*Original Paper*

# The Efficiency of Intellectual Capital Value Creation and Trade Credit Financing—Evidence from China A-Shares Listed Companies

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*Abstract*

*Intellectual capital, as a resource capable of creating value and enhancing corporate competitiveness, has been proven by existing research to possess financing capabilities from both equity financing and debt financing perspectives. However, no studies have yet focused on whether it may affect corporate trade credit financing. This paper utilizes a sample of A-share listed companies from 2011 to 2020, and employs a panel regression model to investigate the impact of the value creation efficiency of intellectual capital on trade credit financing. The findings suggest that: (1) the overall intellectual capital value creation efficiency in an enterprise facilitates the acquisition of trade credit financing. Upon further examination of human capital, structural capital and relational capital respectively, it is found that only the value creation efficiency of structural capital and relational capital exerts a positive impact on trade credit financing, whereas no significant relationship exists between human capital value creation efficiency and trade credit financing; (2) The attention of analysts and shareholdings of institutional investors have a significant negative regulatory effect on the impact of the overall intellectual capital and relational capital value creation efficiency on trade credit financing; (3) Further research indicates that the effect of intellectual capital value creation efficiency on trade credit financing is significantly heterogeneous under the influence of financing constraint degree, property right nature and market position, and property right nature and market position can play a synergistic role. In other words, the promoting effect of value creation efficiency of overall intellectual capital, human capital, structural capital and relational capital on trade credit financing is more significant in enterprises with high financing constraints. Relational capital has effects only in state-owned and highly positioned companies, while structural capital is influential only in non-state-owned companies with lower market positioning. This paper contributes empirical evidence to the factors influencing*

*trade credit financing, enriches the research on the economic consequences of the value creation efficiency of enterprise intellectual capital, and provides a theoretical foundation for enterprises and stakeholders to enhance their emphasis on intellectual capital, a critical resource.*

***Keywords***

*Intellectual Capital, Trade Credit Financing, Financing Constraints, Alternative Financing*

## 1. Introduction

Trade Credit Financing, as a significant informal financing means for enterprises, experienced massive prohibitions and cancellations in the early recovery phase of national economy following the founding of the People's Republic of China. With the advent of the Third Plenary Session of the Eleventh Communist Party of China Central Committee, our state incrementally reestablished and promoted the Trade Credit System, issuing provisions such as the *Interim Measures for Acceptance and Discount of Commercial Draft* and other regulations and policies to enhance the Trade Credit System, which has allowed the Trade Credit System to play a pivotal role in the process of economic operation (Zhao & Wu, 2006). Of these roles, the key is the alleviation of corporate financing constraints (Fishman and Love, 2003; Shi & Zhang, 2010). Amidst China's economic transition, businesses require substantial capital for sustaining rapid development. However, due to the underdeveloped financial system and challenges in securing bank loans, Trade credit has emerged as a crucial alternative financing source (Lin and Chou, 2015). In the "Post-Pandemic" era, recurrent waves of the epidemic have led to a sluggish consumer market, escalating economic decline, and strained corporate liquidity. Problems like "difficult financing" and "expensive financing" have once again become national economic development. In the face of the situation of liquidity shortage, Trade Credit Financing, serving as a mutual liquidity safeguard, could diffuse liquidity risk amongst upstream and downstream enterprises (Appendini & Garriga, 2013; Yang & Birge, 2016). Consequently, both academia and industry are investigating determinants that influence corporate accessibility to trade credit financing, aiming to maximize the compensatory financial function of this informal financing method.

With advancements in science and technology and the improvement of productivity levels, the knowledge economy era has unfolded. Intellectual capital dominates the development of social economy and offers a continuous driving force for the expansion of global capital and economic globalization. Amid an increasingly intricate living environment, the resource structure of enterprises is undergoing transformation. Intellectual capital, characterized by value-addition and sustainability, is superseding the traditional material capital and other production factors. It plays an integral part corporate value creation processes, and has become a decisive element of core competitiveness (Guthrie et al., 2012; Al-Musali & Ismail, 2016). Therefore, enterprises are prioritizing the enhancement of their intellectual capital levels. As an indicator of enterprise performance, the efficiency of the value creation of intellectual capital represents the capacity to generate value from intellectual capital, which in turn can attract more investors and secure stable funding sources.

Therefore, this subject has attracted extensive academic interest. Although numerous scholars have validated the financing function of intellectual capital, they primarily focus on equity financing and debt financing (Sun, 2012; Dang & Shi, 2015; Su, 2018). Research on the impact of value creation efficiency of intellectual capital on trade credit financing is sparse.

Given the above background, this study focuses on A-share listed companies from 2011 to 2020, examining the influence of value creation efficiency of enterprise intellectual capital on trade credit financing. According to Trilism, intellectual capital can be divided into three domains: human capital, structural capital and relationship capital (Stewart, 1994; Bontis et al., 2000). Therefore, this paper separately discusses the influence of value creation efficiency of human capital, structural capital and relationship capital on trade credit financing. As analyst coverage and institutional investor ownership might affect the degree of information asymmetry in companies, this study also researched the moderating roles of these two factors on the impact of intellectual capital value creation efficiency on trade credit financing. Finally, through segmented regression analysis, the research scrutinizes the heterogeneity of the influence of intellectual capital value-creation efficiency on trade credit financing across firms with varying degrees of financing constraints, different property right characteristics, and diverse market positions. It also tests the synergistic effect of property rights and market position.

The principal contributions of this paper are as follows: (1) This paper affirms that enterprise intellectual capital plays a promoting role in obtaining trade credit financing, which provides a strategic approach for enterprises to mitigate issues related to funding scarcity, enhances the level of a firm's intellectual capital, and assists firms in resolving financing constraints whilst augmenting innovation capacity, thereby propelling high-quality economic growth. (2) This study enriches the literature on intellectual capital financing ability and further verifies the importance of intellectual capital to enterprise development from the perspective of trade credit financing. (3) This paper reveals that analysts' attention and institutional investors' shareholding ratio can negatively moderate the impact of intellectual capital value creation efficiency on trade credit financing, suggesting that analysts and institutional investors should augment their understanding and knowledge of intellectual capital, pay heed to enterprises' intellectual capital information, and improve the intellectual capital information environment.

## 2. Theoretical Analysis and Hypothesis

*2.1 The Value Creation of Intellectual Capital efficiency and Trade Credit Financing*

Trade credit financing is a balanced outcome of mutual selection process between the providers and recipients of trade credit. Examining the attainment of commercial credit financing solely from one perspective may result in a biased understanding. Therefore, when analyzing the impact of a specific factor on trade credit financing, it is essential to consider both the supply and demand aspects. Alternative Financing Theory, from the point of view of the trade credit demander, proposes that commercial credit financing serves as a supplementary form of financing when conventional methods

