agronomy

*Article*

# Does Intellectual Capital Measurement Matter in Financial Performance? An Investigation of Chinese Agricultural Listed Companies

**Jian Xu and Yi Zhang ***

School of Management, Qingdao Agricultural University, Qingdao 266109, China; jianxusword@qau.edu.cn
* Correspondence: qauzhangyi@sina.com

**Abstract:** Intellectual capital (IC) has become a crucial strategic resource in the knowledge economy. The purpose of this study is to understand the IC-financial performance relationship of listed Chinese agricultural companies. This paper uses the original value added intellectual coefficient (VAIC) model, the adjusted VAIC (AVAIC) model, and the modified VAIC (MVAIC) model to measure IC. The results show a positive and significant relationship between IC and financial performance (return on assets and return on equity) in three models. Additionally, human capital and physical capital are two major driving forces. In the AVAIC model, innovation capital exerts a positive impact on financial performance, whereas this impact is not significant at the 5% level in the MVAIC model. The results suggest that further improvements in IC measurement are still needed. This study has important implications for both academia and industry regarding IC measurement.

**Keywords:** intellectual capital; measurement method; financial performance; China's agricultural sector

check for updates

**Citation:** Xu, J.; Zhang, Y. Does Intellectual Capital Measurement Matter in Financial Performance? An Investigation of Chinese Agricultural Listed Companies. *Agronomy* **2021**, *11*, 1872. https://doi.org/10.3390/agronomy11091872

Academic Editors: Djamilia Skripnuk, Gulnara Romashkina and Magdalena Sobocińska

Received: 27 July 2021
Accepted: 15 September 2021
Published: 17 September 2021



## 1. Introduction

The theory of endogenous growth suggests that the internal factors are the determinants of the development of enterprises. The driving force of firm growth derives from the resources, knowledge, and ability within an organization. The resource-based view (RBV) also proposes that unique resources including tangibles and intangibles can drive firm performance. However, the important role of intangible resources has been emphasized by many researchers in the knowledge economy era. The sources of wealth creation have changed from traditional production factors, such as land, capital, and labor, to intangible assets [1]. Firms are required to properly manage their internal resources that are scarce, inimitable, and non-substitutable, which helps them to sustain competitiveness [2,3].

Intellectual capital (IC) as an intangible asset is the ability to transform and build knowledge into wealth creating goods. It is the internal driving force of corporate development, which can stimulate the internal vitality of enterprises. IC is also reckoned as an important contributor to sustainable competitive advantage and financial performance enhancement of a firm [4–12]. IC development may vary from industry to industry. Moreover, the methods of IC measurement vary [13].

Agricultural issues have always been the focus of Chinese government. Modern agriculture cannot be limited to land and classic production factors but must comprise advanced technologies and quality standards [14]. The development of agricultural companies is related to agricultural modernization as well as the entire national economy. Agribusiness heavily relies on the efficiency of IC usage [15]. However, the efficiency in agricultural sector may be affected by natural climate conditions and agricultural policies. This might make enterprises which are inefficient formally profitable with subsidies [16]. However, there are still many problems that restrict the development of agricultural listed companies such as insufficient capital investment, rough processing of agricultural products, low economic benefits, strong dependence on government subsidies, and the lack of innovation [17]. The economic performance of agricultural companies is a function of physical capital and IC resources [16]. Researchers in the agricultural sector have disregarded the impact of IC on financial performance. Therefore, it is urgent for agricultural listed companies to tap the potential of value creation of IC resources.

The objective of this paper is to investigate the impact of IC and its components on financial performance of Chinese agricultural listed companies. It is also intended to compare different IC measurement models. IC is measured by the value added intellectual coefficient (VAIC) model, the adjusted VAIC (AVAIC) model, and the modified VAIC (MVAIC) model. The empirical data are drawn from 35 agricultural companies listed on the Shanghai and Shenzhen stock exchanges from 2013 to 2019. Multiple regression analysis is used to analyze this relationship.

This study contributes to the literature in three aspects. Firstly, few studies have been conducted on examining the impact of IC in agricultural sector, except Komnenic et al. [1], Lee and Mohammed [4], Xu et al. [10], Ovechkin et al. [11], Scafarto et al. [15], Kozera [16], Xu and Wang [17], Yang et al. [18], Fei [19], Kozera-Kowalska [20], Ivanovic et al. [21], and Zhang et al. [22]. It enriches the current IC research based on the data from agricultural listed companies in an emerging market (i.e., China), and provides a valuable theoretical basis for enhancing the high-quality development of China's agricultural economy. Secondly, it contributes to IC measurement by providing empirical research on the use of the VAIC model, the AVAIC model, and the MVAIC model. Finally, this study might provide some insights for business managers to improve the utilization efficiency of IC resources, and also help the government to formulate favorable agricultural policies.

The remainder of the paper is organized as follows. The next section provides a review of related literature. Section 3 describes the methodology. In Sections 4 and 5, the results and discussions are presented. Finally, Section 6 concludes the paper.

## 2. Literature Review

### *2.1. IC Definition and Classification*

There are various definitions of IC. At an early stage, Stewart [23] defined IC as the total stocks of knowledge in the firm. IC is also defined as the difference between market value and book value of a company [24].

