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Study on Enterprise Value and Asset Structure Optimization of the Iron and Steel Industry in China under Carbon Reduction Strategy

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Abstract

The iron and steel sector is caught between two worlds: "carbon reduction" and "development." The goal of this study is to show that optimizing asset structure to boost intangible assets, particularly brand assets, is a viable strategy to achieve low-carbon development. This study uses panel data from 38 A-share companies in China's iron and steel industry from 2010 to 2020, as well as World Brand Lab data, to create a comprehensive impact index of enterprise value from the standpoint of an asset structure optimization, and to test the impact of intangible assets and brand equity on enterprise value. The findings show that: the asset structure of iron and steel enterprises is closely related to enterprise value, implying that iron and steel industry development necessitates a transformation of quantity control and quality improvement; the proportion of intangible assets in the asset structure of iron and steel enterprises plays a positive and critical role in enterprise value under surplus conditions. The iron and steel industry begins to shift from tangible to intangible assets; there is heterogeneity in the iron and steel industry transformation. Given certain technological levels, the share of brand assets contributes significantly to the increase in enterprise value.

Keywords: Enterprise Value, Asset Structure Optimization, Iron and Steel Industry, Low-Carbon Sustainable Development

JEL Classification Code: D02, D22, L61

1. Introduction

The global iron and steel industry is up against a long-term challenge of low-carbon, long-term development. China is the world's greatest producer of iron and steel. In China, and even globally, the iron and steel industry is still a major carbon emitter. Realizing a low-carbon shift is still a difficult task. According to data from China's National Bureau of Statistics, China's raw steel output accounted for 56 percent of global output in 2020, and the iron and steel industry's carbon emissions accounted for more than 60 percent of global iron and steel carbon emissions and about 15 percent of China's national carbon emissions. The iron and steel industry continues to be the source of the most carbon emissions.

"Carbon reduction" becomes a national priority strategy during the "14th Five-Year Plan" as the "Carbon Peak and Carbon Neutral" target is suggested. Carbon reduction in the iron and steel sector will face numerous hurdles as a result of tightening governmental limits and a complex changing market environment. "Cutting manufacturing capacity and reducing carbon emissions" has a finite amount of room. "Technology-based carbon reduction" comes at a high price. Industrial integration can help businesses achieve economies of scale and increase their competitiveness (Nguyen & Tran, 2021). However, the size of a business cannot be increased indefinitely (Luu, 2021).). Furthermore, like most Chinese manufacturing businesses, the iron and steel industry is still in the early stages of development, from low-end locking to middle- and high-end breakthroughs. It is heavily reliant on international orders and raw resources, and cannot make significant profits from design, R&D, or marketing. On the one hand, "the entire industry is working for the international behemoth of iron ore," and the increase in iron ore import

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prices reduces profit margins. Iron and steel companies, on the other hand, lack brand premium capacity and are unable to quickly raise prices, thus reducing profit margins and impeding industrial transformation.

Not only must the iron and steel sector add economic value, but it must also add strategic value. What changes are required for iron and steel companies to achieve the dual goals of carbon reduction and sustainable development, given the pressures of the "double circulation" strategy and carbon constraints? Is there any new carbon reduction alternative for the iron and steel sector besides "cutting production capacity and decreasing carbon emissions" and "technology-based carbon reduction"? The iron and steel business, as a classic heavy industrial department, places a premium on tangible assets. In the information economy, intangible assets are becoming the most important factor in generating corporate value. Intangible resources have qualities that contribute to an organization's core competitiveness, such as value, scarcity, irreplaceability, and duplication challenges (Barney, 1991). When iron and steel companies shift their focus from tangible asset expansion to intangible asset expansion, the proportion of intangible assets in the asset structure increases, and given a certain proportion, the proportion of brand assets increases, and the asset structure is continuously optimized. This might be one of the transformation directions of iron and steel enterprises in the new situation. From the perspective of an optimization of asset structure, by exploring influences of asset structure on enterprise value and relevant reasons, this study provides operation and transformation suggestions for iron and steel enterprises to increase the enterprise value. Based on financial panel data of 38 A-share iron and steel enterprises in China, a multiple regression model was built. An experiment was carried out to test whether increasing total intangible assets and their proportion in the total assets continuously as well as increasing the proportion of brand assets continuously can optimize the asset structure and improve the enterprise value.

They strive to tackle difficulties in different stages of growth from the perspectives of supply-demand imbalance, surplus production capacity, industrial concentration ratio, and supply-side structural reform in iron and steel studies. In comparison to this research, this one makes a few minor contributions: 1) It focuses on internal driving forces of enterprise development within the iron and steel industry and recognizes the role of different asset types in an increase of enterprise value. Moreover, the existences and positive roles of intangible assets on the increase of enterprise value in the industry are verified through an empirical analysis; 2) Through brand construction, it can increase the brand premium capacity and provide sustainable profit supports to the high inputs to carbon reduction. For this reason, possible influences of brand assets on enterprise value were further recognized based on evaluation of "excellent iron and steel enterprise brand" and the Chinese brand top 500 enterprises published by the World Brand Laboratory.