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are deficient (Atanasova & Wilson, 2004). According to this theory, when firms receive bank loans that are insufficient to sustain their liquidity requirements due to imbalanced allocation of credit, they seek assistance from upstream and downstream enterprises within the supply chain to secure commercial credit financing (Lu & Yang, 2011). Therefore, the more financing constraints the company are, the more they tend to leverage trade credit financing with inter-firm liquidity as a replacement for conventional formal financing such as short-term loans (Li & Qin, 2020). When adopting aggressive strategies or facing uncertain economic policies, firms need stronger circulating funds to cater to their development needs, which are difficult to meet through formal financing, and therefore have a stronger demand for trade credit financing (Fang & Chu, 2019; Zhang et al., 2021). In contrast, when firms opt for supplier-relationship transactions or operate in a more open capital market, their liquidity requirements diminish, thereby reducing the demand for trade credit financing (Li, 2017; Song & Guo; 2021). From the perspective of trade credit suppliers, the Buyer's Market Theory considers trade credit financing as a means of financing provided by the supply side to upstream and downstream firms with good credit conditions, high market position or certain development potential for operational motives such as promotion or quality assurance (Fabbri & Menichini, 2010; Giannetti et al., 2011; Barrot, 2016). This approach facilitates the supply side to strengthen intrinsic ties with upstream and downstream firms in the supply chain and sustains stable business collaborations (Amiti & Weinstein, 2011). A firm's penalty record can mar its reputation and induce negative impressions, thus lowering credit evaluation by suppliers' and customers'. As a result, it impedes the company's ability to secure enough trade credit financing (Chao & Xiang, 2021). Excessive goodwill can escalate operational risks, triggering concern among trade credit providers regarding the firm's solvency. This could compromise the trust relationship between the two parties and reduce the provision of trade credit to the firm (Wang & Zhi, 2021). In addition, due to the information asymmetry between firms and their suppliers and customers, trade credit providers might fail to promptly discern the genuine operational status of firms. This leads to elevated costs associated with monitoring the firm's goodwill. If enterprises can disclose high-quality information, they can not only convey their confidence in their enterprise performance and growth potential and send positive signals to upstream and downstream enterprises, but also reduce the degree of information asymmetry and the supervision cost of trade credit financing providers, thus facilitating the access to trade credit financing (Yuan & Wang, 2016; Xu et al., 2017; Lai et al., 2018).

The financing capabilities of intellectual capital have been explored and demonstrated by existing research. In a study focusing on small and micro enterprises, Dang and Shi (2015) posited that intellectual capital substantially influences the financing and development environment of a firm. Concurrently, they suggested that the intellectual capital value creation efficiency of enterprises can mitigate the cost of equity capital by improving the audit opinion on accounting statements (Su, 2018). In addition, there are significant differences between the overall and individual components of intellectual capital on corporate financing. Some scholars assert that structural capital and relational capital are superior in aiding firms to secure financing. They also argue that the ability of human capital

to leverage financing is curtailed by the scale of the firm. Conversely, others posit that compared to other types of intellectual capital, it is the value creation efficiency of human capital that predominantly affects the cost of capital (Sun, 2012; Su, 2016). The ability of firms to utilize intellectual capital for financing is attributable to the following reasons: In the first instance, in line with the Resource-Based Theory, a represents an amalgamation of diverse resources. The heterogeneity of a firm's resources determines the difference in competitive capabilities. Intellectual capital is an exclusive, inimitable and irreplaceable intangible asset, embodying the firm's value creation potential. It guarantees efficient business performance and confers a sustainable, competitive advantage to firms. Therefore, investors typically express increased confidence in the ROI of firms with elevated levels of intellectual capital, rendering them more inclined to investment (Guthrie et al., 2012). In the second instance, as suggested by the Governance Effect Theory, due to the existence of principal-agent problems caused by information asymmetry, investors frequently need to monitor and limit agent behavior by establishing strict contractual obligations and seeking enhanced governance mechanisms. Intellectual capital forms a significant part of these corporate governance mechanisms, in which the structural costs directly affect the management level of the enterprise, regulate business risk, and safeguard shareholder returns. Therefore, the higher the level of enterprise intellectual capital, the lower the cost of supervision that investors invest in seeking other governance mechanisms to manage corporate operations, which indirectly augments investors' investment returns and strengthens the firm's financing capabilities (Su, 2018). In the third instance, according to Signal Theory, high-quality firms abundant in intellectual capital utilize the signaling effect to deliver positive information about the firm's profitability and growth prospects to investors. Meanwhile low-quality firms with lesser intellectual capital forfeit positive signaling due to the pressure of elevated imitation costs. These dynamic enables investors to differentiate high-quality firms from low-quality ones, and thus investing more in firms with superior intellectual capital levels. In summary, intellectual capital presents a strong guarantee of a firm's capital-raising abilities.

Building upon the preceding analysis, firstly, from the perspective of alternative financing theory, firms with high intellectual capital value creation efficiency may proactively embrace competitive strategies, undertake vigorous R&D innovation activities, and introduce more differentiated products. Such endeavors allow these enterprises to capitalize on their intellectual capital advantages and elevate their market standing. These initiatives invariably escalate the enterprises' demand for liquid capital, thereby making them susceptible to constraints on financing, and possibly leading them into a financial predicament (Giannetti et al., 2007; Fang & Chu, 2019). When firms are unable to obtain enough financing through formal channels, such as commercial banks and capital markets, they become more active in soliciting trade credit financing from their key external stakeholders, suppliers and customers. Secondly, from the perspective of buyer's market theory, firms with elevated efficiency in intellectual capital value creation possess a distinct negotiating advantage and hold greater appeal to trade credit providers. These enterprises wield unique competitive advantages in the market and demonstrate ample

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resilience to support their prolonged and stable growth. If suppliers and customers extend trade credit financing to companies with high intellectual capital value creation efficiency, they can bolster the cooperative relationships with these firms and get a good future profit for themselves. Simultaneously, an enhanced efficiency in intellectual capital value creation also indicates a more robust internal governance structure and a reduced degree of internal and external information asymmetry. As a result, trade credit providers encounter lower default risk and monitoring cost when dealing with these firms (Love et al., 2005). Therefore, upstream and downstream enterprises in the supply chain are inclined to provide additional trade credit financing to enterprises with a higher degree of efficiency in intellectual capital value creation. Based on the above analysis, this paper proposes the following hypothesis:

H1: The more efficient the firm's overall intellectual capital value creation, the more trade credit financing it obtains.

H1a: The more efficient the enterprise's human capital value creation, the more trade credit financing it obtains.

H1b: The more efficient the enterprise structural capital value creation, the more trade credit financing is obtained.

H1c: The more efficient the value creation of relationship capital, the more trade credit financing is obtained.

*2.2 Analyst Attention and the Moderating Effect of Institutional Investor Holdings*

Information asymmetry between enterprises and stakeholders constitutes a major impediment to accessing external financing. As an informational intermediary, analysts can effectively glean vital corporate information through diverse mechanisms, such as fieldwork and financial statement analysis. Their role as external monitors can enhance corporate transparency by disseminating this information to the market. The focus of analysts can help discern substantial risks in corporate accounting information disclosure, alleviate idiosyncratic corporate risks, and curtail the likelihood of corporate manipulation (Hu & Han, 2020; Liu & Wu, 2021; Wu et al. 2022). More importantly, analysts can directly or indirectly facilitate firms' access to trade credit financing by boosting the quality of firms' disclosures (Huang & Wang, 2018). Therefore, the level of analyst attention mitigates the reliance on intellectual capital value creation efficiency for obtaining trade credit financing. Firms with lower analyst attention exhibit higher degrees of information asymmetry, encounter greater difficulty in accessing external financing, including bank loans, and hence, rely more heavily on the financing utility of intellectual capital value creation efficiency more to help firms obtain trade credit financing. Based on the above analysis, this paper proposes the following hypotheses:

H2: The positive relationship between overall intellectual capital value creation efficiency and trade credit financing decreases with increasing analyst attention.

H2a: The positive relationship between human capital value creation efficiency and trade credit financing decreases with increasing analyst attention.

H2b: The positive relationship between structural capital value creation efficiency and trade credit

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financing decreases with increasing analyst attention.

H2c: The positive relationship between relational capital value creation efficiency and trade credit financing decreases with the increase of analyst attention.