It is generally believed that human capital (HC), structural capital (SC), and relational capital (RC) constitute IC [7–9,25–27]. RC is sometimes referred to as customer capital. HC is the mixture of knowledge, skills, experience, and expertise of employees [28]. Royal and O'Donnell [29] discovered that HC is an essential element in the process of value creation. SC supports employees' performance and firm performance with the function of information, systems, processes, procedures, databases, culture, and the like [30]. SC, as a non-human asset, can be possessed by the firm, and can also be traded. RC is the firm's skill in preserving its internal and external relationships with various stakeholders [31].

Xu and Liu [32], Ge and Xu [33], Liu et al. [34], Lu et al. [35], Xu and Zhang [36], and Zhang et al. [37] defined innovation capital (INC) as the fourth component of IC. INC represents a firm's willingness to extend innovations through research and development (R&D) activities [11].

### *2.2. The VAIC Model*

How to accurately measure IC is still a challenging issue for scholars in the field of corporate governance across the globe [38]. Due to its intangible nature, it is essential to use proper and useful methods to detect where IC elements lay and measure the use of IC. Among various financial and non-financial methods, the VAIC model developed by Pulic [39] gains its popularity in the IC literature. This quantitative method avoids the rationality of validity of survey method. Its data availability from firms' audited financial reports makes it a standardized measurement, which can be used for comparison across organizations [40].

The VAIC model belongs to the output-oriented process method of measuring IC. It attempts to measure how much value is created by per invested monetary unit in resources. This model is an efficient tool that can enable stakeholders to detect strengths and weaknesses in value creation process [41].

The first phase is calculating value added (VA), which is defined as follows:

$$\text{VA} = \text{Net income (NI)} + \text{Interests (I)} + \text{Taxes (T)} + \text{Employee costs (HC)} \quad (1)$$

The second phase is calculating VAIC, which consists of capital employed efficiency (CEE), human capital efficiency (HCE), and structural capital efficiency (SCE). VAIC is calculated as follows:

$$\text{CEE} = \text{VA}/\text{Book value of total assets} \quad (2)$$

$$\text{HCE} = \text{VA}/\text{HC} \quad (3)$$

$$\text{SCE} = 1 - \text{HC}/\text{VA} \quad (4)$$

$$\text{VAIC} = \text{CEE} + \text{HCE} + \text{SCE} \quad (5)$$

The VAIC model also suffers from some criticisms. It has no relation with IC but rather measures the labor and capital coefficient. In addition, RC and INC are missed by scholars and practitioners [42].

### *2.3. The AVAIC Model*

The AVAIC model is a new version of Pulic's [39] VAIC model, which is proposed by Nadeem et al. [43]. There are two changes in the AVAIC model. First, the calculation of VA is adjusted by adding back R&D expenses because R&D should be treated as investments rather than costs. VA is calculated as the sum of NI, I, T, HC, and R&D expenses. Second, because of the problematic calculation of SC in the original VAIC model, Nadeem et al. [43] replaced SC with R&D costs. He argued that this replacement overcomes the overlapping of VA and HC, and innovation capital efficiency (INCE) was the ratio of VA to R&D expenses. However, if a firm does not conduct R&D activities, it is inappropriate to use this model to measure its IC efficiency.

### *2.4. The MVAIC Model*

Some studies extend the original VAIC model by adding other IC components that are missed. Chen et al. [42] used R&D and advertising expenses as proxies for INC and RC. They were divided to book value of common stocks for scaling purposes. It was evidenced that INC may capture additional information on SC. Subsequently, Xu and Wang [5] and Tripathy et al. [44] used the same model to provide further understanding about the role of each IC component in performance improvement. These scholars argued that these expenses should be viewed as intangible asset-like investments instead of costs. Different from Xu and Wang [5], Chen et al. [42], and Tripathy et al. [44], Bayraktaroglu et al. [45] expressed INCE as the proportion of R&D expenses to VA and relational capital efficiency (RCE) as the proportion of VA and sales and marketing expenses. Recently, Xu and Liu [32], Ge and Xu [33], Liu et al. [34], Lu et al. [35], Xu and Zhang [36], and Zhang et al. [37] have observed INC and RC as new IC sub-components, along with human and structural capital. IC is the summation of CEE, HCE, SCE, INCE, and RCE. Similar to Pulic's [39] calculation of SCE, INCE and RCE are calculated as follows:

$$\text{INCE} = \text{R\&D expenses}/\text{VA} \quad (6)$$

$$\text{RCE} = \text{Marketing, selling and advertising expenses}/\text{VA} \quad (7)$$

### *2.5. IC and Financial Performance*

There is much debate on how to accurately measure IC and the degree to which IC influences firms' financial performance [38], but the results are inconsistent. Table 1 summarizes an overview on IC measurement and the IC-financial performance relationship. The measurement in IC is also various, and most studies use the original VAIC model that is criticized by some scholars. Regarding IC components, different scholars also hold different views. In addition, previous IC literature has focused on developed countries, such as the US and the UK [7]. Recently, studies on IC in emerging markets have attracted scholars' eyes, but there is a lack of studies related to IC and agribusiness [20]. Kozera [16] confirmed the growing importance of IC in promoting profitability in agricultural sector. Lee and Mohammed [4] analyzed agricultural firms in Malaysia and found that physical and structural capital are major contributors to financial performance. Ovechkin et al. [11] argued that HC and SC have the biggest impact on the profitability of Russian agricultural businesses. The findings of Xu and Wang [17] and Zhang et al. [22] revealed that physical and human capitals improve financial performance in China's agricultural sector. Taking agricultural enterprises in the West Balkans areas, Ivanovic et al. [21] also found similar results. Thus, more work is needed in the agricultural sector.