2. Development History of China's Iron Steel Industry

Since the founding of the People's Republic of China, China's iron and steel industry has risen from zero to number one in the world. Since Economic Reform and Open Up, the iron and steel industry, in particular, has seen a history of recovery, strengthening, and increasing. In general, China's iron and steel industry development can be split into three stages.

2.1. Stage of Steady Development (The Beginning of Reform and Opening Up ~ late 20th Century)

China has energetically promoted economic system reform and enhanced management autonomy in iron and steel firms since Economic Reform and Open Up. The iron and steel industry's scale and quantity expansion resulted in a major supply-demand imbalance. The iron and steel industry's development should focus on internal structural optimization rather than overall expansion (Chen, 1998). In terms of iron and steel product kinds, quality structures, techniques, and technical device structures, as well as company organizational structure, China still lags behind countries with mature industries (Sun, 1998). Product structural changes should alter the notion by focusing on technology innovation and developing a long-term strategy. During this time, special attention was devoted to structural imbalance issues in the iron and steel industry's recovery and development stages, and qualitative assessments based on case studies and surveys were conducted. It lacked quantitative investigations on empirical tests, though.

2.2. Stage of Leapfrog Development (Early 21st Century ~ 2014)

2.2.1. After China's Accession to the World Trade Organization

China became a member of the World Trade Organization in 2001. (WTO). Some academics have moved their focus from domestic to worldwide market development in the iron and steel industry. China's iron and steel businesses lacked worldwide competitiveness due to a lack of scale effect. As the effects of the financial crisis faded, the iron and steel industry's scale expanded as a result of market forces. Steel consumption has increased as a result of investments in infrastructure, real estate development, and export trading. Meanwhile, issues including supply-demand imbalances and low industrial concentration grew in prominence. Imports were largely used for high-value-added items and specific steel products, while production capacity for ordinary products such as ribbed bars and wires increased (Gao et al., 2004). As a result, it was difficult to actualize the economy's size (Xu & Han, 2006), and it would also result in high total energy consumption, severe environmental pollution, and market turmoil, limiting overall competitiveness growth. Different viewpoints were proposed by some academics. Industrial progress was accompanied by industrial concentration. China is still to complete its industrialization task, and it has taken a long time to realize saturated iron and steel demand. Overinvestment in the iron and steel industry, as well as excess production capacity, would be unavoidable (Yang & Zhao, 2004). Longitudinal integration strategies are commonly utilized by China's listed iron and steel corporations to deal with supply-demand imbalances between the upstream and downstream of the sector, which are created by the rapid expansion of production capacity. It is a normal occurrence in this process for low industrial concentration and high industrial profitability to coexist, which is not a sign of deteriorating industrial organization structure. (Wu et al., 2008; Pian et al., 2014).

2.2.2. China Sets Targets for Energy Conservation and Emission Reduction

In 2006, the "11th Five-Year Plan Outline" proposed energy-saving and emission-reduction constraint indices, which posed a new challenge to the iron and steel sector. Energy conservation, pollution reduction, and circular economy became research hotspots at this point. Several measures, for example, have been proposed, including strictly controlling newly increased production capacity, abandoning backward production capacity, promoting clean production standards, increasing pollution control, optimizing energy consumption structure, and fully recycling residual heats and pressure based on technological advancements (Wei, 2008; Liu & Cao, 2008; Xu & Zhao, 2009). Furthermore, some researchers have looked into the impact of green trading policies (export rebate policies) on the iron and steel industry's energy efficiency and emissions reduction. The export rebate rate was adjusted in favor of improving the structure of iron and steel goods (Wu et al., 2010; Dou, 2012). To address excess production capacity, low industrial concentration, high energy consumption, and excessive pollution, qualitative and quantitative combination studies of the iron and steel industry were conducted at this stage.

2.3. Stage of Innovation Development (Since 2015)

Since 2015, the third stage has been a supply-side structural transformation and innovative development. Excessive industrial investment, slowed domestic demand, impediments to steel material export, low concentration of the iron and steel industry, rising iron ore prices, and excessive local government interference are all contributing factors to the iron and steel sector's surplus production capacity (Zhang et al., 2014). Local government decisions based on GDP, in particular, resulted in the industry's excess production capacity being treated for a long time (Chen & Sun, 2013). Non-market variables, such as financial assistance and sunk costs, also limit the automatic adjustment of supply and demand by market factors in iron and steel firms. To address surplus production capacity, China should, on the one hand, extend the Belt and Road strategy's international iron and steel markets while limiting output expansion of low-end iron and steel products (Ni et al., 2016). On the other hand, it was suggested that the iron and steel sector optimize its production structure, deepen supply-side structural reform, and encourage benign firm mergers and recombination (Chen & Li, 2016). Studies at this point concentrated on the "permanent" excess production capacity that had existed since the early high-quality development of the iron and steel industries.

