RESEARCH ON THE IMPACT OF HETEROGENEOUS HUMAN CAPITAL ON ENTERPRISE VALUE-- BASED ON THE EMPIRICAL TEST OF CHINESE LISTED STEEL COMPANIES

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https://doi.org/10.37904/metal.2022.4518

Abstract

Based on the samples of Shanghai and Shenzhen listed companies in China's steel industry from 2015 to 2020, this paper establishes a fixed effect model to analyze the influence of heterogeneous human capital on enterprise value. The results show that the knowledge-based human capital has less positive impact on the enterprise value of steel enterprises, but the technology-based human capital has a significant impact on them. Therefore, compared with knowledge-based human capital, steel enterprises should pay more attention to the accumulation of technology-based human capital in the process of development to promote the improvement of enterprise value.

Keywords: Heterogeneous human capital, enterprise value, steel enterprises

1. INTRODUCTION

As the new round of scientific and technological revolution and industrial transformation deepens, all sectors of the world are facing profound changes unseen in a century. As an important basic industry in China, the steel industry plays an important role in the development of the national economy. It also has a great impact on the social and economic transformation and upgrading. Since the outbreak of COVID-19, with safe and stable production and operation, Chinese steel industry has shown strong resilience to risks, which has strongly supported the rapid recovery of China's economy. Under the background of the development of industry 4.0 intelligent manufacturing, the development of the steel industry has ushered in a new transformation. The continuous innovation drive is the core internal source leading the benign development of Chinese steel enterprises and enhancing the value of enterprises.

Human capital is the core element of innovation drive. From the existing literature, some scholars have focused on analyzing the relationship between factor input and enterprise value. But in the aspect of human capital elements, it is more limited to the contribution of executive human capital to enterprise value. According to the characteristics of specific industries, there are few literatures on the classification analysis of human capital. Based on this, this paper takes Chinese listed steel companies as the research object and takes two types of heterogeneous human capital as key variables to study the relationship between human capital and enterprise value. To study and analyze whether knowledge-based human capital and technology-based human capital can better promote the enterprise value of steel enterprises.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

When studying the relationship between human capital and enterprise value, many scholars domestic and overseas have conducted empirical studies. According to the empirical data of domestic enterprises, scholars come to the conclusion that human capital can significantly promote the growth of enterprise value [1-4], suggesting that enterprises should further increase the use and cultivation of human capital [1-3], which is

conducive to improving the independent innovation ability of enterprises and is the source and core driving force of enterprise value growth [4].

Some scholars further put forward the concept of “heterogeneous human capital" and subdivided the contribution of different types of human capital to enterprise value. Schultz pointed out that human capital is an essential factor for enterprises to increase marginal rate of return and enhance enterprise value. He further clearly pointed out that human capital has heterogeneity and "professional human capital" has increasing returns [5]. These human capital have decisive significance for the growth of enterprise value and maintenance of competitive advantage. Romer's model of increasing returns also proves this point. It holds that specialized human capital itself has the characteristic of increasing returns, which means the more knowledge accumulated by human capital, the higher the marginal output rate will be.

"Heterogeneous" human capital is usually relative to "homogeneous" human capital. The current research on heterogeneous human capital in the academic circles basically focuses on the contribution of this kind of human capital in a certain aspect much higher than other kinds of human capital. It usually refers to special personnel with high knowledge accomplishment or technical level, who can improve production technology level or input-output efficiency. They usually can realize efficient allocation of resources, and in good innovation spirit and high learning ability in the production and operation of enterprises. Comprehensive domestic and foreign research literature, its common types mainly include entrepreneur human capital represented by entrepreneur ability, technology-based human capital represented by research and development personnel, knowledge-based human capital represented by highly educated personnel, and specialized human capital represented by personnel with specific technology, working skills and information, etc.

