Research Article

Exploring the Nonlinear Effect of Intellectual Capital on Financial Performance: Evidence from Listed Shipping Companies in China

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Received 3 June 2021; Revised 15 July 2021; Accepted 29 July 2021; Published 10 August 2021

Academic Editor: Maricel Agop

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Intellectual capital (IC) is reckoned as a significant driving force of competitive advantage and financial sustainability of any organization. The study’s objective is to explore the nonlinear effect of IC and its components on financial performance (FP) of China’s listed shipping companies over a six-year period (2014–2019). The modified Value Added Intellectual Coefficient (MVAIC) model is used to systematically assess IC. The empirical results show an inverted U-shaped relationship between the aggregate IC and FP (measured through return on assets). Regarding IC components, human, relational, and innovation capitals have an inverted U-shaped relationship with FP, while the quadratic relationship between structural capital and FP is not significant. In addition, physical capital has a U-shaped relationship with FP. This study will offer some new insights for corporate managers to improve firms’ FP by effectively utilizing their IC resources.

1. Introduction

Intellectual capital (IC) as a new strategic resource is important for any organization [1–4]. The resource-based view (RBV) suggests that unique and valuable resources can help companies win more profits and enhance core competitiveness. Nowadays, the development of a company depends mainly on its intangible resources, especially IC [1–12].

Shipping industry has progressed rapidly because of economic globalization in the past decades [13]. This industry is highly capital intensive with huge investment in ship building and purchasing, which does not attract investors because of low returns on investment and high risk [14, 15]. Compared with other industries, shipping industry is characterized by specific voyage schedule, network service relevance, diversified operating costs, and coordinated operation mechanism [16]. It is easily subject to numerous issues concerning the economy, politics, and society [17]. In today’s turbulent and dynamic environment, the competition in shipping industry is particularly fierce [18, 19]. Due to many similar services provided, shipping businesses no longer gain competitive advantages [20]. In addition, with the increasing demand for shipping, these companies urgently need to expand their market share.

Shipping industry as the main freight transportation channel of China’s foreign trade is of great importance to economic and social development [21]. Since 2003, China has the world’s largest port cargo and container throughput for 16 consecutive years. China’s 21st Century Maritime Silk Road as a profound strategy was implemented to promote the sustainable development of shipping industry [22]. However, compared with other developed countries, shipping service trade has been in deficit for a long time. In particular, the competitiveness of high-end service industry is relatively weaker [23]. Most of the shipping companies suffered great losses due to excess capability after 2008 [22, 24]. In 2018, the trade disputes between China and the United States also brought great challenges to China’s shipping industry [25]. Also, the operational efficiency of China’s listed shipping companies varies greatly [26]. Therefore, it is of great significance to analyze how China’s shipping companies enhance their financial performance (FP) via IC resources in today’s competitive business environment.
The paper empirically investigates the nonlinear effect of IC and its components on FP in China’s shipping industry. To do so, this paper selects listed shipping companies during the period 2014–2019 as the research sample, and the Value Added Intellectual Coefficient (VAIC) model proposed by Pulic [27] is modified as a proxy for IC efficiency by introducing two extra components—relational capital (RC) and innovation capital (INC).

The paper’s contributions are presented in three ways. First, this paper first examines the impact of IC on FP from a nonlinear perspective. Little has been done on the nonlinear effect of IC, and this paper attempts to fill this gap. Furthermore, this paper expands the extant IC research by using the data from listed shipping companies in the second largest economy that has caught many scholars’ eyes. Second, we modify Pulic’s [27] VAIC model to systematically measure IC with the inclusion of RC and INC that are neglected in most previous studies. Finally, the findings may help corporate management to make reasonable strategies on investment in IC resources to maximize corporate FP.

The remainder of this paper is organized as follows. Section 2 provides an overview of the literature, followed by Section 3 developing the hypotheses. Section 4 focuses on research methodology, and Section 5 reports the empirical results. The discussion is made in Section 6. Finally, Section 7 concludes the paper.

2. Literature Review

2.1. IC Definition and Measurement. Many researchers have given their own definition of IC in various ways. For instance, Stewart [2] defined IC as the intellectual materials (e.g., knowledge, intellectual property, experience, and information) that can create wealth. It was also defined as the set of all knowledge possessed by the employees as well as the company [28].

It is widely accepted that IC can be classified into three components, namely, human capital (HC), structural capital (SC), and RC. HC includes employees’ knowledge, experience, skills, commitment, and motivation [29]. SC includes processes, systems, databases, culture, and the like [28, 29]. RC refers to the established relationships with customers, competitors, as well as suppliers [30]. However, some researchers [3–5, 7, 10, 31–33] argued that innovation capital (INC) is also an important element of IC, which is related to research and development (R&D) activities.