In a nutshell, the academic community has been watching the iron and steel industry's expansion and devoting itself to exploring and solving industrial difficulties, which has aided China's transition from a large iron and steel manufacturer to an iron and steel power. Currently, the iron and steel sector is embarking on a new path of low-carbon, long-term development. To achieve the new goal of "carbon reduction," the iron and steel industry can optimize asset structure by increasing proportions of intangible assets, particularly the proportion of brand assets, increasing enterprise value, strengthening endogenous power and risk resistance for enterprise development, and consolidating foundations for the industry's long-term stable development.

3. Theoretical Basis and Research Hypotheses

3.1. Theoretical Basis

Enterprise value is a market assessment of a company's tangible and intangible assets. The composition ratios of distinct assets and proportional relations, primarily including proportions of different assets in total assets, are referred to as asset structure. Asset structure is found to be highly connected to enterprise value. A high return on assets is achieved by having a high proportion of monetary capital and other current assets, as well as a low proportion of inventory and fixed assets. Companies with a lot of cash make a lot of money (Dittmar et al., 2003). A good asset structure can help businesses make the most of their assets and increase earnings.

Scholars also explored the impact of intangible assets on business value. "Given the excessive market conditions," Sun (2015) felt, "satisfaction of consumer wants to be offered by tangible assets or material profits of items is marginally reducing, while beautiful experiences brought by emotional profits that can meet happiness desire is marginally expanding." It is more favorable to convert a tangible asset operation to an intangible asset operation based on tangible assets to boost enterprise incomes and promote enterprise value growth. There have been few studies on the impact of intangible assets on enterprise value. A number of prominent viewpoints have been suggested. The operation of intangible assets is beneficial to preserving or enhancing value, therefore improving enterprise value (Zhao, 2005). In most situations, Chinese companies' intangible assets have considerable positive connections with stock prices (Li & Zhan, 2005). Enterprise value is adversely connected with heavy assets, whereas the light-heavy asset ratio is positively correlated (Wu, 2018). Intangible assets have a positive impact on the efficiency with which business values are created. Both brand assets and intellectual property can help to increase the value of a company (Wang & Xu, 2019). Increasing intangible assets may greatly boost enterprise value, and it contributes more than fixed assets (Al-Ani & Tawfik, 2021).

The relationship between brand assets and company value is a hot topic in academia. By researching security industry data, researchers discovered that brand assets can greatly increase firm value (Srinivasan & Hanssens, 2008). Brand assets influence firm operating performance through customer psychological reactions, and they, directly and indirectly, affect investors' return on equity in the capital market (Mizik & Jacobson, 2005). The enterprise values of listed companies with well-known trademarks have dramatically increased (Zhang, 2018). Furthermore, brand assets have a positive relationship with stock prices (Yeung & Ramasamy, 2012)

3.2. Research Hypotheses

The studies mentioned above are mostly aimed at obtaining sample inferences based on finite samples. They are merely restricted by samples and still fall under the category of experiences or rational thought, with no overarching meaning. Sun and Shao (2021) offered a novel argument based on mathematical logic that intangible assets, particularly brand assets, have favorable benefits on company value in excess market conditions. They then proposed the intangible asset ratio theorem, brand asset intensity theorem, and intangible asset intensity theorem in that order. This conclusion gives a solid theoretical foundation and modeling concept for future research into whether variables connected to asset structure and enterprise value can establish theories and logic relationships that can be evaluated repeatedly. It corresponds to the category of strong general meaning.

China's iron and steel industry is now experiencing excess capacity. The following hypotheses concerning the enterprise value of the iron and steel industry were provided based on the above three theorems deduced by Sun and Shao (2021) according to the asset structure optimization path:

H1: *Given the excess production capacity of the iron and steel industry, the proportion of intangible assets in asset structure plays a decisive role in the growth of enterprise value, and it thereby becomes the key in asset structural optimization of enterprises.*

H2: *Given the excess production capacity and fixed technological level, the key of intangible asset structures of iron and steel enterprises is to increase the proportion of trademark-based brand assets and thereby achieve the proportion of revenue sharing as high as possible.*

4. Data and Methodology

4.1. Variable Selection and Data Source

Price-to-book (PB) was chosen as the explained variable (a universal index to evaluate enterprise quality and value in the capital market), while proportions of different types of assets in total assets were chosen as explanatory variables, including a proportion of monetary capitals, proportion of accounts receivable, proportion of inventory, proportion of fixed assets, the proportion of intangible assets, and proportion of fixed assets, according to Sun and Shao (2021). These were the six variables used to assess a company's asset structure. Meanwhile, the control variables were asset-liability ratio (ALR), total assets turnover, total assets, equity concentration degree, and increase the rate of business revenue, which represent asset structure, operation capacity, enterprise-scale, enterprise governance structure, and enterprise growth, respectively. They all have important influences on enterprise values. The selection of specific indexes is listed in Table 1.