**Table 1.** Overview on IC and financial performance.

| No. | Author(s) | Sample | IC Measurement | Dependent Variable | IC Elements | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | HC | SC | INC | RC |
| 1 | Chen et al. [42] | Taiwanese listed companies | MVAIC | Return on assets (ROA), return on equity (ROE), growth in revenues (GR), and employee productivity (EP) | + | +(ROA) | +(ROA and GR) | −(ROA and ROE) |
| 2 | Gan and Saleh [46] | Malaysian technology-intensive companies | VAIC | Market-to-book ratio (MB), ROA, and asset turnover ratio (ATO) | + | Insignificant | N/A | N/A |
| 3 | Phusavat et al. [47] | Thai manufacturing firms | VAIC | ROA, ROE, GR, and EP | +(ROA, ROE, and EP) | −(ROA and EP) | +(GR) −(ROA) | N/A |
| 4 | Mondal and Ghosh [48] | Indian banks | VAIC | ROA, ROE, and ATO | + | +(ATO) | N/A | N/A |
| 5 | Joshi et al. [49] | Australian financial companies | VAIC | ROA | Insignificant | Insignificant | N/A | N/A |
| 6 | Nimtrakoon [50] | Technology firms on five ASEAN countries | MVAIC | Margin ratio and ROA | + | + | N/A | + |
| 7 | Tripathy et al. [44] | Indian companies | MVAIC | ROA and ROE | Insignificant | +(ROA) | − | +(ROE) |
| 8 | Dženopoljac et al. [51] | Serbian information communication technology firms | VAIC | ROA, ROE, return on invested capital (ROIC), profitability, and ATO | +(ROIC) | Insignificant | N/A | N/A |
| 9 | Ozkan et al. [52] | Turkish banks | VAIC | ROA | + | + | N/A | N/A |
| 10 | Smriti and Das [53] | Indian pharmaceutical and drug companies | VAIC | ROA, ATO, and MB | Insignificant | +(ATO) −(MB) | N/A | N/A |
| 11 | Chowdhury et al. [54] | Bangladeshi textile firms | VAIC | ROA, ROE, and ATO | Insignificant | +(ROA and ROE) | N/A | N/A |
| 12 | Smiriti and Das [55] | Indian listed firms | VAIC | ROA, ATO, Tobin's Q (TQ), and GR | +(ATO) | +(ATO, TQ, and GR) | N/A | N/A |

**Table 1.** *Cont.*

| No. | Author(s) | Sample | IC Measurement | Dependent Variable | IC Elements | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | HC | SC | INC | RC |
| 13 | Tran and Vo [56] | Thai listed banks | VAIC | ROA | − | Insignificant | N/A | N/A |
| 14 | Xu and Wang [5] | Korean manufacturing companies | MVAIC | ROA and ROE | + | + (ROA) | − | + |
| 15 | Forte et al. [57] | Italian listed companies | VAIC | ROA, GR, and MB | +(ROA and SG) −(MB) | − | N/A | N/A |
| 16 | Nadeem et al. [43] | 10 developed and developing economies | AVAIC | ROA, ROE, ATO, and MB | + | N/A | + | N/A |
| 17 | Vidyarthi [27] | Indian banks | MVAIC | Efficiency | + | Insignificant | N/A | − |
| 18 | Xu and Wang [17] | Chinese agricultural listed companies | VAIC | Earnings before interest and taxes (EBIT), ROA, ROE, and ATO | +(ROA and ROE) −(EBIT and ATO) | +(EBIT) | N/A | N/A |
| 19 | Kasoga [58] | Tanzanian service and manufacturing firms | VAIC | ROA, ATO, SG, and TQ | − | + | N/A | N/A |
| 20 | Petković et al. [59] | French wineries | VAIC | Operating profit and net income | + | − | N/A | N/A |
| 21 | Ge and Xu [33] | Chinese pharmaceutical companies | MVAIC | EBIT, earnings before interest, taxes, depreciation, and amortization, net profit margin (NPM), gross profit margin, earnings per share, ROIC, ROA, ROE, GR, ATO, and MB | + | +(EBIT) | +(NPM and ROIC) | +(EBIT) −(NPM and ROIC) |
| 22 | Liu et al. [34] | Chinese renewable energy companies | MVAIC | An index system | + | + | Insignificant | + |
| 23 | Lu et al. [35] | Chinese firms that accepted venture-capital syndication funding | MVAIC | ROA and ROE | + | + | + | + |
| 24 | Zhang et al. [37] | Chinese textile and apparel companies | MVAIC | ROA, ROE, MB, and EP | + | +(ROE) −(EP) | −(EP) | −(ROA, ROE, and MB) |

Notes: + means positive impact; − means negative impact; N/A means not applicable.