Among various IC measurement methods, Pulic’s [27] VAIC mode gains its popularity because of its easy calculation and data reliability from publicly audited financial statements [34]. Moreover, this model allows us to compare across organizations, industries, and countries [34]. However, it has also been criticized by some scholars. The synergetic effects between tangible and intangible assets are ignored [35]. The incomplete measurement of SC might ignore the important role of RC and INC [3]. Therefore, the modified Value Added Intellectual Coefficient (MVAIC) model is employed with the introduction of RC and INC.

2.2. IC and FP. Industry 4.0 is reshaping policies that pertain to innovation, and the importance of IC has emerged as a critical determinant for businesses sustainability [36, 37]. This drives companies to make use of a range of emerging physical, digital, and biological technologies, which transforms the traditional production pattern. A considerable amount of literature has analyzed the IC-FP relationship, but the results are still mixed because of different samples used. For example, Chen et al. [3], applying the MVAIC model, concluded that physical, human, structural, and innovation capitals exert a positive influence on FP, while RC shows a negative impact. Xu and Wang [4] found that physical capital, HC, and RC are the contributors to firms’ FP, while INC becomes a detriment in the Korean manufacturing industry. The findings of Xu and Wang [38] revealed that firms return on assets (ROA) and return on equity (ROE) are promoted by physical and human capitals in China’s agricultural sector. Using structural equation modeling, the study carried out by Kulkarni and Bharathi [39] showed that HC, SC, and RC determine FP of Indian information technology (IT) firms. Kuo et al. [40] stated that HC is important to technology innovation, while RC is critical to efficient production. Peković et al. [41] analyzed IC efficiency in FP improvement of French wine companies. They found that physical and human capitals positively impact operating profit and net income, while SC has a negative impact. Pramathana and Widarjo [42], using the MVAIC model, measured IC performance of Indonesia firms and found that the impact of physical capital, HC, and SC is positive, while the impact of RC is negative. In a study on Chinese manufacturing sector, Xu and Liu [43] reported a high significant correlation of IC with corporate profitability and return. Zhang et al. [33] argued that HC positively influences firm performance, while RC exerts a negative impact in China’s textile and apparel industry.

However, in service industries, Jafarnezhad and Tabari [44] pointed out that IC has a direct relationship with banks’ FP in Iran. Sardo et al. [45] argued that three elements of IC (i.e., HC, SC, and RC) positively influence hotel FP in Portugal. The findings of Tran and Vo [6] revealed that banks ROA is driven by physical capital, while HC reduces ROA in the current period. Taking Indonesian banks as the sample, Gama et al. [46] found that IC affects FP (capital, asset quality, management, and earnings). In the case of India, Weqar et al. [47] documented that bank profitability is positively related to physical capital, HC, and SC. In addition, for Tanzanian firms in the service and manufacturing sectors, Kasoga [48] observed a positive relation between SC and ROA and a negative relation between physical and human capitals and ROA.

Figure 1 shows the conceptual framework of this paper.

3. Hypotheses Development

Firms’ FP is a function of both tangible and intangible assets [34]. From the perspective of RBV, intangibles characterized by rareness and imperfect imitability are strategic resources for a firm [9]. It has been proved that IC can enhance firm performance in most researches carried out by Edvinsson...
and Malone [1], Stewart [2], Sveiby [30], Mehri et al. [49], Tripathy et al. [5], Jafarnezhad and Tabari [44], Li and Zhao [50], Sardo et al. [45], Smriri and Das [51], Tran and Vo [6], Haris et al. [52], Xu and Li [9], Xu and Wang [38, 53], Yao et al. [54], Asif et al. [55], Gama et al. [46], Kulkarni and Bharathi [39], Petković et al. [41], Pramathana and Widarjo [42], Xu and Liu [10, 43], Xu et al. [11], and Zhang et al. [33]. On the contrary, Firer and Williams [34] provided no evidence of a strong association between the efficiency of IC and profitability.

On the whole, the driving mechanism of IC can be achieved by the mutual transformation of explicit and tacit knowledge. During this process, individual tacit knowledge is conceptualized and summarized and then embodied into explicit knowledge that is easy to communicate. Each member within the organization can learn it and form their own knowledge in specific situations. In addition, individual tacit knowledge can be accumulated through unintentional observation and imitation in social interaction, which enters a new cycle of knowledge transformation [49, 56].

Specifically, entrepreneurs with tacit knowledge need to spend their wealth in advance on the identification and recognition of market uncertainty and hidden opportunities. At this time, the unique HC begins to form at the initial stage of a company. Next, entrepreneurs transform their experience and skills into capital goods such as setting up organizational structure, developing products, standardizing production process, and advocating corporate culture. Meanwhile, corporate structure has been built, and organizational capital has evolved on the basis of HC. Through systematic training, employees internalize all types of knowledge within a firm, which enables them to create more value. Furthermore, under effective performance appraisal and incentive mechanism, employees share some technique and experience with each other and give feedback to the company, which is beneficial to the improvement in rules and regulations, organizational structure, and cultural atmosphere. HC and SC mutually drive value creation and realize growth potential. With the expansion of business scale, companies have more connections with various external entities (e.g., suppliers, customers, government, and banks). The trust between their cooperation constitutes RC that is heterogeneous. RC can not only bring valuable channel relationship but also improve the added value of the products, thus improving firms’ FP [57]. As stated by Bigliardi [58] and Bockova and Zizlavska [59], investment in innovation can lead to long-term FP. Given these arguments, the following hypotheses are proposed:

(i) $H_1$. IC has a positive impact on FP of listed shipping companies
(ii) $H_{1a}$. Physical capital has a positive impact on FP of listed shipping companies
(iii) $H_{1b}$. HC has a positive impact on FP of listed shipping companies
(iv) $H_{1c}$. SC has a positive impact on FP of listed shipping companies
(v) $H_{1d}$. RC has a positive impact on FP of listed shipping companies
(vi) $H_{1e}$. INC has a positive impact on FP of listed shipping companies

Few studies have explored the nonlinear effect of IC on FP. Haris et al. [52] and Yao et al. [54] evidenced an inverse U-shaped relationship between IC and FP. Concerning the individual element of IC, Asif et al. [55] found that at the initial stage physical investment contributes remarkably to ROA in a positive way. After a certain point, this positive impact reverts to a negative impact. Similarly, Asif et al. [55] also reported an inverted U-shaped, quadratic relationship between HC and FP. SC is not nonlinearly related to FP of Malaysian listed energy firms [55]. As for RC, Zhang [60] proved that it has a significant role in promoting new product development and firm growth of high-tech small- and medium-sized enterprises (SMEs). Excess investment in RC will cause great burden to firm’s financial position [61]. In the context of China, Kim et al. [62] found that as

![Figure 1: Conceptual framework.](image-url)
investment in R&D increases, firm value has an upward trend to a certain point and then starts to decrease. Therefore, the following hypotheses are formulated:

(i) H2a. IC has a nonlinear impact on FP of listed shipping companies
(ii) H2b. HC has a nonlinear impact on FP of listed shipping companies
(iii) H2c. SC has a nonlinear impact on FP of listed shipping companies
(iv) H2d. RC has a nonlinear impact on FP of listed shipping companies
(v) H2e. INC has a nonlinear impact on FP of listed shipping companies

4. Research Methodology

4.1. Data Source. This study collects the data of shipping companies listed on the Shanghai and Shenzhen stock exchanges from 2014 to 2019. The year 2014 is chosen as the starting point because shipping industry in China showed signs of recovery from 2014. Due to the financial crisis in 2008, the performance of China’s shipping industry dropped sharply in 2009. Companies with missing information, companies issuing other kinds of shares, and special treatment (ST) companies are excluded from our original sample. Finally, an unbalanced panel of 30 companies with 155 observations is left for the analysis. Financial data are obtained from the China Stock Market and Accounting Research (CSMAR) database (http://www.gtarsc.com/). The regressions are carried out using Stata 14.

4.2. Variable Definition. With regard to the dependent variable, ROA is used as a measurement of FP, consistent with Chen et al. [3], Tripathy et al. [5], Sardo et al. [45], Smriti and Das [51], Tran and Vo [6], Xu and Wang [4], and Asif et al. [55]. ROA is calculated by dividing net income by average total assets. It measures how well a company generates profits from its total assets.

Regarding the independent variables, the MVAIC model is employed to systemically assess IC. The first step is to calculate value added (VA). Guided by Xu and Wang [53] and Xu et al. [11], it is the sum of net profit, employee cost, interest expenses, and taxes paid. Next, the MVAIC calculation is on the basis of the efficient utilization of physical capital, HC, SC, RC, and INC through computing capital employed efficiency (CEE), human capital efficiency (HCE), structural capital efficiency (SCE), relational capital efficiency (RCE), and innovation capital efficiency (INCE). They are calculated in

\[
CEE = \frac{VA}{\text{invested capital}}, \quad (1)
\]

\[
HCE = \frac{VA}{\text{salaries and wages of all employees}}, \quad (2)
\]

\[
SCE = \frac{(VA - \text{salaries and wages of all employees})}{VA}, \quad (3)
\]

\[
RCE = \frac{\text{selling expenses}}{VA}, \quad (4)
\]

\[
INCE = \frac{R&D \text{ expenditure}}{VA}, \quad (5)
\]

\[
MVAIC = CEE + HCE + SCE + RCE + INCE. \quad (6)
\]

As for the control variables, following Sardo et al. [45], Smriti and Das [51], Xu and Wang [4, 38, 53], Xu and Li [9], Asif et al. [55], and Xu and Liu [10], firm size (SIZE), debt ratio (LEV), and firm age (AGE) are included in regression models. SIZE is measured by the natural logarithm of total assets. LEV is calculated as the ratio of total liabilities to total assets. AGE is the age of sample companies. In addition, a year dummy (YEAR) is also included as a control for economic environmental changes.