The China Stock Market & Accounting Research Database (CSMAR) and annual reports of sample firms provided data for numerous variables. From 2010 to 2020, seasonal statistical data from 38 A-share iron and steel firms in the Wind industrial classification were selected. Firms that were listed for less than two years, as well as ST and *ST companies, were all removed. Furthermore, missing observation values for independent variables were removed, and nonequilibrium panel data was used for regression analysis. To reduce the influence of aberrant values,

Table 1: Definition of Variables

Variable Type	Variables	Variable Index	Sign	Formula
Explained variable	Enterprise value	Price/book value ratio	PB	Price per share/net asset value per share
Explanatory variables	Asset structure	The proportion of monetary capitals	$huobi_1$	Monetary capital/total assets
		The proportion of accounts receivable	$yingshou_2$	Accounts receivable/total assets
		Proportion of inventory	$cunhuo_3$	Inventory/total assets
		The proportion of fixed assets	$guding_4$	Fixed assets/total assets
		The proportion of intangible assets	$wuxing_5$	Intangible assets/total assets
		The proportion of current assets	$liudong_6$	Current assets/total assets
Control variables	Capital structure	Asset-liability ratio	rla	Liabilities/total assets
	Operation capacity	Total assets turnover	tpc	Operation revenues/total assets at end of term
	Enterprise-scale	Total assets of enterprises	es	Natural logarithm of total assets at end of the year
	Governance structure	Equity concentration degree	oc	Number of shares of the largest shareholder/total shares
	Growth ability	Increase rate of business revenue	oig	(Operation revenues of the year)–Operation revenues of the last year)/ Operation revenues of the last year

Winsorize treatment was applied to all dependent variables between 1% and 99 percent.

4.2. Model Construction

Financial panel data of 38 A-share iron and steel enterprises in China from 2010 to 2020 were applied to construct the regression model. An analytical analysis of influencing factors of enterprise value was carried out from the perspective of asset structure. Generally speaking, given excess production capacity, the higher proportion of intangible assets in the total assets can increase enterprise value more effectively compared to other assets. Moreover, the higher proportion of brand assets in intangible assets could increase enterprise value more compared to other assets. The econometric model is introduced as follows:

$$\begin{aligned} PB_{it} = a_{it} + b_0 + b_1\, huobi_{1it} + b_2\, yingshou_{2it} \\ + b_3\, cunhuo_{3it} + b_4\, guding_{4it} + b_5\, wuxing_{5it} \\ + b_6\, liudong_{6it} + b_7\, rla_{it} + b_8\, tpc_{it} \\ + b_9\, es_{it} + b_{10}\, oc_{it} + b_{11}\, oig_{it} + e_{it} \end{aligned} \quad (1)$$

To assure robustness of regression results, the price/book value ratio (PB) was replaced by Tobin's Q, and a new model was constructed:

$$\begin{aligned} TQ_{it} = a_{it} + b_0 + b_1\, huobi_{1it} + b_2\, yingshou_{2it} \\ + b_3\, cunhuo_{3it} + b_4\, guding_{4it} + b_5\, wuxing_{5it} \\ + b_6\, liudong_{6it} + b_7\, rla_{it} + b_8\, tpc_{it} \\ + b_9\, es_{it} + b_{10}\, oc_{it} + b_{11}\, oig_{it} + e_{it} \end{aligned} \quad (2)$$

Where PB refers to the price/book value ratio and TQ refers to the value of Tobin's Q. $huobi_1$ denotes the proportion of monetary capital. $yingshou_2$ is the proportion of accounts receivable. $cunhuo_3$ reflects the proportion of inventory. $guding_4$ shows the proportion of fixed assets. $wuxing_5$ is the proportion of intangible assets. $liudong_6$ refers to the proportion of current assets. rla refers to the asset-liability ratio. tpc is the total assets turnover. es refers to the total assets of an enterprise. oc represents the degree of equity concentration, and oig shows the increasing rate of business revenues. a_{it} is the intercepted item and b_0 is the constant term. b_1, b_2, …, b_6 are coefficients of explanatory variables. b_7, b_8, …, b_{11} are coefficient of control variables.

e_{it} is a random disturbance term, which obeys the normal distribution and is mutually independent.