## 3. Methodology

### 3.1. Sample Selection

The initial sample comprises 49 agricultural companies listed on the Shanghai and Shenzhen stock exchanges over a seven-year period (2013–2019). After screening and removing companies with missing variables, companies with no R&D activities, companies issuing other kinds of shares, and special treatment (ST) companies, an unbalanced panel of 35 companies with 206 observations of agricultural industry is left. Table 2 shows the distribution of samples. Data are taken from the China Stock Market & Accounting Research (CSMAR) database [60] and the Wind database [61]. The analysis is carried out using Stata 14.

**Table 2.** Sample distribution.

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| *n* | 26 | 27 | 27 | 29 | 30 | 33 | 34 |

## 3.2. Variables

### 3.2.1. Dependent Variables

We use two performance measures, ROA and ROE, consistent with previous literature [4,5,35,37,44,62,63]. ROA and ROE are traditional accounting performance measures of financial performance [49]. They are calculated as follows:

$$\text{ROA} = \text{Net income}/\text{Average total assets} \quad (8)$$

$$\text{ROE} = \text{Net income}/\text{Average shareholders' equity} \quad (9)$$

### 3.2.2. Independent Variables

The independent variables are related to three IC measurement models, namely the original VAIC model, the AVAIC model, and the MVAIC model. The original VAIC model of Pulic [39] is introduced in Section 2.1.

Nadeem et al. [43] proposed the AVAIC model. Its IC components include CEE, HCE, and INCE. The VA is calculated as the sum of NI, I, T, HC, and R&D expenses. The AVAIC is calculated as follows:

$$\text{VA} = \text{NI} + \text{I} + \text{T} + \text{HC} + \text{R\&D expenses} \quad (10)$$

$$\text{CEE} = \text{VA}/\text{CE} \quad (11)$$

$$\text{HCE} = \text{VA}/\text{HC} \quad (12)$$

$$\text{INCE} = \text{VA}/\text{R\&D expenses} \quad (13)$$

$$\text{AVAIC} = \text{CEE} + \text{HCE} + \text{INCE} \quad (14)$$

The MVAIC model introduces two extra IC components, namely, RC and INC. In the first step, VA is calculated as the sum of NI, I, T, and HC. In the second step, MVAIC is calculated as follows:

$$\text{CEE} = \text{VA}/\text{CE} \quad (15)$$

$$\text{HCE} = \text{VA}/\text{HC} \quad (16)$$

$$\text{SCE} = 1 - \text{HC}/\text{VA} \quad (17)$$

$$\text{INCE} = \text{R\&D expenses}/\text{VA} \quad (18)$$

$$\text{RCE} = \text{Marketing, selling and advertising expenses}/\text{VA} \quad (19)$$

$$\text{MVAIC} = \text{CEE} + \text{HCE} + \text{SCE} + \text{INCE} + \text{RCE} \quad (20)$$

### 3.2.3. Control Variables

Referring to previous literature [9,42,47,62,64], physical capacity (PC), firm size (SIZE), debt ratio (DR), and firm age (AGE) are chosen as control variables in the study. In addition, a year dummy (YEAR) is included to control for changes in the economic environment in our regression model. It should take the value of 1 for the test year. Otherwise, it should take the value of 0. They are calculated as follows:

$$\text{PC} = \text{Fixed assets}/\text{Total assets} \quad (21)$$

$$\text{SIZE} = \text{Natural logarithm of total assets at year-end} \quad (22)$$

$$\text{DR} = \text{Total liabilities}/\text{Total assets} \quad (23)$$

$$AGE = \text{The age of sample company} \tag{24}$$

### 3.3. Models

Models (1)–(4) (Equations (25)–(28)) are used to investigate the impact of IC and its elements on financial performance in the original VAIC model.

$$ROA_{i,t} = \beta_0 + \beta_1 VAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{25}$$

$$ROE_{i,t} = \beta_0 + \beta_1 VAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{26}$$

$$ROA_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 SCE_{i,t} + \beta_4 PC_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 DR_{i,t} + \beta_7 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{27}$$

$$ROE_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 SCE_{i,t} + \beta_4 PC_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 DR_{i,t} + \beta_7 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{28}$$

Models (5)–(8) (Equations (29)–(32)) are employed to determine the relationship between firms' IC and financial performance in the AVAIC model.

$$ROA_{i,t} = \beta_0 + \beta_1 AVAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{29}$$

$$ROE_{i,t} = \beta_0 + \beta_1 AVAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{30}$$

$$ROA_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 INCE_{i,t} + \beta_4 PC_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 DR_{i,t} + \beta_7 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{31}$$

$$ROE_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 INCE_{i,t} + \beta_4 PC_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 DR_{i,t} + \beta_7 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{32}$$

Models (9)–(12) (Equations (33)–(36)) are applied to explore the IC-financial performance relationship in the MVAIC model.

$$ROA_{i,t} = \beta_0 + \beta_1 MVAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{33}$$

$$ROE_{i,t} = \beta_0 + \beta_1 MVAIC_{i,t} + \beta_2 PC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 DR_{i,t} + \beta_5 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{34}$$

$$ROA_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 SCE_{i,t} + \beta_4 INCE_{i,t} + \beta_5 RCE_{i,t} + \beta_6 PC_{i,t} + \beta_7 SIZE_{i,t} + \beta_8 DR_{i,t} + \beta_9 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{35}$$

$$ROE_{i,t} = \beta_0 + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 SCE_{i,t} + \beta_4 INCE_{i,t} + \beta_5 RCE_{i,t} + \beta_6 PC_{i,t} + \beta_7 SIZE_{i,t} + \beta_8 DR_{i,t} + \beta_9 AGE_{i,t} + YEAR + \varepsilon_{i,t} \tag{36}$$

where i is the firm; t represents the year; β stands for the presumed parameter; ε denotes the error term.