4.3. Model Specification. Model (7) is used to test H1 in this study.

\[
ROA_{it} = \beta_0 + \beta_1MVAIC_{it} + \beta_2SIZE_{it} + \beta_3LEV_{it} + \beta_4AGE_{it} + \Sigma YEAR + \epsilon_{it}. \quad (7)
\]

Model (8) aims to investigate the nonlinear relationship between the aggregate IC and FP of listed shipping companies.

\[
ROA_{it} = \beta_0 + \beta_1MVAIC_{it} + \beta_2MVAIC^2_{it} + \beta_3SIZE_{it} + \beta_4LEV_{it} + \beta_5AGE_{it} + \Sigma YEAR + \epsilon_{it}. \quad (8)
\]

Model (9) is applied to test H1a–H1e.

\[
ROA_{it} = \beta_0 + \beta_1CEE_{it} + \beta_2HCE_{it} + \beta_3SCE_{it} + \beta_4RCE_{it} + \beta_5INCE_{it} + \beta_6SIZE_{it} + \beta_7LEV_{it} + \beta_8AGE_{it} + \Sigma YEAR + \epsilon_{it}. \quad (9)
\]

Models (10)–(14) are employed to explore the nonlinear relationship between IC components and FP.

\[
ROA_{it} = \beta_0 + \beta_1CEE_{it} + \beta_2CEE^2_{it} + \beta_3SIZE_{it} + \beta_4LEV_{it} + \beta_5AGE_{it} + \Sigma YEAR + \epsilon_{it}, \quad (10)
\]

\[
ROA_{it} = \beta_0 + \beta_1HCE_{it} + \beta_2HCE^2_{it} + \beta_3SIZE_{it} + \beta_4LEV_{it} + \beta_5AGE_{it} + \Sigma YEAR + \epsilon_{it}, \quad (11)
\]

\[
ROA_{it} = \beta_0 + \beta_1SCE_{it} + \beta_2SCE^2_{it} + \beta_3SIZE_{it} + \beta_4LEV_{it} + \beta_5AGE_{it} + \Sigma YEAR + \epsilon_{it}. \quad (12)
\]
In Model (7), the coefficient of MVAIC is positive and effects(RE) model is applied in all models. Model (9) with IC of Models (7)–(14). Based on the Hausman test, the random Table 4 presentstheregressionresults

5.3. Empirical Results.

5.2. Correlation Analysis.

5.1. Descriptive Statistics.

As is shown in Table 1, ROA has the mean score of 0.0379, suggesting that listed shipping companies can make profit during the observed period. The mean MVAIC reveals that shipping companies create 3.2760 yuan for one unit of money utilized during 2014–2019. HCE is observed to be the most influential component in performance improvement with the greatest mean value of 2.4057, compared to CEE, SCE, RCE, and INCE. This is in line with Pulic [27], Chen et al. [3], Tripathy et al. [5], Xu and Wang [4], Bayraktaroglu et al. [7], Haris et al. [52], Yao et al. [54], Xu and Liu [10], and Zhang et al. [33]. The sum of the mean values of HCE, SCE, RCE, and INCE (3.0833) is 16 times as much as the mean value of CEE (0.1927), implying that sample companies tend to generate wealth via IC resources instead of tangibles. It is worth noticing that the mean scores of RCE and INCE (0.0157 and 0.0028) are low, which implies that these companies do not attach great attention to the importance of relational and innovation capitals in value creation. In addition, the mean of SIZE, LEV, and AGE is 23.5148, 0.4373, and 18.6, respectively. The standard deviation of SIZE and AGE is 1.2910 and 7.0033, respectively, representing high variations in size and age among these companies.

Table 2 shows the evolution of IC and its components. During this period, listed shipping companies increased investment in physical and human capitals. It was evidenced that shipping companies usually spend a large amount of money in purchasing ships [22]. The level of SC and RC remained relatively stable. It is noticeable that although investment in INC showed an increasing trend, these companies did not fully recognize the important role of innovative activities.

5.2. Correlation Analysis. As is shown in Table 3, ROA is positively correlated with MVAIC, CEE, and HCE, while negatively correlated with SCE. The ROA–RCE and ROA–INCE relationships are not significant. All values of variance inflation factor (VIF) are found to be less than 10, indicating that there does not exist strong multicollinearity in this study.

5.3. Empirical Results. Table 4 presents the regression results of Models (7)–(14). Based on the Hausman test, the random effects (RE) model is applied in all models. Model (9) with IC components has a higher explanation power than Model (7). In Model (7), the coefficient of MVAIC is positive and significant (β = 0.008, t = 4.05), suggesting that an increase in IC can cause the improvement of firms FP. This is in line with Xu and Wang [4], Haris et al. [52], Xu and Li [9], Yao et al. [54], Asif et al. [55], Xu and Liu [10], and Zhang et al. [33]. Therefore, H1 is fully accepted. Model (8) reports the significant positive coefficient of MVAIC (β = 0.041, t = 11.85) and the significant negative coefficient of MVAIC² (β = −0.003, t = −11.04). This confirms the inverted U-shaped relationship between IC and ROA, consistent with the finding of Haris et al. [52] based on the data from Pakistan banks, Yao et al. [54] using data from financial institutions in Pakistan, and Asif et al. [55] focusing on the Malaysian energy sector. Therefore, H2 is fully accepted. The optimal value of MVAIC is calculated to be 6.8333 (0.041−0.006MVAIC², t = 0), which indicates that listed shipping companies still need to increase their investment in IC resources.