5. Results and Discussion

5.1. Descriptive Statistics

Table 2 shows that the mean of PB is 1.702, indicating that the sample companies' market value is somewhat greater than their net book value and that the iron and steel industry's listed enterprises have a solid overall operational state. The standard deviation of PB, on the other hand, is 1.434, showing significant variances in business value across industries and severe competition. In various explanatory factors, the mean, minimum, and maximum of $yingshou_2$ are 0.0405, 0, and 0.198, respectively, indicating a low proportion of accounts receivable in listed iron and steel industries. On the surface, low $yingshou_2$ data shows that businesses are in better financial shape and have a competitive edge. However, according to a review of the iron and steel industry's development during the last ten years, this could be tied to client needs. Customers typically buy bulk commodities using bank loans, however, bulk commodities may also offer mortgage loans. The loans are then paid straight to the iron and steel mills.

The mean, minimum, and maximum of $guding_4$ are 0.391, 0.0820, and 0.760, respectively, indicating the relatively high overall fixed asset input. This is consistent with industry features such as equipment concentration and a focus on physical assets, as well as large gaps in enterprise size and a low degree of industrial concentration. The SD is 0.0366, while the mean, minimum, and maximum of $wuxing_5$ are 0.0416, 0, and 0.156, respectively. This indicates that the share of intangible assets in sample businesses is extremely low, even zero, implying a small SD. Intangible assets input to the iron and steel sector has a lot of room to grow in the future. The mean, lowest, and maximum of ALR in various control variables are 0.568, 0.110, and 0.992, respectively. The iron and steel industry's overall liability ratio is less than 60%, although the ALR of some companies exceeds 90%.

The mean, minimum, and maximum of tpc are 0.586, 0.0503, and 1.909, respectively. The overall total assets turnover is relatively low, accompanied by great differences. Hence, the asset operation capability of listed iron and steel enterprises has to be further improved. The mean of es is 23.84 and SD is 1.23, indicating that the total assets of the iron and steel industry are at a high level and there are significant differences among different enterprises. In the future, asset operation shall pay more attention to structural optimization. The oc mean is 0.490. In general, controlling shareholders in China's iron and steel industry have significant equity control capacity over their companies. oig has a mean of 0.393, a minimum of –0.845, and a maximum of 1.735. The iron and steel industry's average growth rate of operating revenues is 39.3 percent, showing that the industry is still in its high-speed development stage. The growth rate of accounts receivable, on the other hand, indicates that industrial development is obviously out of equilibrium.

5.2. Effects of Intangible Assets on Enterprise Value

According to the LSDV test, it finds that most dummy variables of sample enterprises are significant ($P < 0.05$),

Table 2: Descriptive Statistics of Variables

Variables	Number	Mean	Std.Dev	Min	Max
PB	1309	1.702	1.434	0.455	8.822
TQ	1309	1.232	0.498	0.768	3.856
$huobi_1$	1309	0.121	0.0790	0.0103	0.368
$yingshou_2$	1309	0.0405	0.0449	0	0.198
$cunhuo_3$	1309	0.144	0.0674	0.0283	0.326
$guding_4$	1309	0.391	0.156	0.0820	0.760
$wuxing_5$	1309	0.0416	0.0366	0	0.156
$liudong_6$	1309	0.435	0.148	0.112	0.790
rla	1309	0.568	0.205	0.110	0.992
tpc	1309	0.586	0.405	0.0503	1.909
es	1309	23.84	1.230	21.06	26.31
oc	1309	0.490	0.162	0.161	0.825
oig	1309	0.393	0.682	–0.845	1.735

thus rejecting the null hypothesis. Hence, the fixed-effect model is used. Meanwhile, the Hausman test results are chi^2 (12) = 19.53 and P-value = 0.0765, thus rejecting the null hypothesis that "the random effect model is an accurate model". Hence, the fixed-effect model was applied in the present study. Regression results are listed in section "Asset Structure and Enterprise Value" of Table 3.

The proportion of intangible assets is proportionate to enterprise value, and their marginal contributions to enterprise value are higher than those of other types of assets, according to a comparison of estimation variation coefficients and significance. This is in line with what theorists predicted. In particular, the proportion of monetary capital is relevant at the 10% level, implying that it has only little effect on firm value. The proportion of accounts receivable is substantial at 5%, and for every 1% increase in the proportion of accounts receivable, enterprise value increases by 3.902 percent. To a significant extent, the percentage of accounts receivable