## 4. Empirical Results

Empirical analysis is carried out through descriptive statistics, normality test, correlation analysis, and multiple regression models.

### 4.1. Descriptive Statistics

Table 3 presents the results of the descriptive statistics of all variables. The means of ROA (0.0166) and ROE (–0.0162) suggest that agricultural listed companies tend to have relatively lower profitability, consistent with Xu and Wang [17], Zhang et al. [22], and Liu et al. [65]. Victoria et al. [66] also found that non-agricultural firms have higher profitability than agricultural firms. The mean values of VAIC, AVAIC, and MVAIC are 1.9159, 57.4471, and 2.4013, respectively, which implies that sample companies accomplish a relatively high efficiency in the management of tangible and intangible resources. Komnenic et al. [1] concluded that 10 out of 17 Serbian companies in the field of agriculture contribute to a high level of IC efficiency with VAIC greater than 1.75. In Panels A and C, HCE has the biggest mean value among IC elements, which is in line with the findings of Lee and Mohammed [4], Kozera [14], Xu and Wang [17], Yang et al. [18], and Zhang et al. [22]. SCE has the mean value of 0.4042 with the standard deviation of 1.5101, meaning that agricultural companies' SCE has a bigger variation. The mean value of RCE is 0.3638 in Panel C, implying that investing one monetary unit in RC can create an average value of 0.3638. In Panel B, INCE has an average value of 55.9353 and a standard deviation of 156.5563, indicating that agricultural companies' INCE has a bigger variation. In Panel

C, the mean value of INCE is 0.1216. In addition, the contribution of physical assets for creating value is low.

**Table 3.** Descriptive statistics.

| Variable | Observation | Mean | Maximum | Minimum | Std. Dev. |
|---|---|---|---|---|---|
| ROA | 206 | 0.0166 | 0.6754 | −1.8591 | 0.1679 |
| ROE | 206 | −0.0162 | 0.8360 | −6.8500 | 0.5339 |
| PC | 206 | 0.2788 | 0.6948 | 0.0477 | 0.1524 |
| SIZE | 206 | 22.0273 | 24.9065 | 20.0966 | 0.9183 |
| LEV | 206 | 0.4373 | 0.9801 | 0.0594 | 0.1888 |
| AGE | 206 | 17.72 | 32 | 8 | 4.4422 |
| | | *Panel A: The VAIC model* | | | |
| VAIC | 206 | 1.9159 | 10.0198 | −81.0352 | 6.4182 |
| CEE | 206 | 0.1278 | 2.4115 | −9.2089 | 0.7083 |
| HCE | 206 | 1.3839 | 8.4492 | −72.8400 | 5.6111 |
| SCE | 206 | 0.4042 | 5.0422 | −15.1912 | 1.5101 |
| | | *Panel B: The AVAIC model* | | | |
| AVAIC | 206 | 57.4471 | 722.6715 | −1553.399 | 161.0128 |
| CEE | 206 | 0.1278 | 2.4115 | −9.2089 | 0.7083 |
| HCE | 206 | 1.3839 | 8.4492 | −72.8400 | 5.6111 |
| INCE | 206 | 55.9353 | 720.993 | −1471.35 | 156.5563 |
| | | *Panel C: The MVAIC model* | | | |
| MVAIC | 206 | 2.4013 | 10.0702 | −81.0391 | 6.3120 |
| CEE | 206 | 0.1278 | 2.4115 | −9.2089 | 0.7083 |
| HCE | 206 | 1.3839 | 8.4492 | −72.8400 | 5.6111 |
| SCE | 206 | 0.4042 | 5.0422 | −15.1912 | 1.5101 |
| INCE | 206 | 0.1216 | 3.6871 | −1.7180 | 0.3944 |
| RCE | 206 | 0.3638 | 14.8569 | −2.1466 | 1.1576 |

In addition, PC has the mean value of 0.2788, which suggests that fixed assets do not occupy a large proportion of total assets. The mean value of SIZE is 22.0273. The standard deviation of SIZE is high, suggesting that there are significant variations in size among the sample companies. LEV has a mean value of 0.4373, indicating that agricultural listed companies have a strong ability to guarantee the solvency of their debt. The mean value of AGE is 17.72 with high standard deviation.

Table 4 shows the results of normality test. Using the Shapiro–Wilk test shows that all variables do not have a normal data distribution ($p < 0.05$).