In Model (9), physical and human capitals are the determinants of FP, while SC, RC, and INC have no significant impact on ROA. Liu [63] suggested that human resource incentives can provide a guarantee for sustainable development of shipping companies. In this sector, Wang et al. [64] concluded that customer retention improves corporate performance by suppressing earnings management. However, Del Giudice and De Paola [65], using a case study of a shipping company, found that HC does not contribute to business value, while SC and RC are the most influential contributors. Regarding HC, employee skills and turnover are decidedly absent within the business. Chen et al. [20] argued that RC becomes an important factor in performance improvement in China’s shipping industry. Ji et al. [66], based on a survey for shipping companies, also found that the integration of supply chain can help companies achieve sustainable development through management innovation and technological innovation. For China’s transportation enterprises, Liu [67] concluded that HC, SC, and RC have a significantly positive impact on profitability. In the digital economy, advanced information technology can make shipping companies improve operational efficiency and innovate their services [68].

Regarding a quadratic relationship between CEE and ROA, we find a relationship in the form of a U in Model (10). However, in Models (11), (13), and (14), we find an inverted U-shaped relationship between human, relational, innovation capitals, and ROA. From these results, we can conclude that up to a certain level of efficiency, these capitals are the positive factors and that they become restrictive factors of FP beyond that level. Model (12) shows that the coefficients of SCE and CEE² are not significant, indicating that SC does not have nonlinear effect on ROA. Keramati et al. [69] believed that IT investment can stimulate banks’ performance. Asif et al. [55] observed that there is an inverse U-shaped relationship between CEE and HCE and energy companies performance (measured through ROA) in Malaysia. The quadratic relationship does not exist between SCE and ROA. In addition, LEV has a negative and significant impact on ROA. Zhang and Shen [22] found that bank loan is one of the main sources of financing activities in this industry.

\[
\text{ROA}_{i,t} = \beta_0 + \beta_1 \text{RCE}_{i,t} + \beta_2 \text{RCE}_{i,t}^2 + \beta_3 \text{SIZE}_{i,t} + \\
+ \beta_4 \text{LEV}_{i,t} + \beta_5 \text{AGE}_{i,t} + \Sigma \text{YEAR} + \epsilon_{i,t},
\]

(13)

\[
\text{ROA}_{i,t} = \beta_0 + \beta_1 \text{INCE}_{i,t} + \beta_2 \text{INCE}_{i,t}^2 + \beta_3 \text{SIZE}_{i,t} + \\
+ \beta_4 \text{LEV}_{i,t} + \beta_5 \text{AGE}_{i,t} + \Sigma \text{YEAR} + \epsilon_{i,t},
\]

(14)

where \(i\) is the firm; \(t\) is the year; \(\beta\) stands for the presumed parameter; and \(\epsilon\) denotes the measurement error term.
5.4. Robustness Check. The robustness test is conducted by using ROE (measured by the ratio of net income to average shareholders' equity) instead of ROA to reestimate Models (7)–(14). The fixed effects (FE) model is applied in Models (8)–(11), and the RE model is used in other models. The results in Table 5 are similar to our previous finding, suggesting that our conclusion is robust.

6. Discussion

Supporting the RBV theory, IC is the backbone of any knowledge-based sector. Listed shipping companies need to take a strategic approach to IC measurement and investment. It is really noticeable that too much IC investment is not a good thing. Liu et al. [31] concluded that IC has an inverted U-shaped relationship between IC and financial competitiveness in China’s renewable energy sector. In addition, IC components are found to affect brand reputation [39], which means that shipping companies could capitalize on their IC in creating strong brands. Good brand reputation can help shipping companies obtain revenue for several years by an increase in sales.

As discussed earlier, shipping industry is a capital-intensive industry, and physical assets are the fundamental guarantee for the company’s daily operation. Unlike other industries, physical capital in this industry is movable [70]. However, in a developing country (i.e., Tanzania), firms do not employ efficiently physical assets [48]. Sufficient investment in this capital is beneficial to firm’s scale expansion and business enlargement.

HC is observed to positively influence FP of listed shipping companies. Li and Zhao [50] found that capital-intensive firms rely more on HC than on labor-intensive firms in the case of China. Human resource performance management is also required to evaluate their officers and maximize the productivity of employees [70]. However, overinvestment in human resources tends to occupy a big amount of money, resulting in a decrease in FP.