According to the efficient market's hypothesis, institutional investors serve as rational arbitrageurs in the financial market, and can see the essential problems of enterprises through the phenomena with their information advantages, capital advantages and professional skills, and act as supervisors and correctors in the capital market. Specifically, institutional investors can identify the intrinsic true rationale behind corporate dividends, thereby securing valuable information (Jiang and Huo, 2022). Furthermore, institutional investors can induce firms to optimize their governance structure and improve their information environment, thereby elevating their social responsibility performance (Yuan & Wang, 2021). On the other hand, they can also contribute to the capital market reduce stock mispricing (Fang &Niu, 2021). Huang and Wang (2018) further argue that institutional investors can play a supervisory role over analysts, enabling them to convey the relevant information about the firm better to the outside world and effectively reduce information asymmetry. Therefore, institutional investors' shareholding would also diminish the reliance on the efficiency of intellectual capital value creation for firms to obtain trade credit financing. Considering these considerations, this paper proposes the following hypotheses:

H3: The positive relationship between overall intellectual capital value creation efficiency and trade credit financing decreases with increasing institutional investors' shareholding.

H3a: The positive relationship between human capital value creation efficiency and trade credit financing decreases with the increase of institutional investors' shareholding.

H3b: The positive relationship between structural capital value creation efficiency and trade credit financing decreases with the increase of institutional investors' shareholding.

H3c: The positive relationship between relational capital value creation efficiency and trade credit financing decreases with the increase of institutional investors' shareholding.

## 3. Research Design

### 3.1 Sample Selection and Data Sources

This paper utilizes data of Chinese A-share listed companies from 2011 to 2020 and screens the samples according to the following standards: (1) exclude the firms designated as ST and *ST; (2) exclude the samples of listed companies in the financial sector; (3) exclude the samples of listed companies with missing or abnormal data. Through these criteria, a final sample of 22,433 valid observations from 3,369 companies. This paper classifies industries according to the *Guideline for Industry Classification of Listed Companies* issued by the CSRC in 2012. All the data of listed companies used in this paper are obtained from CSMAR database of China.

*3.2 Variable Definition and Model Specification*

3.2.1 Model Specification

3.2.1.1 Principal Regression Model

To validate the contribution of different types of intellectual capital value creation efficiency to firms' access to trade credit financing, a panel regression model is constructed as follows:

$$TC = \alpha_0 + \alpha_1 VAIC + ControlVariable + \sum Ind + \sum Year + \varepsilon \quad (1)$$

$$TC = \alpha_0 + \alpha_1 HCE + ControlVariable + \sum Ind + \sum Year + \varepsilon \quad (2)$$

$$TC = \alpha_0 + \alpha_1 SCE + ControlVariable + \sum Ind + \sum Year + \varepsilon \quad (3)$$

$$TC = \alpha_0 + \alpha_1 RCE + ControlVariable + \sum Ind + \sum Year + \varepsilon \quad (4)$$

In these four models, the explained variable *TC* is trade credit financing, and the explanatory variables *VAIC, HCE, SCE,* and *RCE* are intellectual capital value creation efficiency, human capital value creation efficiency, structural capital value creation efficiency, and relational capital value creation efficiency, respectively. *Control Variable* is the manipulated variable, which includes a total of 13 variables, such as bank loans and cash holdings. *ΣInd* is the industry dummy variable controlling for the effect of inherent differences between industries. *ΣYear* is the year dummy variable controlling for the effect of macro-annual economic factors. α1 is the coefficient to be tested. If the α1 is a positive number, it indicates that intellectual capital, human capital, structural capital or relational capital value creation efficiency has a facilitating effect on the acquisition of trade credit financing, while the α1 is a negative number, it indicates a dampening effect.

3.2.1.2 Moderating Effect Model

To examine the moderating influences of analyst concerns and institutional investor holdings on the effects of different types of intellectual capital value creation efficiency on trade credit financing, the following model is constructed:

$$TC = \alpha_0 + \alpha_1 VAIC + \alpha_2 VAIC \times Mod + \alpha_3 Mod + ControlVariable \\ + \sum Ind + \sum Year + \varepsilon \quad (5)$$

$$TC = \alpha_0 + \alpha_1 HCE + \alpha_2 HCE \times Mod + \alpha_3 Mod + ControlVariable \\ + \sum Ind + \sum Year + \varepsilon \quad (6)$$

$$TC = \alpha_0 + \alpha_1 SCE + \alpha_2 SCE \times Mod + \alpha_3 Mod + ControlVariable \\ + \sum Ind + \sum Year + \varepsilon \quad (7)$$

$$TC = \alpha_0 + \alpha_1 RCE + \alpha_2 RCE \times Mod + \alpha_3 Mod + ControlVariable \\ + \sum Ind + \sum Year + \varepsilon \quad (8)$$

In these models, *Mod* represents the moderator variables, including analyst attention *RA* and institutional investor holdings *INS*. *VAIC×Mod, HCE×Mod, SCE×Mod* and *RCE×Mod* are the cross product of intellectual capital value creation efficiency, human capital value creation efficiency, structural capital value creation efficiency and relationship capital value creation efficiency with the two moderator variables, respectively. α2 is the coefficient to be tested. If the α2 is a positive number, it indicates a negative moderating effect of analyst attention or institutional shareholding on the value

creation efficiency of intellectual capital, human capital, structural capital or relational capital on enterprise trade credit financing, while a negative α2 denotes a positive moderating effect.

3.2.2 Variable Selection

3.2.2.1 Explained Variable

For the measurement of trade credit financing, some studies use accounts payable or the sum of accounts payable and notes payable to measure the trade credit financing obtained by firms only from the perspective of trade credit provided by suppliers (Wang, 2014; Chen, 2017). However, the advance receipts received from customers are an equally significant source of trade credit financing, and therefore, this paper refers to the measurement method in the studies of Yu et al. (2021) and Hu and Zheng (2021). This approach calculates the scale of a firm's trade credit financing as the proportion of the sum of accounts payable, bills payable, and advance receipts to total assets, as outlined in Table 1.

3.2.2.2 Explanatory Variable

There are many different academic approaches to measuring intellectual capital, which can be generally categorized into two groups: measurement using non-financial data and measurement using financial data. For non-financial data, numerous scholars use the H-S-C model to further dividing human capital, structural capital, and relational capital, establish measurement scales, and design questionnaires to collect intellectual capital data from managers and employees in the company (Cao & Zhang, 2021; Hu & Li, 2021). For financial data, the most prevalent method is the value-added intellectual coefficient method (VAIC method), first proposed by Public in 2000, which has been constantly refined and applied by scholars as the research on intellectual capital has intensified (Riahi-Belkaoui, 2003; Mavridis & Kyrmizoglou, 2005; Chen et al, 2010; Fu, 2016). Therefore, this paper, in line with the "triadic theory" (Bontis, 1998), considers intellectual capital as consisting of three dimensions: human capital ($HC$), structural capital ($SC$) and relational capital ($RC$), and following the research of Zeng and Zhou (2016), the VAIC method is used to calculate the intellectual capital, human capital, structural capital and relational capital of an enterprise, and relational capital value-added coefficients. First, the following formula was used to measure enterprise value creation:

$$VA = NI + Tax + Pay$$

Where $VA$ is the value creation of the firm, $NI$ is the net profit of the firm for the period, $Tax$ is the income tax paid by the firm for the period, and $Pay$ is the wage level of the firm's employees, measured using cash paid to and for employees in the cash flow statement. Then, the efficiency of the human capital, structural capital and relational capital value creation are calculated by the following formula:

$$HCE = \frac{VA}{HC}$$

$$SCE = \frac{VA}{SC}$$

$$RCE = \frac{VA}{RC}$$

Among them, *HCE, SCE* and *RCE* are human capital, structural capital and relational capital value creation efficiency, respectively. *HC* is measured using the wage level of corporate employees, *SC* is measured using corporate overhead, and *RC* is measured using corporate selling expenses. The value creation efficiency of these three components is summed to obtain the intellectual capital value creation efficiency *VAIC*, and the data are normalized finally.