Specifically, scholars have carried out research on the relationship between heterogeneous human capital and enterprise value with different focuses. One part focuses on the human capital of the management team. They point out that human capital investment in key positions and managers can greatly improve the company's production efficiency [6]. An empirical study of the data of 42 British high-tech enterprises show that enterpriser-specific human capital has a more significant positive promoting effect on enterprises than general human capital [7]. A research subdivided the characteristics of the senior management team into age, tenure, education level and title, and found that all the variables except title significantly promoted the growth of enterprise value [8].

Part of the classification is by level of education. It showed that employing highly educated workers can increase enterprise value [9]. There was a significant positive correlation between the operating efficiency of a company and the educational level of employees [10]. Studies of small commercial and trade enterprises in East Africa and Taiwan biotechnology companies, the results showed that both education level and work experience can significantly promote the improvement of enterprise value [11,12]. Some scholars believe that intellectual capital is the knowledge stored in the minds of employees and intangible resources. Together with material resources, intellectual capital constitutes the total value of an enterprise, and such knowledge makes an enterprise unique [13]. It was proved that professional personnel, as measured by the proportion of employees with college degree or above, had a positive promoting effect on enterprise value [14].

Another part is aimed at the effect of technology-based human capital and other special heterogeneous human capital on enterprise value. A research conducted an empirical study on the data of listed agricultural enterprises and found that the higher the proportion of technical personnel and senior management personnel, the better the comprehensive performance of enterprises [15]. A series of scholars have demonstrated the same point of view: The more high-quality and technical talents an enterprise has, the stronger its vitality and innovation will be, and the stronger its core competitiveness will be.

Due to the availability of data, this paper mainly focuses on the influence of knowledge-based heterogeneous human capital and technology-based heterogeneous human capital on enterprise value in Chinese listed steel enterprises. Therefore, the following hypotheses are proposed in this paper:

H1: In listed steel companies, knowledge-based human capital has a significant positive impact on enterprise value.

H2: In listed steel companies, technical heterogeneous human capital has a significant positive impact on enterprise value.

3. RESEARCH DESIGN

3.1. Sample selection and data sources

This paper selects listed companies in Shanghai and Shenzhen A-share steel industry ("ferrous metal smelting and rolling processing industry") from 2015 to 2020 as the research object. This paper sorted out and counted the financial data disclosed by all listed companies in the steel industry as of December 31, 2020. After removing the sample companies with missing data and abnormal data, the balanced panel data of 35 listed companies in Shanghai and Shenzhen A-share steel industry in the past 6 years are obtained. A total of 210 study sample sites were selected.

The data in this paper mainly come from WIND database, CSMAR database and flush database. Stata13.1 and Excel are used to complete data processing.

3.2. Definition of variables

3.2.1. Explained variables

Enterprise value. Tobin Q, economic value added and related financial performance indexes are the main indexes to measure enterprise value. Based on existing literature research, Tobin Q is used to measure enterprise value, which not only takes into account the market value and book value of an enterprise, but also considerate the stock market value and debt market value of the enterprise, which is relatively comprehensive. The specific calculation method is the proportion of the sum of the market value of equity and the present value of debt to the total assets at the end of the period.

Tobin Q = (Price per share × number of outstanding shares + Net asset per share × number of non-outstanding shares + book value of liabilities) ÷ total assets (1)

3.2.2. Explanatory variables

About the measurement of human capital, the current research can be roughly divided into two types. One is measured based on the output from the perspective of wages and remuneration of human resources. The other is based on the input, which is measured by educational investment value, educational level and educational background of employees [16]. In addition, some scholars use the ratio of specific heterogeneous manpower to all employees to measure it [17]. Each method has its own advantages and disadvantages and is mainly selected according to the availability of data. From the statement data released by China's listed steel companies, we can get the educational background and post composition of each enterprise's employees over the years. While the salary stratification, income rules, specific training costs and other data are not available. Therefore, this paper chooses the most widely used method of years of education to measure the knowledge-based heterogeneous human capital. The ratio of technical R&D personnel to all employees is used to measure the technology-based heterogeneous human capital.