Table 1: Descriptive statistics.

| Variable | N  | Mean  | 25%  | 50%  | 75%  | Min   | Max   | SD    |
|----------|----|-------|------|------|------|-------|-------|-------|
| ROA      | 155| 0.0379| 0.0168 | 0.0319 | 0.0574 | −0.1437 | 0.2397 | 0.0364 |
| MVAIC    | 155| 3.2760| 2.4821 | 3.1083 | 3.9398 | −2.2203 | 12.1283 | 1.3361 |
| CEE      | 155| 0.1927| 0.1497 | 0.1756 | 0.2269 | −0.3737 | 0.8811 | 0.1039 |
| HCE      | 155| 2.4057| 1.7389 | 2.3118 | 2.9673 | −3.0965 | 5.8620 | 1.0403 |
| SCE      | 155| 0.6591| 0.4404 | 0.5801 | 0.6727 | 0.1438 | 12.3808 | 1.0434 |
| RCE      | 155| 0.0157| 0.0018 | 0.0186 | −0.1197 | 0.2546 | 0.0397 | 0.0079 |
| INCE     | 155| 0.0028| 0.000 | 0.0025 | −0.0303 | 0.0458 | 0.0079 | 0.1522 |
| SIZE     | 155| 23.5148| 22.6509 | 23.5622 | 24.3070 | 20.0564 | 26.2925 | 1.2910 |
| LEV      | 155| 0.4373| 0.3651 | 0.4226 | 0.5229 | 0.0633 | 0.8919 | 0.1522 |
| AGE      | 155| 18.6 | 14 | 17 | 24 | 6 | 37 | 7.0033 |

Table 2: Yearwise means for IC and its components.

| Year (Mean) | MVAIC | CEE | HCE | SCE | RCE | INCE |
|-------------|-------|-----|-----|-----|-----|------|
| 2014        | 2.9263 | 0.1690 | 2.1764 | 0.5651 | 0.0145 | 0.0013 |
| 2015        | 3.2727 | 0.1978 | 2.3165 | 0.7370 | 0.0190 | 0.0024 |
| 2016        | 3.5154 | 0.1720 | 2.3241 | 1.0042 | 0.0133 | 0.0018 |
| 2017        | 3.3323 | 0.2039 | 2.5416 | 0.5667 | 0.0168 | 0.0033 |
| 2018        | 3.2423 | 0.2012 | 2.4754 | 0.5471 | 0.0156 | 0.0030 |
| 2019        | 3.3447 | 0.2081 | 2.5608 | 0.5563 | 0.0150 | 0.0045 |

Table 3: Correlation analysis.

| Variable  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|-----------|----|----|----|----|----|----|----|----|----|----|
| 1 ROA     | 1  |    |    |    |    |    |    |    |    |    |
| 2 MVAIC   | 0.288** | 1  |    |    |    |    |    |    |    |    |
| 3 CEE     | 0.660*** | 0.044 | 1  |    |    |    |    |    |    |    |
| 4 HCE     | 0.561*** | 0.665*** | 0.201** | 1  |    |    |    |    |    |    |
| 5 SCE     | −0.262*** | 0.621*** | −0.251*** | −0.167** | 1  |    |    |    |    |    |
| 6 RCE     | 0.098 | −0.173** | 0.182** | 0.016 | −0.294*** | 1  |    |    |    |    |
| 7 INCE    | 0.196 | −0.144* | 0.060 | 0.114 | −0.313*** | 0.024 | 1  |    |    |    |
| 8 SIZE    | −0.201*** | 0.269*** | −0.137* | 0.192** | 0.179* | −0.346*** | 0.153* | 1  |    |    |
| 9 LEV     | −0.487*** | −0.012 | 0.153* | −0.164** | 0.133* | 0.014 | −0.165** | 0.433*** | 1  |    |
| 10 AGE    | 0.205** | 0.038 | 0.144* | 0.116 | −0.099 | 0.352*** | 0.451*** | −0.120 | −0.064 | 1  |

*p < 0.10, **p < 0.05, and ***p < 0.01.
Table 4: Results of regression analysis.

