Five forces model was used to analyze the basic competitive conditions of enterprises, but the static theoretical perspective is not enough to analyze and understand the competitive environment to cope with the changing environment. So how can oil companies impact competitiveness through digital transformation? If so, what is

the mechanism? The discussion of these problems has certain reference significance for petroleum enterprises to promote the digitalization of petroleum enterprises, improve labor production efficiency and enhance the competitiveness of petroleum enterprises. To sum up, this paper takes A-share listed oil enterprises as the research object, selects 98 A-share listed oil enterprises as the research object, builds A theoretical model of digital transformation and enterprise competitiveness of oil enterprises, analyzes the regulatory role of knowledge transfer ability in this process, and empirthetically discusses the impact of digital transformation of oil enterprises on enterprise competitiveness. On this basis, countermeasures and suggestions are put forward to promote the digital transformation of petroleum enterprises, improve labor production efficiency and enhance enterprise competitiveness.

2. Research Hypotheses

2.1. Digital transformation and competitiveness of petroleum enterprises

The impact of digital transformation on enterprise competitiveness is mainly reflected in the following three aspects: First, digital transformation improves the product competitiveness of petroleum enterprises. Enterprises use digital technology to collect, mine and use data in real time, shorten design cycle, improve design quality, reduce manufacturing costs, and enhance product competitiveness; With the help of digital platforms, petroleum enterprises can accurately capture consumer preference information, manufacture mainstream products, timely track consumer dynamics from consumption to after-sales, improve customer satisfaction, reduce the return rate, and improve enterprise competitiveness. Second, digital transformation improves the production efficiency of petroleum enterprises. Through digital transformation, enterprises apply digital technology to traditional production to realize the automation and intellectualization of production and service. Meanwhile, traditional production tools monitor the production operation status of enterprises in real time through Internet programs, timely detect hidden dangers, reduce maintenance costs and miss time, optimize the operation mode of enterprises with the help of digital transformation, ensure competitive advantages and improve production efficiency. Improving the production efficiency of petroleum enterprises by means of digital transformation can promote the competitiveness of petroleum enterprises. Thirdly, digital transformation enhances the adaptability of petroleum enterprises in competitive environment. Enterprises use the Internet big data to obtain market and industry information, competitor enterprise operation information, industry value chain information, on this basis to predict market trends, reduce the information asymmetry and competitive environment changes caused by business risks.

Therefore, digital transformation enhances the adaptability of petroleum enterprises in the competitive environment, and can help petroleum enterprises obtain the competitiveness of sustainable development. Based on the above analysis, the following hypotheses are proposed:

H1: Digital transformation has a positive impact on enterprise competitiveness

2.2. The moderating effect of knowledge transfer ability

Digital transformation of enterprises directly affects the competitiveness of enterprises through its own characteristics. On the one hand, timely grasp of technical feedback from technology recipients and market feedback can help enterprises improve and perfect internal technology and enhance the competitive advantage of new products. On the other hand, in the process of enterprise knowledge transfer, it can be directly transformed into business opportunities and benefits. The enterprise or individual quoting the patent may need to purchase or use the technology involved in the patent, thus bringing business opportunities and benefits to the enterprise holding the patent.[2] At the same time, the cited patents can also be used as a powerful tool for enterprises to communicate and negotiate with customers, suppliers, investors and other stakeholders, and help improve the negotiation and bargaining power of enterprises in business exchanges. [3]Enterprises need to have the ability of knowledge transfer to dynamically match and allocate resources to achieve the success of knowledge transfer .[4]Based on this, this paper attempts to embed the knowledge transfer ability factor into the above theoretical mechanism model, further expand the research boundaries of the existing theoretical model and propose the following hypotheses:

H2: Knowledge transfer ability has a positive moderating effect on the relationship between digital transformation and enterprise competitiveness

3. Research Hypotheses

3.1. Sample selection and data sources

In this paper, 40 A-share oil companies in Shanghai and Shenzhen from 2007 to 2021 are selected from the National Tai 'an database. The reason why this paper takes 2007 as the research starting point is that the Ministry of Finance of the People's Republic of China revised the Accounting Standards for Business Enterprises in 2006, so it is necessary to avoid the impact caused by the difference of data statistical rules. The following processing is done to the data: (1) Delete the sample ST and *ST from 2007 to 2021 and enterprises with abnormal changes; (2) Delete the enterprises whose main business has nothing to do with oil; (3) Delete other enterprises with incomplete data; Finally, 35 listed oil companies were selected as samples of the relationship between digital transformation and enterprise competitiveness. This paper studies listed companies advertising promotion data and patent data source Ifind flush; Other data are from the National Tai 'an database.