3.2.3 Moderator Variable

Since analysts usually convey corporate information to stakeholders through the publication of research reports, this paper uses the number of analysts' research reports received by enterprises in a year to represent the degree of analysts' attention, and refers to the practice of Fu et al. (2020), using the median number of analysts' research reports as the criterion and setting the 0-1 variable *RA*, where *RA*=1 if the number of analysts' research reports received by enterprises is less than or equal to the median and *RA*=0 if it is greater than the median. For institutional holders, this paper chooses to use the institutional shareholding ratio as a measure, and also takes the median institutional shareholding ratio as the criterion, and sets the 0-1 variable *INS*, with *INS*=1 if the firm's institutional shareholding ratio is less than or equal to the median, and *INS*=0 if it is greater than the median.

3.2.4 Manipulated Variable

Drawing on previous studies, this paper selects a series of financial and corporate governance indicators as manipulated variables, including bank loans (*Banklev*), cash holdings (*Cash*), firm size (*Size*), debt to asset ratio (*Lev*), operating cash flow (*CF*), growth capacity (*Growth*), profitability (*Roa*), the shareholding ratio of the first largest shareholder ( *Top1*), nature of effective control (*Soe*), size of directors (*Board*), percentage of independent directors (*Inddr*), whether it is Big 4 audit (*Big4*) and whether it is standard unqualified opinion (*Audop*). (Geng et al. 2021; Zhang et al. 2021; Wu and Gong, 2021), all manipulated variables were selected to be measured by current period data as shown in Tab 1:

**Table 1. Variable Definition**

| Variable Type | Variable Name | Variable Symbol | Calculation Instructions |
|---|---|---|---|
| explained variable | Trade Credit Financing | *TC* | (Notes payable+Accounts payable+Advance receipts) / Total assets |
| explanatory variable | Intellectual capital value creation efficiency | *VAIC* | *HCE*＋*SCE*＋*RCE* |
| | Human capital value creation efficiency | *HCE* | *VA* / Payment to employees and cash paid for employees |
| | Structural capital value creation efficiency | *SCE* | *VA* / Overhead |
| | Relational capital value | *RCE* | *VA* / Selling expenses |

| | | | |
|---|---|---|---|
| | creation efficiency | | |
| moderator variable | Analyst Attention | RA | RA=1 if the number of analyst reports received by the firm is less than or equal to the median, and RA=0 if it is greater than the median. |
| | Institutional investor shareholding | INS | INS=1 if the firm's institutional ownership ratio is less than or equal to the median, and INS=0 if it is greater than the median. |
| manipulated variable | Bank loan | Banklev | (long－term loan + short－term loan + non－current liabilities due within one year) / Total asset |
| | Cash holdings | Cash | (Monetary capital+ Trading financial assets) / Total asset |
| | Firm side | Size | Total assets' natural logarithm |
| | Debt to asset ratio | Lev | Total Liabilities / Total assets |
| | Operating cash flow | CF | Operating cash flow / Total assets |
| | Growth capacity | Growth | (Revenues of the period- Revenues for the same period in last year) / (Renenues for the same period in last year) |
| | Profitability | Roa | Return on Total Asset |
| | Shareholding ratio of the first largest shareholder | Top1 | Shareholding numbers of the first largest shareholder / Total number of shares |
| | Nature of effective control | Soe | state －owned=1，others= 0 |
| | Size of directors | Board | number of directors |
| | Percentage of independently directors | Inddr | independent director number / number of directors |
| | Whether it is Big 4 audit | Big4 | Yes= 1 , No= 0 |
| | Whether it is standard unqualified opinion | Audop | Yes= 1 , No= 0 |
| | Industry | Ind | Industry dummy variable |
| | Year | Year | Annual dummy variable |

## 4. Empirical Results and Analysis

### 4.1 Descriptive Statistics

Tab 2 displays the results of descriptive statistics for TC and the intellectual capital value creation efficiency. All data are distributed within a reasonable interval, which is consistent with the results of existing studies. The overall variance inflation factor is calculated to be 2.52, indicating that there is no multicollinearity problem among the variables, and regression analysis can be performed.

**Table 2. Descriptive Statistics**

| Variable Name | Observations | Average Value | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| *TC* | 22433 | 0.162 | 0.118 | 0 | 1.202 |
| *VAIC* | 22433 | 145.6 | 10293.486 | -45209.434 | 1.513e+06 |
| *HCE* | 22433 | 2.081 | 4.789 | -457.2 | 105.6 |
| *SCE* | 22433 | 3.446 | 4.228 | -127.6 | 108.3 |
| *RCE* | 22433 | 140.1 | 10292.678 | -45197.008 | 1.513e+06 |

*4.2 Empirical Results*

4.2.1 Intellectual Capital Value Creation Efficiency and Trade Credit Financing

Tab 3 presents the results of the tests of models (1) to (4). Column (1) reports the regression results of model (1) with a coefficient of 0.0394 for *VAIC*, which is significantly positive at the 1% level, and H1 is verified, indicating that the intellectual capital value creation efficiency has a significant contribution to trade credit financing. Columns (2) to (4) report the results of models (2) to (4) with coefficients of 0.1401 but not statistically significant for *HCE*, 0.1749 and 0.0392 for *SCE* and *RCE*, respectively. And both are significant at the 1% level, and H1b and H1c are verified, indicating that only the value creation efficiency of structural capital and relational capital can significantly contribute to trade credit financing. And in terms of the magnitude of the coefficients, the positive effect of structural capital on trade credit financing is stronger. This shows that although the intellectual capital has significant trade credit financing ability, human capital among them cannot play a direct role, and structural capital and relational capital can play a significant role. This may be because human capital needs to work indirectly through other intellectual capital or in combination with other intellectual capital. Structural capital, on the other hand, often represents organizational characteristics such as orderly management mechanisms, ambitious development strategies and advanced innovation levels within the firm, all of which, according to buyer's market theory, can attract upstream and downstream firms to provide trade credit financing to them. Similarly, relational capital represents the information advantage and trust relationship with suppliers and customers that a company has through building and maintaining a relationship network, which can also directly promote the company to obtain more trade credit financing.

**Table 3. Regression Results of Intellectual Capital Value Creation Efficiency and Trade Credit Financing**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
|  | TC | TC | TC | TC |
| VAIC | 0.0394*** | | | |

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| | | | | |
|---|---|---|---|---|
| | (3.73) | | | |
| HCE | | 0.1401 | | |
| | | (1.27) | | |
| SCE | | | 0.1749*** | |
| | | | (2.86) | |
| RCE | | | | 0.0392*** |
| | | | | (3.78) |
| Controls | YES | YES | YES | YES |
| Constant | 0.0787 | -0.0300 | -0.0029 | 0.0788 |
| | (1.59) | (-0.29) | (-0.05) | (1.59) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| Observations | 22,433 | 22,433 | 22,433 | 22,433 |
| adj_R2 | 0.379 | 0.380 | 0.381 | 0.379 |
| F | 59.13 | 59.50 | 60.26 | 59.13 |

Note . The number in parentheses is t. ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively, the same below.