Knowledge-based heterogeneous human capital is calculated by means of years of schooling. The education level of employees is divided into five levels, namely high school or below, college degree, bachelor degree, master degree and doctor degree. Years of schooling followed by 12 years, 15 years, 16 years, 19 years and 22 years. Then taking the proportion of employees at all levels of education as the weight, the average length of education is calculated comprehensively.

Technology-based heterogeneous human capital = the number of technical R&D personnel ÷ the number of all employees. (2)

3.2.3. Control variables

Enterprise value is the result of a series of business decisions, which are influenced by business decisions, financing conditions and internal governance. Referring to existing literature, this paper takes enterprise size, employee size, enterprise age, capital structure and material capital as control variables to improve the accuracy of regression results. Among them, material capital, employee size and enterprise scale are all logarithmic in order to reduce the possible nonlinear relationship and non-stable sequence problems in regression analysis. Specific variables are described as follows.

Material capital. Material capital is expressed as the logarithm of net fixed assets. Generally speaking, the more material capital an enterprise has, the more disposable resources it has in the future, the better its expected growth and the greater its value.

Employee size. Employee size is expressed as the logarithm of the number of employees in an enterprise. Generally speaking, the more abundant the employee size and manpower, the more potential high-quality talents and the greater the value of the enterprise.

Enterprise scale. The enterprise scale is expressed as the logarithm of total assets. The influence of enterprise scale on enterprise value is complex. On the one hand, enterprises will have scale advantage in financing and management. On the other hand, it will also increase the operating cost, management cost and transaction cost of enterprises.

Capital structure. Capital structure is expressed as total liabilities as a percentage of total assets. Generally speaking, the debt to asset ratio reflects a company's long-term solvency. On the one hand, too much debt will increase the financial risk of enterprises. On the other hand, liabilities have tax saving effect and do not threaten the control right of enterprises.

Enterprise age. The year of investigation minus the year of establishment of the enterprise. Generally speaking, the longer an enterprise is established, the stronger its strength and the greater its value.

Table 1 Variable description

Characters of variables	Variable notation	Variable names	Variable definition
Explained variables	*Tobin Q*	Enterprise value	(Price per share × number of outstanding shares + Net asset per share × number of non-outstanding shares + book value of liabilities) ÷ total assets
Explanatory variables	*KBC*	Knowledge-based heterogeneous human capital	means of years of schooling mentioned above
	TBC	Technology-based heterogeneous human capital	the number of technical R&D personnel ÷ the number of all employees
Control variables	*LNFS*	Material capital	the logarithm of net fixed assets
	LNSN	Employee size	the logarithm of the number of employees
	LNTA	Enterprise scale	the logarithm of total assets
	DAR	Capital structure	total liabilities ÷ total assets
	AGE	Enterprise age	the year of investigation - the year of establishment

3.2.3. Model setting

This part empirically tests the influence of knowledge-based human capital and skill based human capital on the enterprise value of Chinese listed steel companies, and adopts the panel regression model as follows:

$$Tobin\ Q_{it}=\beta_0+\beta_1 KBC_{it}+\beta_2 TBC_{it}+\beta_3 LNFS_{it}+\beta_4 LNSN_{it}+\beta_5 LNTA_{it}+\beta_6 DAR_{it}+\beta_7 AGE_{it}+u_{it} \quad (3)$$

Note:$1\le i\le 35$，$2015\le t\le 2020$

i and t indicate the enterprise and year respectively. β_0 is Intercept item. u_{it} is the random perturbation term. The explained variable *Tobin Q* is the Tobin Q value corresponding to each enterprise every year. The explanatory variable KBC_{it} is the corresponding annual level of knowledge heterogeneity human capital of each enterprise. TBCit is the level of technology-based heterogeneous human capital corresponding to each enterprise each year. $LNFS_{it}$ is the logarithm of the net fixed assets of each enterprise for each year. $LNSN_{it}$ is the logarithm of the size of each company's workforce in each year. $LNTA_{it}$ is the logarithm of the total assets of each enterprise in each year. DAR_{it} The ratio of a company's annual debt to total assets. AGE_{it} indicates the number of years in which an enterprise has been established.