3.2. Definition of variables

3.2.1 Explained variable: enterprise competitiveness. Based on the research of Jin Bei, this paper selects three indicators that affect the competitiveness of enterprises, and calculates the competitiveness score of comprehensive enterprises through factor analysis.[5]

3.2.2 Explanatory variable: digital transformation. Based on Wu Fei's literature, this paper collects and organizes the annual reports of A-share listed petroleum enterprises from 2007 to 2021 by using Python crawler function, and extracts all text contents through JavaPDFbox database as the database of digital transformation keywords.[6] Finally,

through keyword search, matching and keyword frequency statistics, The index system of digital transformation is obtained.

3.2.3 Intermediary variable: dynamic capability. Based on the research methods of Zhao Feng et al., dynamic capacity is measured in three dimensions: innovation capacity, absorptive capacity and adaptive capacity. The operation is as follows:[7]

(1) Innovation ability, the value of annual R&D expenditure intensity of the sample company and the proportion of researchers after standardized treatment is obtained.

(2) Absorption capacity, using the ratio of R&D expenditure to operating income of sample firms

(3) Adaptability: The coefficient of variation of R&D input, capital expenditure and advertising expenditure of sample companies is used to reflect the flexibility of resource allocation of petroleum enterprises, so as to reflect the adaptability of petroleum enterprises. In order to ensure the consistency of the direction of variation coefficient and adaptability, the negative coefficient of variation is taken in this paper, and the adjusted coefficient of variation is proportional to the adaptability of petroleum enterprises.

3.2.4 Control variables: Referring to relevant studies in existing literatures, variables that have an impact on enterprise competitiveness are selected as control variables.

4. Model Setting

4.1. Setting the main effect model of the influence of digital transformation of petroleum enterprises on enterprise competitiveness

In order to verify the hypothesis that the digital transformation of H1 oil enterprise is positively correlated with its enterprise competitiveness, this paper takes the enterprise competitiveness as the explained variable and the total frequency of digital transformation keywords as the explanatory variable, while controlling other variables that may have an impact on the enterprise competitiveness. In this paper, control variables are selected from the aspects of Dual, Indratio, Size, Age, SOE, Top1 Lev, Cash and year dummy variables to analyze and construct the model. The formula is as follows:

$$\mathrm{EC}_{\mathrm{it}} = \alpha_0 + \alpha_1 \mathrm{EDT}_{\mathrm{it}} + \mathrm{CV} + \sum \mathrm{year} + \varepsilon_{\mathrm{it}} \quad (1)$$

4.2. Setting moderating effect model of knowledge transfer ability

$$\mathrm{EC}_{\mathrm{it}} = \alpha_0 + \alpha_1 \mathrm{EDT}_{\mathrm{it}} + \alpha_2 \mathrm{KTC}_{\mathrm{it}} + \alpha_3 \mathrm{KTC}_{\mathrm{it}} * \mathrm{EDT}_{\mathrm{it}} + \mathrm{CV} + \sum \mathrm{year} + \varepsilon_{\mathrm{it}} \quad (2)$$

5. Empirical Analysis

5.1. Descriptive Analysis

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
EC	1052	0.0113	0.4779	-1.0657	3.9193
EDT	1052	0.3965	0.5209	0.0000	1.6094
EDT1	1052	0.0765	0.1976	0.0000	1.0000
KTC	1052	2.3747	2.0878	0.0000	8.5940
Dual	1052	0.1683	0.3743	0.0000	1.0000
Indratio	1052	37.2780	4.9883	30.0000	57.1400
Size	1052	22.6829	1.4924	19.0286	27.6163
Age	1052	16.9850	5.5458	5.7500	28.7500
SOE	1052	0.5105	0.5001	0.0000	1.0000
Top1	1052	36.5955	16.3696	9.3300	75.8400
Lev	1052	0.5107	0.1922	0.0714	0.9024
Cash	1052	0.0452	0.0783	-0.2137	0.2779