4.2.2 Intellectual Capital Value Creation Efficiency, Analyst Attention and Trade Credit Financing

Since the principal regression results show that only intellectual capital, structural capital, and relational capital value creation efficiency contribute to trade credit financing, this paper examines the moderating effect of analyst attention for these three intellectual capital value creation efficiencies. Tab 4 shows the test results, and columns (1) to (3) show the regression results of models (5), (7), and (8), respectively. Among them, the coefficient of *SCE×RA* is not significant, indicating that the moderating effect of analyst attention in the effect of structural capital on trade credit financing is not significant. The coefficients of *VAIC×RA* and *RCE×RA* are 0.4261 and 0.4206, respectively, and both are significant at the 1% level, suggesting that analyst attention has a significant negative moderating effect, i.e., which means that the lower the analyst attention, the better it is for the intellectual capital and relational capital to perform their financing functions and better promote the firm to obtain more trade credit financing, as verified by H2, H2b and H2c.

**Table 4. Moderation effects of Analysis Attention**

| VARIABLES | (1) | (2) | (3) |
|---|---|---|---|
| | TC | TC | TC |
| VAIC | 0.0294*** | | |
| | (12.99) | | |
| SCE | | 0.1680*** | |

| | | | |
|---|---|---|---|
| | | (2.94) | |
| RCE | | | 0.0293*** |
| | | | (12.88) |
| VAIC×RA | 0.4261** | | |
| | (2.49) | | |
| SCE×RA | | -0.0037 | |
| | | (-0.06) | |
| RCE×RA | | | 0.4206** |
| | | | (2.50) |
| Controls | YES | YES | YES |
| Constant | 0.0860* | 0.0070 | 0.0859* |
| | (1.68) | (0.13) | (1.68) |
| Year/ Ind | manipulated | manipulated | manipulated |
| Observations | 22,107 | 22,107 | 22,107 |
| adj_R2 | 0.378 | 0.379 | 0.378 |
| F | 56.45 | 56.63 | 56.41 |

### 4.2.3 Intellectual Capital Value Creation Efficiency, Institutional Investor Shareholding and Trade Credit Financing

Similarly, this paper also tests the moderating effect of institutional investors' shareholding for intellectual capital value creation efficiency, structural capital value creation efficiency and relational capital value creation efficiency. Tab 5 shows the test results, and columns (1) to (3) show the regression results of models (5), (7) and (8), respectively. The coefficients of $SCE×RA$ are insignificant, indicating that the moderating effect of institutional investors' shareholding in the effect of structural capital on trade credit financing is not significant. The coefficients of $VAIC×RA$ and $RCE×RA$ are 0.8835 and 0.8916, respectively, and both of them are significant at the 10% level, indicating that institutional investors' shareholding has a negative moderating effect in the effect of intellectual capital and relational capital on trade credit financing, which means that the lower the shareholding ratio of institutional investors, the more favorable it is for intellectual capital and relational capital to perform their financing functions and facilitate firms' access to trade credit financing, as verified by H3, H3b and H3c.

**Table 5. Moderating Effect of Institutional Shareholding Ratio**

| VARIABLES | (1) | (2) | (3) |
|---|---|---|---|
| | TC | TC | TC |
| VAIC | 0.0359*** | | |

| | | | |
|---|---|---|---|
| | (4.91) | | |
| SCE | | 0.1619** | |
| | | (2.30) | |
| RCE | | | 0.0356*** |
| | | | (5.03) |
| VAIC×INS | 0.8835* | | |
| | (1.85) | | |
| SCE×INS | | 0.0197 | |
| | | (0.19) | |
| RCE×INS | | | 0.8916* |
| | | | (1.87) |
| Controls | YES | YES | YES |
| Constant | 0.0827 | 0.0086 | 0.0827 |
| | (1.61) | (0.14) | (1.61) |
| Year/ Ind | manipulated | manipulated | manipulated |
| Observations | 22,087 | 22,087 | 22,087 |
| adj_R2 | 0.377 | 0.378 | 0.377 |
| F | 55.85 | 56.85 | 55.86 |

*4.3 Further Analysis*

4.3.1 High Financing Constraint vs. Low Financing Constraint

Due to the imperfect financial market in China, external fund providers often control risks by raising the interest rate of funds supply and imposing credit rationing. So Chinese enterprises, particularly SMEs, tend to face financing constraints (Zhang et al., 2021), which seriously impede the long-term growth. On one hand, the financing constraint will stymie the R&D innovation investment of enterprises (Huang et al., 2021; Liu & Jiao, 2021) and negatively impact the level of enterprise value creation and competitiveness, thereby suppressing the role of financing intellectual capital value creation efficiency. On the other hand, according to alternative financing theory, the stronger the financing constraint is, the more inclined businesses are to utilize trade credit financing to replace traditional short-term financing (Li & Qin, 2020), thereby highlighting the promoting role of intellectual capital value creation efficiency in promoting trade credit financing. In an endeavor to further explore the heterogeneity of the impact of intellectual capital value creation efficiency on trade credit financing among firms with different degrees of financing constraints, this paper uses the KZ index to measure the degree of financing constraints (Wei et al., 2014) and divides firms with KZ indexes greater than or equal to the median into a high financing constraint group and other firms into a low financing constraint group for grouped regressions. Tab 6 presents the results of grouped

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regressions. The results show that the coefficients of *VAIC*, *HCE* and *RCE* are significantly positive at 10% significance level in the high constraint group (0.1965, 0.1965 and 0.1891, respectively) and insignificant in the low constraint group firms, and the coefficients of *SCE* are significant in both the high and low constraint groups but are more significant in the high constraint group. This indicates that the higher the level of financing constraints, the stronger the contribution of intellectual capital, human capital, structural capital and relational value creation efficiency to firms' access to trade credit financing.

**Table 6. Grouped Regressions by Level of Financing Constraints**

| VARIABLES | (1) TC | | (2) TC | | (3) TC | | (4) TC | |
|---|---|---|---|---|---|---|---|---|
| | low constraint | high constraint | low constraint | high constraint | low constraint | high constraint | low constraint | high constraint |
| VAIC | -0.0639 | 0.1965* | | | | | | |
| | (-0.48) | (1.83) | | | | | | |
| HCE | | | -0.3486 | 0.1965*** | | | | |
| | | | (-1.22) | (5.08) | | | | |
| SCE | | | | | 0.1010* | 0.1853*** | | |
| | | | | | (1.65) | (2.76) | | |
| RCE | | | | | | | -0.0643 | 0.1891* |
| | | | | | | | (-0.48) | (1.82) |
| Controls | YES | YES | YES | YES | YES | YES | YES | YES |
| Constant | 0.1812*** | -0.0469 | 0.4569** | -0.2104*** | 0.1330** | -0.1309* | 0.1813*** | -0.0467 |
| | (3.81) | (-0.76) | (1.99) | (-3.05) | (2.54) | (-1.88) | (3.81) | (-0.76) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated |
| Observations | 10,538 | 10,538 | 10,538 | 10,538 | 10,538 | 10,538 | 10,538 | 10,538 |
| adj_R2 | 0.390 | 0.362 | 0.390 | 0.363 | 0.390 | 0.363 | 0.390 | 0.362 |

4.3.2 State-owned Enterprises vs. Non-state-owned Enterprises

Business practices, governance structures, and corporate goals vary across the nature of ownership. In state-owned enterprises, innovation performance that impacts structural capital accumulation significantly underperforms when compared to Non-state-owned enterprises (Zhang & Zhang, 2003), but their unique political attributes and institutional advantages can attract suppliers and customers to establish good cooperative relationships with them. Consequently, there may be heterogeneity in the effect of intellectual capital value creation efficiency on trade credit financing among firms with different ownership systems. To investigate the heterogeneity, this paper categorizes the property rights

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nature of enterprises according to the nature of the effective controller, divides the total sample into two subsamples of state-owned enterprises and non-state-owned enterprises, and runs regressions on models (1) to (4), respectively. Tab 7 shows the regression results. The results show that the coefficients of *VAIC* and *RCE* are significantly positive at the 1% level only in state-owned enterprises, while the coefficient of *SCE* is significantly positive at the 1% level in non-state-owned enterprises. The coefficient of *HCE* is not significant in either state-owned enterprises or non-state-owned enterprises. This suggests that relational capital value creation efficiency can only promote trade credit financing in state-owned enterprises, while structural capital value creation efficiency can only play its role in promoting trade credit financing in non-state-owned enterprises, probably because state-owned enterprises are more likely to have good external relationships, while non-state-owned enterprises are more adept at improving structural capital value creation through R&D innovation.