4. EMPIRICAL RESEARCH

4.1. Descriptive statistics

Table 2 Descriptive statistics

Variable	N	Mean	Std. Dev.	Min	Max
Tobin Q	210	1.31841	.5951117	.811279	4.38343
KBC	210	13.37276	.6631392	12.15244	15.11114
TBC	210	.0727867	.0517441	.004436	.3034728
LNTA	210	24.01582	1.180462	21.06625	26.59883
LNFS	210	23.01967	1.6186	13.58781	25.76166
LNSN	210	9.22431	0.8907931	7.239215	10.9535
AGE	210	20.98	3.936139	12	31.6
DAR	210	0.5527424	0.2131723	0.068619	1.11778

4.2. Correlation analysis

Pearson correlation test. It can be seen from the table that all selected variables are significantly correlated with enterprise value at the level of 0.05, indicating that variables are appropriately selected. Correlation coefficients between variables in the model constructed in this paper are all less than 0.6, indicating a low level of multi collinearity between variables.

Table 3 Results of correlation analysis

	Tobin Q	***LNTA***	***DAR***	***LNSN***	***TBC***	***AGE***	***KBC***	***LNFS***
Tobin Q	1.0000							
LNTA	-0.5984 ***	1.0000						
DAR	-0.2160 ***	0.4420 ***	1.0000					
LNSN	-0.5110 ***	0.5296 ***	0.4939 ***	1.0000				
TBC	-0.0341 **	-0.0364	-0.0599	-0.0588	1.0000			
AGE	-0.1822 ***	-0.0348	-0.1726 **	-0.0434	0.0507	1.0000		
KBC	-0.3562 ***	0.5762 ***	0.1057 *	0.4473 ***	0.1267 **	0.1462 **	1.0000	
LNFS	-0.4620 ***	0.5153 ***	0.5347 ***	0.4208 ***	0.0018	-0.0385	0.3238 ***	1.0000

Note: significance level:***=p<0.01; **=p<0.05; *=p<0.1

4.2.3. Unit root test and Hausman test

Use the Harris-Tzavalis unit-root test applied to the short panel. After the test, the explained variable, the explained variable and the control variable all passed the test at the significance level of 0.1. It shows that there is no panel unit root in panel data, which is stable data and can be used for regression analysis.

Table 4 Results of unit root test

Variable	Statistic	p-value
Tobin Q	0.2449***	0.0000
KBC	0.4392**	0.0319
TBC	0.3074***	0.0001
LNTA	0.3929***	0.0062
LNFS	0.4840*	0.0901
LNSN	0.4640*	0.0661
AGE	0.0000***	0.0000
DAR	0.4051***	0.0098

Note: significance level:***=p<0.01; **=p<0.05; *=p<0.1

Hausman test found that the p-value was 0.0014, so the fixed-effect model was used to determine the regression of variables.

4.2.4. Regression analysis

Table 5 Results of regression analysis

Tobin Q	Coef.	Std. Err.	t	P>|t|
KBC	.0014281	.1042601	0.01	0.989
TBC	2.709804	1.100295	2.46	0.015**
LNFS	.1117516	.0593363	1.88	0.061*
LNSN	.2978082	.1894105	1.57	0.098*
LNTA	-.8773357	.1742416	-5.04	0.000***
DAR	.9048953	.2742443	3.30	0.001***
AGE	.0027911	.0232026	0.12	0.904
R-squared 0.4907				

Note: significance level:***=p<0.01; **=p<0.05; *=p<0.1

Analysis of the model results is as follows:

There is a significant positive correlation between technology-based heterogeneous human capital and enterprise value in steel enterprises. At the significance level of 5%, the *TBC* regression coefficient is positive, and every change of 1 unit, the value of steel enterprises changes about 2.710 units. It can be seen that the ratio of R&D personnel has a significant impact on the enterprise value of steel enterprises, and the higher the ratio of R&D personnel, the greater the promotion of enterprise value, which verifies hypothesis 2.