In this paper, the regression analysis of industry dummy variables is carried out to obtain the research results. Column (1) is the result without adding control variables, and column (2) is the result with adding control variables. The result obtained is more accurate.Table 1 shows the estimation results of regression model: The R^2 of the model is 0.3798, the adjusted R^2 is 0.3659, and the goodness of fit is 36.59%. Due to the large fluctuation of the explained variables of enterprise data, the degree of fit is generally not too high. The goodness of fit in this paper is 36.59%, which is reasonable after consulting several literatures, and the F test value is 27.3713. At the significance level of 0.01, it means that there is a high probability that the whole model passes the significance test. At this time, the influence coefficient of EDT is 0.1975. At the significance level of 1%, the increase of EDT will lead to the increase of EC, and every 1 unit increase of EDT will lead to an average increase of 0.1975 units of EC. Control variables Size, SOE, Top1, Lev and Cash all have a significant impact, and SOE and Lev have a significant negative impact, while Size, Top1 and Cash have a significant positive impact.

5.2. Correlation analysis

The correlation coefficient between EDT and EC is 0.3881, and the correlation test is passed at the significance level of 1%, that is, the relationship between EDT and EC presents a positive significant relationship, that is, the higher the digital transformation of EDT, the higher the competitiveness of EC enterprises.

Table 2. Correlation analysis

Variable	EC	EDT	DC_In	DC_Ab	DC_Ad	KTC	Dual	Indratio	Size	Listage	SOE	Top1	Lev	Cash
EDT	0.0100	1												
DC In	-0.110**	-0.00200	1											
DC Ab	-0.098**	-0.0630	0.824***	1										
DC Ad	-0.104**	0.110**	0.506***	0.467***	1									
KTC	0.689***	0.124**	-0.0790	-0.0570	0.0310	1								
Dual	-0.087*	-0.0690	0.251***	0.313***	0.091*	-0.0760	1							
Indratio	0.112**	-0.095*	0.299***	0.298***	0.148***	0.128***	0.0270	1						
Size	0.700***	0.113**	-0.178***	-0.155***	-0.114**	0.762***	-0.180***	0.115**	1					
Listage	0.0550	0.189***	-0.172***	-0.317***	-0.00900	0.210***	-0.091*	-0.171***	0.172***	1				
SOE	0.225***	0.0440	-0.240***	-0.243***	-0.173***	0.431***	-0.227***	-0.153***	0.329***	0.344***	1			
Top1	0.564***	0.111**	-0.138***	-0.102**	-0.209***	0.533***	-0.172***	0.0550	0.620***	0.0100	0.431***	1		
Lev	-0.0410	-0.0130	-0.371***	-0.408***	-0.225***	-0.0730	-0.178***	-0.118**	0.229***	0.157***	0.287***	0.0610	1	
Cash	0.336***	0.0640	-0.090*	-0.0730	-0.0330	0.371***	0.00200	0.084*	0.361***	0.101**	0.168***	0.226***	-0.130***	1
Roa	0.246***	0.0730	-0.100**	-0.0680	-0.0800	0.139***	-0.0300	0.0340	0.136***	-0.0580	0.0290	0.265***	-0.377***	0.358***

5.3. Main effect hypothesis testing

This paper makes a regression analysis of the relationship between digital transformation and enterprise competitiveness by controlling industry dummy variables. Column (1) is the result without adding control variables, and column (2) is the result with adding control variables. The estimated results of the regression model are shown in Table 5.4, R^2 of the model is 0.3798, adjusted R^2 is 0.3659, and goodness of fit is 36.59%. Due to the large fluctuation of the explained variables of enterprise data, the degree of fit is generally not too high. The goodness of fit in this paper is 36.59%, which is reasonable after consulting multiple literatures. The F test value is 27.3713, which is significant at the significance level of 0.01, indicating that there is a high probability that the whole model passes the significance test. At this time, the influence coefficient of EDT is 0.1975, which is significant at the significance level of 1%. The increase of EDT will lead to the increase of EC. EC will increase by an average of 0.1975 units, and the control variables Size, SOE, Top1, Lev, and Cash all have a significant impact, and SOE and Lev have a significant negative impact, while Size, Top1, and Cash have a significant positive impact.