Table 3: Relevant Empirical Results

Variables	Asset Structure and Enterprise Value		Effects of Brand on Enterprise Values		Effects of Brand Assets on Enterprise Value	
	(1)	(2)	(1)	(2)	(1)	(2)
	PB	PB	PB	PB	PB	PB
			Brand Enterprises	Non-Brand Enterprises	Brand Enterprises	Non-Brand Enterprises
$huobi_1$	–1.145*	–1.179*	3.577**	–0.726	3.317*	–0.753
	(–1.74)	(–1.72)	(2.00)	(–0.97)	(1.96)	(–0.98)
$yingshou_2$	3.902**	9.756***	–18.06***	5.500***	–12.82*	5.563***
	(2.01)	(5.56)	(–2.65)	(2.63)	(–1.97)	(2.62)
$cunhuo_3$	–6.897***	–1.812**	1.139	–8.455***	–2.188	–8.691***
	(–6.76)	(–2.01)	(0.57)	(–7.27)	(–1.10)	(–7.01)
$guding_4$	2.568***	2.892***	–3.121***	2.304***	–2.713**	2.427***
	(5.18)	(5.85)	(–2.79)	(4.07)	(–2.56)	(4.17)
$wuxing_5$	7.348***	4.262***	21.92***	5.989***	22.86***	6.331***
	(4.24)	(4.49)	(3.42)	(3.20)	(3.77)	(3.33)
$liudong_6$	3.827***	2.843***	–8.662***	3.741***	–10.09***	3.982***
	(5.60)	(4.23)	(–5.19)	(4.62)	(–6.31)	(4.83)
rla	4.227***		3.568***	4.183***	0.00182***	–0.000162
	(12.28)		(3.46)	(10.98)	(5.18)	(–0.84)
tpc	–0.0898		–0.413***	–0.0470	2.579**	4.300***
	(–0.94)		(–2.68)	(–0.44)	(2.60)	(11.08)
es	–0.751***		–0.190	–1.060***	–0.387***	–0.0305
	(–7.77)		(–1.25)	(–7.91)	(–2.66)	(–0.27)
oc	–0.918**		–5.471***	–0.774	–0.0986	–1.060***
	(–2.39)		(–10.27)	(–1.43)	(–0.68)	(–7.70)
oig	–0.00228		0.115*	–0.0184	–5.469***	–0.955*
	(–0.05)		(1.79)	(–0.37)	(–10.87)	(–1.70)
_cons	15.71***	–0.803*	11.07***	23.15***	0.0960	–0.0260
	(6.38)	(–1.80)	(2.89)	(6.68)	(1.58)	(–0.52)
N	1309	1309	240	1069	9.885***	23.00***

Source: STATA 15. Notes: ***, ** and *indicates significant at 1%, 5% and 10% level of significance based on *t*-statistics.

reflects the current state of excess production capacity in the iron and steel industry. Due to excess manufacturing capacity, iron and steel companies are forced to sell on credit to remain competitive in the market. The inventory proportion is significant at the 1% level, and every 1% increase results in a 6.897 percent drop in enterprise value.

This also indicates the iron and steel industry's excess production capacity. Iron and steel companies stockpile iron ores as a result of global iron ore price fluctuations, causing inventory management issues. The share of fixed assets is considerable at 5%, and every 1% increase in fixed assets corresponds to a 2.568% increase in enterprise value. The iron and steel business is a heavy sector, and increasing production scale necessitates significant fixed asset investments. This is also the reason for China's iron and steel industry's rapid growth. However, due to surplus production capacity, mergers and recombination are slowing, production scale cannot expand indefinitely, and fixed asset input is limited.

On a 1% scale, the proportion of intangible assets is considerable, and every 1% increase can result in a 7.348 percent increase in enterprise value. Table 2 shows that, although intangible assets account for a small percentage of total assets in China's iron and steel companies, their parameter coefficient to enterprise value, also known as the marginal contribution, is relatively high. This confirms H1 by implying that the proportion of intangible assets has a high potential for improving the value of the iron and steel industry. Optimization of asset structure and transformation development of iron and steel firms are primarily to enhance the proportion of intangible assets in a market setting with excess production capacity.

"Intangible assets reflect innovation capabilities of firms to a very big extent, especially in patent technologies (hard inventions) and trademark income," Sun and Shao (2021) believed (soft innovations). When businesses reach specific technological milestones, the key to growth is trademark-carrying brand asset construction." The coefficient of the proportion of intangible assets is higher than those of other types of assets, indicating that intangible assets begin to exert positive impacts on enterprise value and iron and steel enterprises began to implement transformation. However, the share of intangible assets was still insufficient, and it was not the primary driver of further enterprise value increase. As a result, the key to the iron and steel industry's future development is a shift from "trademark input" to "brand construction" at specific technological levels, with the goal of building strong brands and increasing brand premium capacity.

5.3. Correlation Test and Robustness Test

It can be seen from correlation test results in Table 4 that the maximum variance inflation factor (VIF) is 5.54, which is far smaller than 10. This reflects that the explanatory variables and control variables have no multicollinearity, which assures the validity of regression results.