**Table 7. Grouped Regression by Nature of Ownership**

| VARIABLES | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | TC | | TC | | TC | | TC | |
| | State-owned | non-state-owned | State-owned | non-state-owned | State-owned | non-state-owned | State-owned | non-state-owned |
| VAIC | 0.0392*** | 0.9333 | | | | | | |
| | (5.21) | (1.18) | | | | | | |
| HCE | | | 0.2474 | 0.1552 | | | | |
| | | | (1.14) | (1.32) | | | | |
| SCE | | | | | 0.0531 | 0.2314*** | | |
| | | | | | (0.87) | (2.82) | | |
| RCE | | | | | | | 0.0392*** | 0.8864 |
| | | | | | | | (5.22) | (1.16) |
| Controls | YES | YES | YES | YES | YES | YES | YES | YES |
| Constant | -0.0149 | 0.1546** | -0.2129 | 0.0618 | -0.0405 | 0.0754 | -0.0149 | 0.1560** |
| | (-0.18) | (2.25) | (-1.12) | (0.52) | (-0.47) | (1.06) | (-0.18) | (2.28) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated |
| Observations | 7,934 | 14,499 | 7,934 | 14,499 | 7,934 | 14,499 | 7,934 | 14,499 |
| adj_R2 | 0.427 | 0.354 | 0.427 | 0.355 | 0.427 | 0.356 | 0.427 | 0.354 |

4.3.3 High Market Position vs. Low Market Position

The level of market position affects the access to trade credit financing. From the perspective of buyer's market theory, a higher market position implies that firms have stronger bargaining power with suppliers and customers, who are more inclined to establish long-term business ties with them and offer

greater trade credit financing (Liu et al., 2015). At the same time, there are also studies showing that firms with low market position can better use trade credit financing to enhance investment efficiency (Liu, 2019). Therefore, there may be heterogeneity in the relationship between intellectual capital value creation efficiency and trade credit financing among firms with different market positions. To explore the heterogeneity, this paper quantifies the status of firms by the proportion of their main business revenue in the total annual revenue of the industry, and sets the firms with the proportion of main business revenue higher than the industry annual median as the subsample with the high market status, and the other firms as the subsample with the low market status, and regresses model (1) to (4), respectively. Tab 8 shows the regression results. The results reveal that the coefficients of *VAIC* and *RCE* are significantly positive at the 1% level only in firms with the high market status, while the coefficients of *HSC* and *SCE* are significantly positive at the 1% level in firms with the low market status, suggesting that the value creation efficiency of relational capital can promote trade credit financing only in firms with high market status, while the human capital value creation efficiency and structural capital value creation efficiency can help firms obtain more credit financing only in firms with the low market status. This may be since firms with the high market status can more easily obtain trade credit financing through external relationships, while firms with low status can only attract trade credit financing by trying to improve their own innovation level and develop more innovations.

**Table 8. Group Regression by Market Position**

| VARIABLES | (1) TC | | (2) TC | | (3) TC | | (4) TC | |
|---|---|---|---|---|---|---|---|---|
| | high status | low status | high status | low status | high status | low status | high status | low status |
| VAIC | 0.0342*** | 0.7610 | | | | | | |
| | (6.09) | (1.48) | | | | | | |
| HCE | | | 0.0177 | 0.1784*** | | | | |
| | | | (0.06) | (3.90) | | | | |
| SCE | | | | | 0.0499 | 0.2462*** | | |
| | | | | | (0.83) | (4.52) | | |
| RCE | | | | | | | 0.0342*** | 0.7265 |
| | | | | | | | (6.09) | (1.43) |
| Controls | YES | YES | YES | YES | YES | YES | YES | YES |
| Constant | 0.1926*** | 0.1633** | 0.1795 | 0.0455 | 0.1704** | 0.0685 | 0.1926*** | 0.1643** |
| | (2.60) | (2.41) | (0.82) | (0.56) | (2.29) | (0.99) | (2.60) | (2.43) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated |
| Observations | 10,995 | 11,079 | 10,995 | 11,079 | 10,995 | 11,079 | 10,995 | 11,079 |
| adj_R2 | 0.370 | 0.357 | 0.370 | 0.358 | 0.370 | 0.360 | 0.370 | 0.357 |

4.3.4 Synergy between the Nature of Property Rights and Market Status

The study by Xu et al. (2017) argues that a synergistic effect exists between the nature of property rights and the market status of enterprises, and that the quality of accounting information can play a trade credit financing function only when state-owned enterprises also have a high market position. To ascertain whether the nature of property rights and market status still play a synergistic role in the effect of intellectual capital value creation efficiency on trade credit financing, this paper further stratifies state-owned enterprises and non-state-owned enterprises based on their high market status on the basis of their grouping, and divides the total sample into four groups: high state-owned status, low state-owned status, high non-state-owned status, and low non-state-owned status. The regressions of models (3) and (4) are conducted separately, and Tab 9 shows the regression results. The results reveal that the coefficient of *SCE* is significantly positive only in the non-state and low-status firms, and the coefficient of *RCE* is significantly positive only in the state and high-status firms. This indicates that structural capital value creation efficiency can only play a role in promoting trade credit financing in non-state-owned enterprises with low market status, and relational capital can only promote trade credit financing in state-owned enterprises with high status. This result confirms the synergistic effect of property rights nature and market status in the study of heterogeneity of intellectual capital value creation efficiency.

**Table 9. A test of Synergy between the Nature of Property Rights and Market Position**

| VARIABLES | (1) | | | | (2) | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | TC | | | | TC | | | |
| | State-owned | | non-state-owned | | State-owned | | non-state-owned | |
| | high status | low status | high status | low status | high status | low status | high status | low status |
| SCE | 0.0911 | 0.0178 | -0.0249 | 0.2999*** | | | | |
| | (1.15) | (0.19) | (-0.27) | (4.47) | | | | |
| RCE | | | | | 0.0386*** | 1.1751 | 11.7387 | 0.7773 |
| | | | | | (5.37) | (0.89) | (0.39) | (1.23) |
| Controls | YES | YES | YES | YES | YES | YES | YES | YES |
| Constant | 0.0284 | 0.1050 | 0.3789*** | 0.1057 | 0.0712 | 0.0794 | 0.0286 | 0.2241*** |
| | (0.25) | (0.75) | (4.20) | (1.33) | (0.63) | (0.58) | (0.03) | (2.88) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated | manipulated |
| Observations | 5,211 | 2,700 | 5,784 | 8,379 | 5,211 | 2,700 | 5,784 | 8,379 |
| adj_R2 | 0.420 | 0.400 | 0.329 | 0.347 | 0.420 | 0.400 | 0.329 | 0.343 |