Table 3. Model estimation

Variable	(1)	(2)
	EC	EC
EDT	0.3923***	0.1975***
	(14.6648)	(7.5294)
Dual		0.0203
		(0.6199)
Indratio		-0.0032
		(-1.3163)
Size		0.1530***
		(14.1479)
Age		-0.0016
		(-0.5771)
SOE		-0.0731**
		(-2.5385)
Top1		0.0032***
		(3.7862)
Lev		-0.5015***
		(-7.2572)
Cash		0.4434***
		(2.7588)
Constant	0.0175	-3.0266***
	(0.2594)	(-12.6363)
Year	Control	Control
Observations	1,052	1,052
R-squared	0.1804	0.3798
r2_a	0.1685	0.3659
F	15.1996***	27.3713***

5.4. Testing of the moderating effect hypothesis

The coefficient of EDT is 0.1562 and passes the significance test at the significance level of 1%, while the coefficient of interaction term between KTC and EDT is 0.1836. There is also a probability of more than 99% that the interaction term between KTC and EDT is significant, and the knowledge transfer ability has a positive regulating effect on the digital transformation of petroleum enterprises and enterprise competitiveness. With the increase of patent citations, the positive impact of digital transformation on enterprise competitiveness is strengthened, that is, the positive regulatory effect of KTC is relatively obvious. Assuming that H2 is verified, knowledge transfer ability has a positive regulatory effect on the relationship between digital transformation and enterprise competitiveness.

Table 4. Regulatory effect analysis

Variable	(1)	(2)
	EC	EC
EDT	0.2324***	0.1562***
	(10.6248)	(6.9939)
KTC	0.0186***	0.0087
	(3.0905)	(1.4842)
KTC*EDT	0.2172***	0.1836***
	(22.6723)	(18.8645)
Dual		0.0039
		(0.1402)
Indratio		-0.0022
		(-1.0522)
Size		0.0835***
		(8.5053)
Age		-0.0047**
		(-1.9903)
SOE		-0.0489**
		(-2.0086)
Top1		0.0023***
		(3.2455)
Lev		-0.2327***
		(-3.8898)
Cash		0.1886
		(1.3829)
Constant	-0.1358**	-1.7388***
	(-2.5699)	(-8.1984)
Year	control	control
Observations	1,052	1,052
R-squared	0.5044	0.5592
r2_a	0.4962	0.5484
F	61.8923***	52.0587***

6. Conclusion and Discussion

The digital transformation of oil companies can indeed have a significant positive impact on their corporate competitiveness. Digital technology can help oil companies

improve production efficiency, optimize production processes and reduce costs, thus improving corporate profitability and market competitiveness. Digital transformation can also promote the transformation of enterprises from the traditional production-oriented production mode to the data - and user-oriented production mode, and realize the intelligent, networked collaboration and personalized service of production, sales and service through digital technology, so as to meet the personalized and diversified needs of customers and accelerate the innovation of products and services. Promote the emergence and development of new business models. In addition, digital technology can also help oil companies strengthen risk management, improve management efficiency and decision-making quality, promote the reform of enterprise management system and mechanism, and form a more efficient, flexible and innovative enterprise organization and culture. The digital transformation of petroleum enterprises is a comprehensive, deep and wide change process, which will have a profound impact on the development and competitiveness of enterprises, and is an indispensable strategic choice for enterprises.

Knowledge transfer ability has a positive moderating effect on the impact of digital transformation on the competitiveness of petroleum enterprises. With the increasing frequency of patent citations, the stronger the knowledge transfer ability, the stronger the impact of digital transformation on the competitiveness of petroleum enterprises.

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