Table 4: Correlation Analysis and Robustness Test Results

Variables	VIF	Regression coefficient	*T*-value
$huobi_1$	2.07	–1.090***	–5.29
$yingshou_2$	2.59	0.523	0.92
$cunhuo_3$	2.6	–2.035***	–6.51
$guding_4$	3.3	0.978***	6.53
$wuxing_5$	1.57	1.538*	2.95
$liudong_6$	5.54	1.481***	6.99
rla	1.94	0.431***	4.14
tpc	1.43	–0.035	–1.13
es	2.19	–0.241***	–9.45
oc	1.46	–0.465***	–4.01
oig	1.07	–0.002	–0.15
Cons	1.94	6.712***	9.63

Notes: ***, ** and *indicates significant at 1%, 5% and 10% level of significance based on *t*-statistics.

Tobin's Q is an important index proposed by Lang and Stulz (1994) et al. to measure enterprise value. It not only can reflect the current value of an enterprise but also can disclose its expected profits. As an important index that measures whether the market values of an enterprise are overestimated, Tobin's Q has been extensively used in studies on the market values of Chinese enterprises. Hence, Tobin's Q was used to replace PB in the robustness test, aiming to assure the stability of regression results. Results are listed in Table 4.

According to the comparison of Table 3 and Table 4, most variables have consistent signs and signs with the original regression results, indicating that the regression results by replacing *c* with Tobin's Q are relatively stable. Hence, the robustness of the original regression results is proved.

According to regression results of PB in Table 3 and Tobin's Q in Table 4 regression coefficients were normalized. Weights of influences of each variable on enterprise value were calculated. On this basis, Table 5 was gained.

According to Table 5, 1) during regression with PB, the influences of on enterprise value achieve not only the maximum marginal value, that is, regression coefficient, but also the maximum weights. In regression results with Tobin's Q, the regression coefficient and weights of are only next to those of . The high coefficient indicates the high marginal value, indicating that enterprise development in the future shall pay more attention to intangible assets. 2) The influencing coefficients of on enterprise value are negative

Table 5: Normalization Results of Independent Variables

Variables	The Marginal Value of PB	Weights of PB	The Marginal Value of Tobin's Q	Weights of Tobin's Q	The Marginal Value of Brand Enterprises	Weights of Brand Enterprises	The Marginal Value of Non-Brand Enterprises	Weights of Non-Brand Enterprises
$huobi_1$	–1.145	0.045	–1.090	0.143	3.577	0.063	–0.726	0.027
$yingshou_2$	3.902	0.152	0.523	0.068	–18.06	0.320	5.500	0.206
$cunhuo_3$	–6.897	0.268	–2.035	0.266	1.139	0.020	–8.455	0.317
$guding_4$	2.568	0.100	0.978	0.128	–3.121	0.055	2.304	0.086
$wuxing_5$	7.348	0.286	1.538	0.201	21.92	0.388	5.989	0.224
$liudong_6$	3.827	0.149	1.481	0.194	–8.662	0.153	3.71	0.139

in both regressions with PB and Tobin's Q. Moreover, there are high weights. It is worth noting that the regression coefficient of is negative and it also reflects the excess production capacity which has been existing in the iron and steel industry. In other words, iron and steel enterprises have to arrange production reasonably, strengthen inventory management and decrease inventory size. 3) Marginal values of other indexes in both regression methods have consistent signs, but there are differences in numerical values. This just reflects the differences between regression methods using PB and Tobin's Q.

The mean, SD, minimum, and maximum of are 0.0461, 0.037, 0.000 and 0.156, respectively. The low amount of intangible assets in Chinese iron and steel companies is striking. Both the marginal value (regression coefficient) of the fraction of intangible assets and the weights after coefficient normalization show considerable positive effects on enterprise value in both the PB and Tobin's Q regression methods. This simply suggests that, in the future, increasing the proportion of intangible assets will provide significant growth opportunities for businesses. This is something that Chinese iron and steel executives should pay close attention to. If the proportion of intangible assets in the asset structure can be enhanced even higher, the enterprise value will undoubtedly rise.

5.4. Effects of Brand Assets on Enterprise Value

5.4.1. Preliminary Analysis

According to the research of the core competitiveness of 38 A-share iron and steel companies revealed in annual reports, companies that place a high priority on intangible asset management and brand development have greater advantages and higher values. For the regression test, the 38 listed iron and steel firms were split into brand enterprises and non-brand enterprises based on further investigation of the effects of brand assets on enterprise value. (The division is based on the following: Since 2017, China Metallurgical News has been selecting the "Outstanding Steel Enterprise Brand" in the steel industry, and we have separated the firms chosen as the outstanding steel brand in 2017-2020 into brand enterprises and brand enterprises. Due to the fact that China's top 500 brand businesses were not selected before 2017, the world Brand Laboratory released China's top 500 brand enterprises as the basis for converting China's top 500 steel brands into brand enterprises. It should be highlighted that the top 500 steel brands in China from 2017 to 2020 have been designated as exceptional steel brand companies). Table 3's "Effects of Brand on Enterprise" section contains the results.