| Variable | Model (7) | Model (8) | Model (9) | Model (10) | Model (11) | Model (12) | Model (13) | Model (14) |
|----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|
|          | RE        | RE        | RE        | RE         | RE         | RE         | RE         | RE         |
| Constant | 0.095* (1.80) | 0.112** (2.03) | -0.045 (-1.52) | -0.156*** (-3.76) | 0.141** (2.50) | 0.038 (0.63) | -0.005 (-0.08) | 0.060 (0.95) |
| MVAIC    | 0.008*** (4.05) | 0.041*** (11.85) | -0.003*** (-11.04) | 0.255*** (21.97) | 0.275*** (20.75) | -0.010 (-0.43) | 0.001 (0.26) | 0.1399 Prob > $\chi^2$ |
| MVAIC$^2$|            |           |           |            |            |            |            |            |
| CEE      | 0.010*** (7.87) | 0.075*** (3.67) |            | 0.035*** (11.27) |           | -0.010 (-1.02) | 0.0002 (0.27) |            |
| CEE$^2$  |            |           |           |            |            |            |            |            |
| HCE      |            |           |           |            |            |            |            |            |
| HCE$^2$  |            |           |           |            |            |            |            |            |
| SCE      | 0.001 (0.96) |            |            |            |            |            |            |            |
| SCE$^2$  |            |           |           |            |            |            |            |            |
| RCE      |            |           |           |            |            |            |            |            |
| RCE$^2$  |            |           |           |            |            |            |            |            |
| INCE     |            |           |           |            |            |            |            |            |
| INCE$^2$ |            |           |           |            |            |            |            |            |
| SIZE     | -0.002 (-0.96) | -0.006** (-2.43) | 0.003** (2.26) | 0.009** (4.95) | -0.006** (-2.44) | 0.002 (0.58) | 0.003 (1.17) | 0.0001 (0.03) |
| LEV      | -0.103*** (-5.42) | -0.057*** (-3.10) | -0.144*** (-14.42) | -0.177*** (-14.73) | -0.061*** (-3.32) | -0.109*** (-5.14) | -0.110*** (-5.27) | -0.102*** (-4.68) |
| AGE      | 0.001** (2.00) | 0.0002 (0.48) | 0.0003 (1.40) | 0.0005 (1.54) | 0.0002 (0.58) | 0.001* (1.87) | 0.001* (1.79) | 0.001* (1.88) |
| YEAR     | Yes        | Yes       | Yes       | Yes        | Yes       | Yes       | Yes       | Yes |
| N        | 155        | 155       | 155       | 155        | 155       | 155       | 155       | 155 |
| $R^2$    | 0.3569     | 0.5405    | 0.9079    | 0.8837     | 0.5511    | 0.3086    | 0.3920    | 0.3204   |
| Wald     | 71.43***   | 190.55*** | 1169.40***| 958.17***  | 205.90*** | 53.22***  | 72.98***  | 52.40*** |
| Hausman test | Prob > chi2 = 0.1399 | Prob > chi2 = 0.1096 | Prob > chi2 = 0.1244 | Prob > chi2 = 0.5386 | Prob > chi2 = 0.2799 | Prob > chi2 = 0.0991 | Prob > chi2 = 0.5324 | Prob > chi2 = 0.4062 |

*p < 0.10, **p < 0.05, and ***p < 0.01. t-values are in parentheses.
Table 5: Results of robustness check.

| Variable | Model (7) | Model (8) | Model (9) | Model (10) | Model (11) | Model (12) | Model (13) | Model (14) |
|----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|
|          | RE        | FE        | RE        | FE         | RE         | RE         | RE         | RE         |
| Constant | 0.171     | 0.223     | -0.803*** | -3.18      | 0.443      | 0.018      | -0.138     | 0.093      |
|          | (1.28)    | (0.45)    | (-3.18)   | (-3.76)    | (0.90)     | (0.13)     | (-1.06)    | (0.66)     |
| MVAIC    | 0.018***  | 0.148***  | -0.012*** | (-15.52)   | 0.443      | 0.018      | -0.138     | 0.093      |
|          | (3.44)    | (15.55)   | (-15.52)  |            |            |            |            |            |
| CEE      | 0.929***  | 0.896***  | (22.90)   | (29.16)    |            |            |            |            |
|          | (22.90)   | (29.16)   |           |            |            |            |            |            |
| CEE\(^2\) | 0.001    | 0.102**   |           |            |            |            |            |            |
|          | (0.20)    | (2.20)    |           |            |            |            |            |            |
| HCE      | 0.005     | 0.005     |           |            | -0.012*** | -0.035     | -0.001     |            |
|          | (1.72)    | (1.72)    |           |            | (-7.54)   | (-1.33)    | (0.46)     |            |
| HCE\(^2\) | 0.126*** |            | 0.012     |            |           |            |            |            |
|          | (15.67)   |           | (-7.54)   |            |           |            |            |            |
| SCE      | 0.284     | 0.284     |           |            | 1.784***  | -9.096***  |            |            |
|          | (1.97)    | (1.97)    |           |            | (5.99)    | (-6.11)    |           |            |
| SCE\(^2\) | 0.005    | 0.005     |           |            |           |            |            |            |
|          | (1.72)    | (1.72)    |           |            |           |            |            |            |
| RCE      | 0.776     | 0.776     |           |            |            |            |            |            |
|          | (1.28)    | (1.28)    |           |            |            |            |            |            |
| RCE\(^2\) | 4.284*** |            |           |            | -134.432*** | (-3.38)    |            |            |
|          | (3.06)    | (-3.38)   |           |            |           |            |            |            |
| SIZE     | -0.008    | -0.024    | -0.005    | -0.005     | 0.0003    | 0.0003     | 0.0003     | 0.0003     |
|          | (-1.29)   | (-1.01)   | (-3.04)   | (-3.00)    | (0.08)    | (0.09)     | (0.09)     | (0.09)     |
| LEV      | -0.064    | 0.139     | -0.005    | -0.005     | 0.0003    | 0.0003     | 0.0003     | 0.0003     |
|          | (-1.32)   | (2.01)    | (-3.04)   | (-3.00)    | (0.08)    | (0.09)     | (0.09)     | (0.09)     |
| AGE      | 0.002     | 0.0003    | -0.005    | -0.005     | 0.0003    | 0.0003     | 0.0003     | 0.0003     |
|          | (1.63)    | (0.08)    | (-3.04)   | (-3.00)    | (0.09)    | (0.09)     | (0.09)     | (0.09)     |
| YEAR     | Yes       | Yes       | Yes       | Yes        | Yes       | Yes        | Yes        | Yes        |
|          |           |           |           |            |           |            |            |            |
| N        | 155       | 155       | 155       | 155        | 155       | 155        | 155        | 155        |
|          |           |           |           |            |           |            |            |            |
| F (wald) | 25.84***  | 32.05***  | 124.42*** | 169.48***  | 32.66***  | 27.31***   | 57.01***   | 26.34***   |
| Hausman  |           |           |           |            |           |            |            |            |
| test     | Prob > chi2 = 0.1774 | Prob > chi2 = 0.0009 | Prob > chi2 = 0.0000 | Prob > chi2 = 0.0001 | Prob > chi2 = 0.0351 | Prob > chi2 = 0.0841 | Prob > chi2 = 0.5260 | Prob > chi2 = 0.5699 |