*4.4 Robust Test*

4.4.1 Two-stage Regression Using Residual Terms

To address potential endogeneity issues with intellectual capital value creation efficiency, this paper refers to Yao and Zhao (2016) and designs a two-stage regression using residual terms. In the initial stage, with intellectual capital value creation efficiency as the explained variable, a series of variables that affect the value and creation efficiency of firms' intellectual capital are selected as explanatory variables based on previous studies, including corporate governance characteristics variables such as Nature of Property Right (Right), Ownership Concentration (Top1), Power Balance with Shareholder Structure (Balance), Executive Shareholding Ratio (Exe), Board Size (LnBS), CEO Daulity (DI), Independent Director Ratio (IDR), and corporate financial characteristics variables such as Asset Liability Ratio (Lev), Enterprise Size (Size), Performance Level (Roa), Company Value (TQA), and Asset Turnover (TurA) (Fu, 2015; Ran and Zhou, 2018). The regressions were then run according to the following model to obtain the regression residuals *eVAIC*.

$$
\begin{aligned}
VAIC = {} & \alpha_0 + \alpha_1 Right + \alpha_2 Top1 + \alpha_3 Balance + \alpha_4 Exe \\
& + \alpha_5 LnBS + \alpha_6 DI + \alpha_7 Lev + \alpha_8 Size + \alpha_9 Roa \\
& + \alpha_{10} TQA + \alpha_{11} TurA + \alpha_{12} IDR \\
& + \sum Ind + \sum Year + eVAIC
\end{aligned}
\tag{9}
$$

In the second stage, the explanatory variables *VAIC* in the original model (1) were replaced with the regression residuals *eVAIC* from the first stage to obtain the regression model:

$$
TC = \alpha_0 + \alpha_1 eVAIC + ControlVariable + \sum Ind + \sum Year + \varepsilon
\tag{10}
$$

Then testing model (10) and if α1 remains significantly positive, the endogeneity can be excluded. Following the same method, the endogeneity of value creation efficiency of human capital, structural capital and relational capital can be excluded in turn.

Tab 10 shows the regression results for the second stage of intellectual capital, human capital, structural capital and relational capital value creation efficiency, where the coefficients of *eVAIC*, *eSCE* and *eRCE* are 0.0388, 0.2067 and 0.0387, respectively, which are still significant at the 1% level, and the coefficient of *eHCE* remains insignificant and has not changed substantially from the previous regression results. Therefore, the effect of endogeneity on the empirical results can be excluded.

**Table 10. Results of the Second Stage Regression in the Two-stage Regression Using the Residual Term**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | TC | TC | TC | TC |
| eVAIC | 0.0388*** | | | |
| | (3.79) | | | |

| | | | | |
|---|---|---|---|---|
| eHCE | 0.1189 | | | |
| | (0.48) | | | |
| eSCE | | 0.2067*** | | |
| | | (3.13) | | |
| eRCE | | | 0.0387*** | |
| | | | (3.83) | |
| Controls | YES | YES | YES | YES |
| Constant | 0.1043** | 0.1044** | 0.1048** | 0.1043** |
| | (2.18) | (2.18) | (2.20) | (2.18) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| Observations | 20,710 | 20,710 | 20,710 | 20,710 |
| adj_R2 | 0.380 | 0.381 | 0.382 | 0.380 |
| F | 56 | 56.24 | 57.45 | 56 |

### 4.4.2 Heckman Two-stage Return

To further avoid the bias of the empirical results caused by the possible self-selection problem between intellectual capital value creation efficiency and trade credit financing, this paper refers to Fu et al. (2019) and uses a Heckman two-stage regression to control for this endogeneity. In the first stage, the dummy variable of whether the firm has a high level of intellectual capital value creation efficiency ($VAIC\_H$, $VAIC\_H$=1 when the intellectual capital value creation efficiency is greater than or equal to the median, otherwise $VAIC\_H$=0) is used as the explained variable, and the dummy variables of Nature of Property Right (Right), Ownership Concentration (Top1), Power Balance with Shareholder Structure (Balance), Executive Shareholding Ratio (Exe), Board Size ( LnBS), CEO Daulity (DI), Independent Director Ratio (IDR), and corporate financial characteristics variables such as Asset Liability Ratio (Lev), Enterprise Size (Size), Performance Level (Roa), Company Value (TQA), and Asset Turnover (TurA) (Fu, 2015; Ran and Zhou, 2018) as explanatory variables. Probit regressions were conducted according to the following model, and then the inverse Mills ratio (Imr) was calculated based on the regression results.

$$
\begin{aligned}
VAIC\_H = {} & \alpha_0 + \alpha_1 Right + \alpha_2 Top1 + \alpha_3 Balance + \alpha_4 Exe \\
& + \alpha_5 LnBS + \alpha_6 DI + \alpha_7 Lev + \alpha_8 Size + \alpha_9 Roa \\
& + \alpha_{10} TQA + \alpha_{11} TurA + \alpha_{12} IDR \\
& + \sum Ind + \sum Year + \varepsilon
\end{aligned}
\tag{11}
$$

In the second stage regression, $Imr$ is added to the model as a manipulated variable to control for possible self-selection problems, and the regression model is as follows:

$$
TC = \alpha_0 + \alpha_1 VAIC + \alpha_2 Imr + ControlVariable + \sum Ind + \sum Year + \varepsilon \tag{12}
$$

Following the same approach, the self-selection problem of the efficiency of value creation of human, structural and relational capital can be controlled in turn.

Tab 11 shows the results of the second-stage regression. The coefficients of *VAIC*, *SCE* and *RCE* are all significant at the 1% level with values of 0.0395, 0.1961 and 0.0388, respectively, while the coefficient of *HCE* remains insignificant and does not change substantially compared to the previous test results. And the coefficient of *Imr* is significant in the regressions of structural and relational capital value creation efficiency. The above results indicate that the self-selection problem does exist in the original model, but after controlling for the self-selection problem, the intellectual capital, structural capital and relational capital value creation efficiency can still significantly contribute to trade credit financing, and the previous results are robust.

**Table 11. Results of the Second Stage Regression in Heckman Two-stage Regression**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
|  | TC | TC | TC | TC |
| VAIC | 0.0395*** |  |  |  |
|  | (3.63) |  |  |  |
| HCE |  | 0.1132 |  |  |
|  |  | (0.45) |  |  |
| SCE |  |  | 0.1961*** |  |
|  |  |  | (2.95) |  |
| RCE |  |  |  | 0.0388*** |
|  |  |  |  | (3.62) |
| Controls | YES | YES | YES | YES |
| Constant | 0.0974** | 0.0144 | 0.0355 | 0.0797* |
|  | (2.06) | (0.07) | (0.65) | (1.67) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| Observations | 20,710 | 20,710 | 20,710 | 20,710 |
| adj_R2 | 0.380 | 0.381 | 0.382 | 0.381 |
| F | 54.91 | 55.22 | 55.98 | 55.33 |

4.4.3 Changing the Measurement of the Explained Variables

In order to circumvent potential measurement errors in trade credit financing variables, this paper draws from Yuan and Wang (2016) and considers only the trade credit that firms receive from upstream suppliers, using *TC1* = (Notes Payable + Accounts Payable)/Total Assets, to measure the amount of trade credit financing. Tab 12 illustrates the regression results after replacing the explained variables, and the results show that the coefficients of *VAIC* and *RCE* are still significantly positive at the 1%

level, while the coefficient of *SCE* is significant at the 5% level with a slight decrease in the significance level. These results suggest that the structural capital value creation efficiency may have a more significant impact on the trade credit financing from downstream customers compared to upstream suppliers. The regression results don't change substantially, and the empirical results of this paper demonstrate robustness.