**Table 4.** Normality test.

| Variable | Statistic | dif | Sig. |
|---|---|---|---|
| *Panel A: The VAIC model* | | | |
| ROA | 0.503 | 206 | 0.000 |
| ROE | 0.303 | 206 | 0.000 |
| VAIC | 0.289 | 206 | 0.000 |
| CEE | 0.251 | 206 | 0.000 |
| HCE | 0.253 | 206 | 0.000 |
| SCE | 0.433 | 206 | 0.000 |
| PC | 0.932 | 206 | 0.000 |
| SIZE | 0.977 | 206 | 0.002 |
| LEV | 0.980 | 206 | 0.004 |
| AGE | 0.978 | 206 | 0.003 |
| *Panel B: The AVAIC model* | | | |
| ROA | 0.503 | 206 | 0.000 |
| ROE | 0.303 | 206 | 0.000 |
| AVAIC | 0.527 | 206 | 0.000 |
| CEE | 0.251 | 206 | 0.000 |
| HCE | 0.253 | 206 | 0.000 |
| INCE | 0.537 | 206 | 0.000 |
| PC | 0.932 | 206 | 0.000 |
| SIZE | 0.977 | 206 | 0.002 |
| LEV | 0.980 | 206 | 0.004 |
| AGE | 0.978 | 206 | 0.003 |
| *Panel C: The MVAIC model* | | | |
| ROA | 0.503 | 206 | 0.000 |
| ROE | 0.303 | 206 | 0.000 |
| MVAIC | 0.261 | 206 | 0.000 |
| CEE | 0.251 | 206 | 0.000 |
| HCE | 0.253 | 206 | 0.000 |
| SCE | 0.433 | 206 | 0.000 |
| INCE | 0.429 | 206 | 0.000 |
| RCE | 0.333 | 206 | 0.000 |
| PC | 0.932 | 206 | 0.000 |
| SIZE | 0.977 | 206 | 0.002 |
| LEV | 0.980 | 206 | 0.004 |
| AGE | 0.978 | 206 | 0.003 |

### 4.2. Correlation Analysis

Tables 5–7 present the results of Pearson's correlation analysis in the three models. In the original VAIC model, ROA and ROE are positively correlated with VAIC, CEE, and HCE. Table 6 shows that ROA and ROE have a significant positive correlation with AVAIC, CEE, HCE, and INCE. With regard to the MVAIC model, the findings show a positive correlation with MVAIC, CEE, and HCE with the exception of SCE, INCE, and RCE. All values of variance inflation factor (VIF) are calculated to be less than 10, demonstrating the non-existence of multi-collinearity.

**Table 5.** Correlation analysis of the VAIC model.

| Variable | ROA | ROE | VAIC | CEE | HCE | SCE | PC | SIZE | DR | AGE |
|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 1 | | | | | | | | | |
| ROE | 0.936 *** | 1 | | | | | | | | |
| VAIC | 0.885 *** | 0.922 *** | 1 | | | | | | | |
| CEE | 0.847 *** | 0.884 *** | 0.911 *** | 1 | | | | | | |
| HCE | 0.902 *** | 0.949 *** | 0.972 *** | 0.934 *** | 1 | | | | | |
| SCE | 0.012 | −0.021 | 0.210 *** | −0.066 | −0.021 | 1 | | | | |
| PC | 0.040 | 0.029 | 0.009 | 0.068 | −0.005 | 0.023 | 1 | | | |
| SIZE | 0.205 *** | 0.142 ** | 0.131 * | 0.120 * | 0.127* | 0.029 | 0.114 | 1 | | |
| DR | −0.377 *** | −0.355 *** | −0.223 *** | −0.129 * | −0.250 *** | 0.039 | 0.228 *** | 0.041 | 1 | |
| AGE | 0.109 | 0.043 | 0.067 | 0.112 | 0.063 | −0.003 | 0.124 * | 0.166 ** | −0.029 | 1 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

**Table 6.** Correlation analysis of the AVAIC model.

| Variable | ROA | ROE | AVAIC | CEE | HCE | INCE | PC | SIZE | DR | AGE |
|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 1 | | | | | | | | | |
| ROE | 0.936 *** | 1 | | | | | | | | |
| AVAIC | 0.686 *** | 0.725 *** | 1 | | | | | | | |
| CEE | 0.847 *** | 0.884 *** | 0.721 *** | 1 | | | | | | |
| HCE | 0.902 *** | 0.949 *** | 0.714 *** | 0.934 *** | 1 | | | | | |
| INCE | 0.670 *** | 0.708 *** | 0.999 *** | 0.703 *** | 0.694 *** | 1 | | | | |
| PC | 0.040 | 0.029 | 0.061 | 0.068 | −0.005 | 0.063 | 1 | | | |
| SIZE | 0.205 *** | 0.142 ** | 0.092 | 0.120 * | 0.127 * | 0.090 | 0.114 | 1 | | |
| DR | −0.377 *** | −0.355 *** | −0.249 *** | −0.129 * | −0.250 *** | −0.247 *** | 0.228 *** | 0.041 | 1 | |
| AGE | 0.109 | 0.043 | 0.172 ** | 0.112 | 0.063 | 0.174 ** | 0.124 | 0.166 ** | −0.029 | 1 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