*p < 0.10, **p < 0.05, and ***p < 0.01. \(t\)-values are in parentheses.
With regard to SC, the results reveal that listed shipping companies underutilize SC. It can function in supporting employees' performance and firm performance. This insignificant relationship implies that listed shipping companies need to continuously upgrade their knowledge and apply this knowledge into the process of the company, which can lead to higher productivity and efficiency in operations. Papoutsidakis et al. [71] pointed out that using new technologies and information systems such as enterprise resource planning (ERP) system and electronic navigation system is essential for smooth operation of shipping companies, which can save valuable time and check for any shortages of goods and materials. Similarly, Smriti and Das [51] reported an insignificant and negative link between SC and ROA in Indian companies.

It is essential for China's shipping companies to maintain long-term customer relationships and provide good customer services because customer feedback can help companies continuously improve their service quality in today's competitive environment. On the contrary, such excess expenditure (e.g., entertainment and marketing expense) will bring great burden to financial position.

Technology investment is also one of the driving forces of the firms. Kim et al. [62] and Qi and Deng [72] also confirmed an inverse U-shaped curve between R&D investment and firm performance. The process of technology transfer generally needs a long time, but R&D expenditures are expensed on the basis of accounting standards, which in turn lowers current FP of a firm. In addition, with the rise of digital trade, global shipping is in the early stage of digital transformation. In this context, shipping companies need to build a digital platform and enhance the competitiveness of global digital trade through digital technological innovation [73].

7. Conclusions

This paper examines the nonlinear relationship between IC and its components and FP in China's shipping industry from 2014 to 2019. The empirical results show that IC has a nonlinear effect on FP of listed shipping companies. In addition, physical capital has a U-shaped relationship with firms' FP, while HC, RC, and INC have an inverted U-shaped relationship. The nonlinear relationship between SC and FP is not significant.

The paper has the following theoretical contributions. First, it examines the nonlinear impact of IC and its components on FP by using the data from shipping companies in the case of China. The existing studies on IC mostly ignore this nonlinear relationship, which enriches the relevant literature. Second, it might become the foundation to guide in-depth research investigating the IC's impact on FP in other economies or regions.

There are several practical implications of this paper. First, listed shipping companies should focus on the important role of IC and make the optimal strategy on both tangible and intangible investment. Second, these companies should make incentive policies in human resource management, improve employees' performance by continuous training, and lay off their redundant staff. Third, the non-significant impact of SC suggests that management should establish a specific mission and vision, have a clear knowledge strategy, use automated management control systems, and establish a good corporate culture. Fourth, managers need to continuously adjust their corporate strategies based on the market demand to gain a better position. In addition, such companies ought to establish a long-term relationship with old customers, attract new customers by price differentiation and cost leadership, and satisfy customer need with professional knowledge to strengthen their competitiveness. Fifth, such companies should apply new technology to accounting information management system to improve the work efficiency. Finally, listed shipping companies can calculate immaterial IC resources and announce a report on off-balance-sheet assets, which will help analysts to improve FP.

There are some limitations that are needed to be addressed in future research. First, we focus only on shipping industry, and further research could compare with other industries. We also suggest extending this research in other emerging markets. Second, the long-term impact of IC is not taken into consideration. In addition, some macro-economic factors (e.g., gross domestic product) should also be included in the regression model.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This research was supported by the Soft Science Research Plan of Shandong Province (grant no. 2019RKB01222) and the Scientific Research Foundation for High-Level Talents of Qingdao Agricultural University (grant no. 6631120701).

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