A comparison of the effects of the brand on enterprise values in Table 3 shows that the regression coefficient of wuxing5 is more than 0 and significant at the 1% level, indicating the relevance of raising the share of intangible assets in asset structure optimization. Furthermore, the wuxing5 regression coefficient for brand firms is 21.92, which is significantly higher than the wuxing5 regression coefficient for non-brand enterprises (5.989). This demonstrates that brand plays a significant role in the creation of intangible assets and is beneficial to increasing enterprise values, proving H2. The regression findings of both brand and non-brand firms were adjusted in the same way.

5.4.2. Further Analysis

The registered trademarks of enterprises are the sole element for legal continuous operation. Intangible assets can bring lasting benefits (Sun & Shao, 2021). As a result, brand assets carried by trademarks were chosen for examination separately from intangible assets. In this study, brand assets were chosen as 5% of sales revenues of brand enterprises in the iron and steel industry, whereas non-brand firms' brand assets were chosen as 2% of sales revenues.

(To charge trademark licensing fees, each firm normally takes sales revenue as the base in line with a specific proportion (international standard 5%).) The variable of brand assets intensity ($brand_7$ = brand assets/intangible assets) was set and put into Model (1). Empirical tests of brand and non-brand firms were conducted, respectively.

Table 3's section "Effects of Brand Assets on Enterprise Value" contains the results. The regression coefficients of $wuxing_5$ are significantly positive in both brand and non-brand firms, as shown in columns (1) and (2). Furthermore, the regression coefficient of $wuxing_5$ of brand firms is much greater than that of non-brand enterprises, confirming the previous findings. Furthermore, the regression coefficient of $brand_7$ is only significantly positive in brand companies, while it is very small and inconsequential in non-brand firms, according to subsequent observations. This reveals that iron and steel enterprises can gain continuous profits by creating brands and brand assets that can improve enterprise value significantly. This further proves that under market conditions of excess production capacity, the key to optimizing intangible asset structure is to increase the proportion of brand assets continuously. This is the key to strengthening the continuous growth of enterprise values, thus verifying H2.

5.5. Interpretation to Endogenous Problems

To begin, data for explanatory variables were obtained without measurement errors from authentic and verifiable accounting statements. Second, all explanatory variables were derived from the balance sheet asset indicators, which were mutually independent. There is no missing explanatory variable in the model that can affect explanatory variables. The model in this study is mathematically sound, and there is no mutual influence between the explanatory and explained variables, implying that there is no causality. At the very least, there is no relationship between the proportion of intangible assets and enterprise value, implying that there are no endogenous problems.

6. Conclusion and Suggestions

The *Opinions for Promoting High-quality Development of Iron and Steel Industry* during the "14th Five-year plan" stipulates explicitly to form green low-carbon sustainable development pattern basically in the industry by 2025. The study discovered that: First, the asset structure of iron and steel companies is closely related to the value of the company. Increases in the proportions of monetary capitals and inventories can stifle growth in business value, but increases in the proportions of accounts receivable, fixed assets, and current assets can boost growth. Relevant results not only reflect the current state of excess production capacity in Chinese iron and steel enterprises, but also reveal that under excess production capacity, the industrial scale cannot expand indefinitely, and industrial development must focus on quantity control and quality improvement; second, when excess production capacity exists, the proportion of intangible assets plays a positive and key role in enterprise value.

The proportion of intangible assets boosts corporate value and helps businesses transition to low-carbon development (mainly hard technologies including patent technologies in intangible assets). Third, at particular technological levels, the share of brand assets in intangible assets of iron and steel firms plays a significant role in improving enterprise value. Only brand enterprises have a significantly positive proportion of brand assets, implying heterogeneity in the transformation of iron and steel enterprises. Iron and steel companies that focus on brand development have higher enterprise values than those that don't.

In the future, China's iron and steel industry will focus on the following issues during its low-carbon development. To begin with, because green development is costly, firms with strong endogenous power can establish a solid basis for the decarbonization of the iron and steel industry. It is necessary to increase enterprise value to strengthen endogenous motivation in businesses. Second, the existence of structural surplus for a long time and adequate scale expansion of iron and steel enterprises must be considered. It is suggested that capital be shifted from tangible to intangible assets, that inputs be increased to green technology innovation, that technological brand advantages based on advanced technologies be formed, and that product premium capacity be increased. Third, the severe competition between middle- and low-end items in the Chinese iron and steel market must be taken into account.

The iron and steel industry's reliance on product homogeneity must be disproved. Iron and steel are not cold materials, but they have a significant role to play in the construction of a beautiful world. People have higher hopes for the future. As a result, iron and steel products cannot only develop competitive advantages based on technology but also continue to deepen brand assets in intangible assets and give emotional benefits to customers through brand construction to create strong emotional brands and boost brand premium.

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