**Table 7.** Correlation analysis of the MVAIC model.

| Variable | ROA | ROE | MVAIC | CEE | HCE | SCE | INCE | RCE | PC | SIZE | DR | AGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 1 | | | | | | | | | | | |
| ROE | 0.936 *** | 1 | | | | | | | | | | |
| MVAIC | 0.893 *** | 0.939 *** | 1 | | | | | | | | | |
| CEE | 0.847 *** | 0.884 *** | 0.931 *** | 1 | | | | | | | | |
| HCE | 0.902 *** | 0.949 *** | 0.992 *** | 0.934 *** | 1 | | | | | | | |
| SCE | 0.012 | −0.021 | 0.029 | −0.066 | −0.021 | 1 | | | | | | |
| INCE | −0.005 | 0.016 | 0.084 | 0.007 | 0.029 | −0.366 *** | 1 | | | | | |
| RCE | −0.039 | 0.004 | 0.009 | 0.020 | 0.007 | −0.881 *** | 0.450 *** | 1 | | | | |
| PC | 0.040 | 0.029 | −0.026 | 0.068 | −0.005 | 0.023 | −0.180 *** | −0.130 * | 1 | | | |
| SIZE | 0.205 *** | 0.142 ** | 0.097 | 0.120 * | 0.127 * | 0.029 | −0.114 | −0.158 ** | 0.114 | 1 | | |
| DR | −0.377 *** | −0.355 *** | −0.254 *** | −0.129 * | −0.250 *** | 0.039 | −0.121 * | −0.103 | 0.228 *** | 0.041 | 1 | |
| AGE | 0.109 | 0.043 | 0.060 | 0.112 | 0.063 | −0.003 | −0.074 | −0.017 | 0.124 * | 0.166 ** | −0.029 | 1 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

### *4.3. Regression Results*

The results of the impact of the integrated IC on financial performance are shown in Table 8. Hausman test is applied to determine whether the fixed effects (FE) model or random effects (RE) model is used in this study. In the AVAIC model, the adjusted $R^2$ shows a slight decrease from 0.8493 in Model (1) and 0.8831 in Model (2) to 0.7793 in Model (5) and 0.8084 in Model (6). However, it is observed that the adjusted $R^2$ of Models (9) and (10) is the highest. Thus, it can be inferred that the MVAIC model, which introduces RC and INC, enhances model explainability. Table 8 shows that the integrated IC has a positive impact on ROA and ROE in the three models. Similarly, Kozera [14] found that the efficiency of the generation of added value from IC is strongly related to financial performance in Polish agricultural firms.

**Table 8.** Regression results of Models (1), (2), (5), (6), (9), and (10).

| Variable | Model (1) | Model (2) | VIF | Model (5) | Model (6) | VIF | Model (9) | Model (10) | VIF |
|---|---|---|---|---|---|---|---|---|---|
| | RE | RE | | FE | FE | | FE | RE | |
| Constant | −0.359 *** (−2.63) | −0.275 (−0.65) | | −1.359 *** (−2.85) | −3.556 ** (−2.46) | | −0.639 * (−1.70) | −0.702 ** (−2.44) | |
| VAIC | 0.022 *** (28.10) | 0.074 *** (34.31) | 1.08 | | | | | | |
| AVAIC | | | | 0.001 *** (19.65) | 0.003 *** (22.44) | 1.12 | | | |
| MVAIC | | | | | | | 0.022 *** (26.75) | 0.077 *** (39.55) | 1.08 |
| PC | 0.064 * (1.70) | 0.230 * (1.95) | 1.08 | −0.157 (−1.41) | 0.106 (0.31) | 1.09 | −0.140 (−1.58) | 0.296 *** (3.68) | 1.08 |
| SIZE | 0.018 *** (2.88) | 0.017 (0.85) | 1.06 | 0.068 *** (3.00) | 0.178 ** (2.60) | 1.04 | 0.030 * (1.69) | 0.030 ** (2.29) | 1.05 |
| DR | −0.194 *** (−6.47) | −0.509 *** (−5.68) | 1.12 | −0.441 *** (−7.96) | −1.163 *** (−6.93) | 1.14 | −0.272 *** (−6.01) | −0.416 *** (−6.25) | 1.13 |
| AGE | −0.001 (−0.57) | −0.007 (−1.49) | 1.05 | 0.004 (1.04) | −0.005 (−0.45) | 1.07 | 0.006 * (1.94) | −0.006 ** (−1.99) | 1.05 |
| YEAR | Included | Included | | Included | Included | | Included | Included | |
| *n* | 206 | 206 | | 206 | 206 | | 206 | 206 | |
| Adj. $R^2$ | 0.8493 | 0.8831 | | 0.7793 | 0.8084 | | 0.8622 | 0.9096 | |
| F (Wald) | 1076.09 *** | 1483.80 *** | | 56.85 *** | 67.92 *** | | 100.77 *** | 1953.62 *** | |
| Hausman test | Prob > chi2 = 0.1066 | Prob > chi2 = 0.8419 | | Prob > chi2 = 0.0000 | Prob > chi2 = 0.0000 | | Prob > chi2 = 0.0482 | Prob > chi2 = 0.9635 | |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *t*-values are in parentheses.

In terms of control variables, firm size (SIZE) has a positive impact on ROA and ROE. Debt ratio (LEV) has a significant negative influence on financial performance of agricultural listed companies. There is no significant relationship between AGE and financial performance.

As seen in Table 9, the adjusted $R^2$ of Models (3)–(12) shows improvement compared to that of models (1)–(6). This implies that IC components are good explanatory factors of variations in the dependent variables. Measuring the relationship between IC components and financial performance, it is found that the adjusted $R^2$ of the AVAIC model is the highest. This might indicate that investors place different values on individual components of value-added efficiencies.