**Table 12. Regression Results after Changing the Way the Explanatory Variables Are Measured**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | TC1 | TC1 | TC1 | TC1 |
| VAIC | 0.0380*** | | | |
| | (2.84) | | | |
| HCE | | 0.0861 | | |
| | | (0.73) | | |
| SCE | | | 0.1340** | |
| | | | (2.18) | |
| RCE | | | | 0.0378*** |
| | | | | (2.86) |
| Controls | YES | YES | YES | YES |
| Constant | 0.1123** | 0.0459 | 0.0499 | 0.1123** |
| | (2.43) | (0.42) | (0.92) | (2.43) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| Observations | 22,433 | 22,433 | 22,433 | 22,433 |
| adj_R2 | 0.314 | 0.314 | 0.315 | 0.314 |
| F | 38.29 | 38.71 | 38.80 | 38.29 |

4.4.4 Changing the Measurement of Explanatory Variables

To circumvent any bias caused by the way of measured the firm's intellectual capital value creation efficiency, this paper adheres to Sun et al. (2015) and utilizes the following approach to remeasure the intellectual capital, human capital, structural capital, and relational capital value creation efficiency. First, the following formula is used to measure corporate value creation:

$$VA1 = Pbt + Pay + Int$$

In the formula, *VA1* is the firm's value creation, *Pbt* is the firm's current pre-tax profit, *Pay* is the wage level of the firm's employees, and *Int* is the firm's current interest expense. Then, using the following equations to calculate the firm's human, structural, and relational capital value creation efficiency:

$$HCE1 = \frac{VA1}{HC}$$

$$SCE1 = \frac{VA1}{VA1 - HC}$$

$$RCE1 = \frac{VA1}{RC}$$

Here, $HCE1$, $SCE1$ and $RCE1$ are human capital, structural capital and relational capital value creation efficiency, respectively. $HC$ is measured using the wage level of the firm's employees, and $RC$ is measured using the firm's sales expense. Finally, the intellectual capital value creation efficiency $VAIC1$ can be obtained by summing these three components of value creation efficiency:

$$VAIC1 = HCE1 + SCE1 + RCE1$$

Tab 13 shows the regression results after replacing the explanatory variables. The results illustrate that the coefficient of $SCE1$ changes from 0.1749 to -0.0258 and lacks significance, probably because the use of ($VA1$-$HC$) does not measure the true level of structural capital of the firm. The coefficients of $VAIC1$ and $RCE1$ remain significantly positive at the 1% level and the coefficient of $HCE1$ remains insignificant and does not change compared to the results above substantial, which indicates that the regression results are robust.

**Table 13. Regression Results after Changing the Measurement of Explanatory Variables**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | TC | TC | TC | TC |
| VAIC1 | 0.0373*** | | | |
| | (4.24) | | | |
| HCE1 | | 0.0272 | | |
| | | (0.20) | | |
| SCE1 | | | -0.0258 | |
| | | | (-0.61) | |
| RCE1 | | | | 0.0374*** |
| | | | | (4.23) |
| Controls | YES | YES | YES | YES |
| Constant | 0.0770 | 0.0499 | 0.0748 | 0.0770 |
| | (1.57) | (0.46) | (1.52) | (1.57) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| Observations | 22,473 | 22,906 | 22,907 | 22,474 |
| adj_R2 | 0.380 | 0.374 | 0.374 | 0.380 |
| F | 59.50 | 58.92 | 58.75 | 59.50 |

4.4.5 Changing the Sample Scale

This initial data sample for this study consisted of Chinese A-share listed companies from 2011 to 2020 as the sample. However, given the potentially significant anomalies in financial data brought on by the COVID-19 pandemic in 2020, measures were taken to safeguard the integrity of the empirical results. To mitigate the potential effects of such aberrant data, the sample from 2020 was excluded and the analysis was conducted anew. Tab 14 shows the regression results after excluding the 2020 sample. The magnitude and significance of the coefficients of *VAIC*, *HCE*, *SCE* and *RCE* did not alternate substantially, indicating that the empirical results are robust.

**Table 14. Regression Results after Excluding the 2020 Sample**

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *TC* | *TC* | *TC* | *TC* |
| *VAIC* | 0.0436*** | | | |
| | (2.97) | | | |
| *HCE* | | 0.1450 | | |
| | | (1.32) | | |
| *SCE* | | | 0.1744*** | |
| | | | (2.66) | |
| *RCE* | | | | 0.0434*** |
| | | | | (3.00) |
| Controls | YES | YES | YES | YES |
| *Constant* | 0.0756 | -0.0361 | -0.0061 | 0.0756 |
| | (1.35) | (-0.34) | (-0.10) | (1.35) |
| Year/ Ind | manipulated | manipulated | manipulated | manipulated |
| *Observations* | 19,900 | 19,900 | 19,900 | 19,900 |
| *adj_R2* | 0.407 | 0.407 | 0.408 | 0.407 |
| *F* | 51.57 | 51.89 | 52.35 | 51.56 |

## 5. Research Conclusion

Based on alternative financing theory and buyer's market theory, this paper examines the impact of intellectual capital, human capital, structural capital, and relational capital value creation efficiency on trade credit financing. It further investigates the moderating role of analysts' attention and institutional investors' shareholding in this impact, concluding with a group regression analysis on the heterogeneous promoting effect of intellectual capital value creation efficiency on trade credit financing under varying degrees of financing constraints. The research yielded the following conclusions: (1) Intellectual capital has a financing function, and the intellectual capital, structural capital and relational

capital value creation efficiency can promote the acquisition of trade credit financing, but the human capital value creation efficiency cannot directly promote trade credit financing. (2) Both analyst attention and institutional investors' shareholding exert a significant negative moderating effect on the influence of intellectual capital and relational capital on trade credit financing, indicating that the performance of relational capital financing function in intellectual capital will be enhanced with the decrease of analyst attention and institutional investors' shareholding ratio. (3) The impact of intellectual capital value creation efficiency on trade credit financing exhibits significant heterogeneous under diverse financing constraints, property rights and market positions. For firms with high level of financing constraints, the trade credit financing functions of intellectual capital, human capital, structural capital and relational capital are all more pronounced. Due to the combined effect of the nature of property rights and market status, relational capital can only facilitate trade credit financing function in state-owned firms with high status, while structural capital can only do so in non-state-owned firms with low status.

The insights from the study suggest that: (1) In the process of enterprise development, the accumulation of intellectual capital, particularly structural capital and relational capital, should be prioritized. This involves refining corporate governance mechanisms, bolstering internal control, augmenting enterprise innovation investment, and emphasizing relationships with upstream and downstream enterprises in the supply chain, so that intellectual capital can be used to obtain trade credit financing when the enterprise is short of capital and has difficulty in turnover. Capital to obtain trade credit financing to help enterprises overcome difficulties. (2) Analysts' attention and institutional investors' shareholding lessen the reliance of enterprises on the efficiency of intellectual capital value creation in obtaining trade credit financing, which may be due to the insufficient attention and transmission of information related to the intellectual capital of enterprises by analysts' attention and institutional investors, and excessive attention to other information. Therefore, analysts and institutional investors should reinforce their understanding and learning of intellectual capital, realize the importance of intellectual capital, and promote the function of intellectual capital financing. (3) Policymakers should devote substantial attention to the development of intellectual capital of enterprises, especially for small and medium-sized enterprises with low analysts' attention and institutional investors' shareholding and high financing constraints and formulate tax preferential policies to promote the improvement of the intellectual capital of enterprises and reduce the cost of developing intellectual capital of enterprises.

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