There is no significant correlation between knowledge-based human capital and enterprise value in steel enterprises. *KBC* has a positive coefficient in the regression model, but the result is not significant. The results

show that knowledge-based human capital has no significant effect on enterprise value in steel enterprises. Hypothesis 1 is rejected. This may be due to the particularity of the industry. As a non-knowledge-intensive industry, steel enterprises have a large number of employees and more low-education workers, which makes the overall educational level is not high and the role of knowledge heterogeneity human capital is not prominent.

Except enterprise age, most of the control variables can play a significant role in the value of steel enterprises. The regression results of logarithm of total assets are significant, but the coefficient is negative, which means that the size of steel enterprises is negatively correlated with enterprise value, that is, the larger the enterprise size is, the lower the enterprise value is. This may be because listed steel enterprises are generally large-volume enterprises, which will increase the management cost and transaction cost of enterprises as the scale continues to increase, thus affecting the enterprise value. There is a significant positive correlation between the asset-liability ratio and enterprise value, which means that within a certain range, the higher the asset-liability ratio, the greater the enterprise value. The logarithm of employee size and fixed assets are the same as expected, showing a significant positive correlation with enterprise value, which means that sufficient human resources and material capital can help improve enterprise value.

4.2.5. Robustness analysis

In order to investigate the stability and reliability of the research conclusions, the robustness test was carried out by substituting the explained variables. Since non-tradable shares have a distorting effect on the price discovery mechanism of the stock market, *Tobin Q* is replaced with a different calculation method and regression analysis is conducted again.

Tobin Q= (market value of equity + market value of net debt)/(Total assets - net intangible assets) (4)

Among them, the market value of non-tradable equity is replaced by the stock price of tradable shares.

The results show that the value of the variable coefficient has changed, but the significance level of the variable and the positive and negative results of the coefficient have not changed significantly, and the results are robust.

5. MAIN RESEARCH CONCLUSIONS AND SUGGESTIONS

With today's society from the traditional industrial economy into the knowledge economy, heterogeneous human capital due to its scarcity, value and difficult to imitate, gradually become a modern enterprise in the market competition to maintain vitality and innovation advantage of strategic resources. In steel enterprises, we should pay special attention to the training and investment of technology-based heterogeneous human capital represented by R&D personnel. To this end, this paper gives the following suggestions:

Firstly, in the process of changing the growth mode of steel enterprises, we should attach strategic importance to the construction of technology personnel team, and guide the whole link of human capital planning, recruitment and allocation, training and development, performance and incentive by strategy.

Secondly, in resource investment and management, compared with knowledge talents, steel enterprises should increase the introduction and training of technology talents, through job training, mentoring and other forms to improve the skills of steel enterprise employees. At the same time, increase the investment in research and development, optimize the integration of skills, personnel, equipment, capital and other factors to achieve the best human capital investment benefits, and give full play to the promotion effect of technology-based human capital.

Thirdly, under the background of industry 4.0, steel enterprises should pay attention to the development of research and development activities, realize the fit of skilled talents and research and development activities, and promote the construction and rational allocation of talent team by daily research and development activities.

ACKNOWLEDGEMENTS

This research was funded by (a) the Youth Foundation for Humanities and Social Sciences Research of the Ministry of Education of China (Grant No. 20YJCZH084): "Research on Green Technology Innovation and Policy in the Yangtze River Economic Belt from the Perspective of International Technology Spillover";

and (b) 2020 Science-Technology Innovation Team Project for Outstanding Middle-aged and Young Researchers in Higher Education Institutions of Hubei Province (Grant No. T2020035): "Research on business environment evaluation and policy based on uncertain circumstances";

and (c) Education Science Planning project of Hubei Province(Grant No. 2020GB083):Research on high-quality development of undergraduate education of Business Economics major based on "whole-course tutorial System".

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