**Table 9.** Regression results of Models (3), (4), (7), (8), (11), and (12).

| Variable | Model (3) FE | Model (4) RE | VIF | Model (7) FE | Model (8) RE | VIF | Model (11) FE | Model (12) RE | VIF |
|---|---|---|---|---|---|---|---|---|---|
| Constant | −0.752 ** (−2.13) | −0.313 (−1.08) | | −0.883 ** (−2.56) | −0.379 (−1.26) | | −0.728 ** (−2.07) | −0.283 (−0.91) | |
| CEE | 0.059 *** (2.76) | 0.064 (1.37) | 9.14 | 0.043 ** (2.05) | 0.041 (0.87) | 9.41 | 0.054 ** (2.53) | 0.061 (1.28) | 9.26 |
| HCE | 0.018 *** (6.52) | 0.079 *** (13.05) | 9.47 | 0.016 *** (5.69) | 0.077 *** (12.75) | 9.40 | 0.018 *** (6.69) | 0.080 *** (12.95) | 9.57 |
| SCE | 0.001 (0.35) | 0.003 (0.47) | 1.03 | | | | −0.009 (−1.43) | −0.0003 (−0.02) | 5.06 |
| INCE | | | | 0.0002 *** (3.14) | 0.0003 ** (2.54) | 2.15 | −0.005 (−0.40) | −0.029 (−0.94) | 1.29 |
| RCE | | | | | | | −0.017 * (−1.72) | −0.002 (−0.07) | 5.50 |
| PC | −0.188 ** (−2.27) | 0.217 *** (2.65) | 1.10 | −0.195 ** (−2.45) | 0.198 ** (2.34) | 1.11 | −0.190 ** (−2.30) | 0.207 ** (2.43) | 1.15 |
| SIZE | 0.038 ** (2.28) | 0.018 (1.32) | 1.06 | 0.044 *** (2.69) | 0.021 (1.50) | 1.06 | 0.038 ** (2.24) | 0.017 (1.21) | 1.14 |
| DR | −0.293 *** (−6.88) | −0.438 *** (−6.42) | 1.23 | −0.306 *** (−7.39) | −0.420 *** (−6.02) | 1.27 | −0.297 *** (−7.00) | −0.443 *** (−6.40) | 1.24 |
| AGE | 0.004 (1.46) | −0.006 ** (−2.02) | 1.07 | 0.004 (1.55) | −0.007 ** (−2.16) | 1.09 | 0.005 (1.60) | −0.006 ** (−2.01) | 1.07 |
| YEAR | Included | Included | | Included | Included | | Included | Included | |
| *n* | 206 | 206 | | 206 | 206 | | 206 | 206 | |
| Adj. $R^2$ | 0.8845 | 0.9234 | | 0.8911 | 0.9254 | | 0.8871 | 0.9236 | |
| F (Wald) | 101.45 *** | 2332.53 *** | | 108.47 *** | 2421.49 *** | | 88.14 *** | 2323.62 *** | |
| Hausman test | Prob > chi2 = 0.0099 | Prob > chi2 = 0.8724 | | Prob > chi2 = 0.0034 | Prob > chi2 = 0.0621 | | Prob > chi2 = 0.0149 | Prob > chi2 = 0.8506 | |

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *t*-values are in parentheses.

In the VAIC model, HCE has a significant positive impact on financial performance. SCE does not relate to ROA and ROE, which suggests that agricultural listed companies do not optimally manage SC to generate profit. CEE positively influences only ROA. The results are in line with Xu and Wang [17].

Similarly, both the AVAIC model and the MVAIC model reveal that HCE affects financial performance proxied by ROA and ROE, and CEE has a positive impact on only the ROA indicator. The AVAIC model shows that INC positively affects financial performance, while the MVAIC model fails to prove the effect of INC on ROA and ROE. The coefficient of RCE in Model (11) is negative and statistically significant at the 1% level. As mentioned by Xu and Wang [8] and Tiwari [67], the MVAIC model with an introduction of only RC is more informative than the original VAIC model.

### *4.4. Robustness Check*

All variables are winsorized at the 1% level, and we re-estimate Models (1)–(12). Robustness check results are presented in Tables 10 and 11. The results are similar to our previous findings, which suggests that our conclusion is robust.

**Table 10.** Robustness check results of Models (1), (2), (5), (6), (9), and (10).

| Variable | Model (1) | Model (2) | Model (5) | Model (6) | Model (9) | Model (10) |
|---|---|---|---|---|---|---|
| | RE | RE | RE | FE | RE | RE |
| Constant | −0.430 *** (−3.42) | −0.543 ** (−2.42) | −0.476 ** (−2.36) | −0.570 (−0.58) | −0.051 (−0.16) | −0.770 *** (−3.64) |
| VAIC | 0.021 *** (10.77) | 0.055 *** (13.76) | | | | |
| AVAIC | | | 0.0004 *** (5.51) | 0.001 *** (5.95) | | |
| MVAIC | | | | | 0.030 *** (11.20) | 0.065 *** (13.68) |
| PC | 0.056 * (1.68) | 0.145 ** (2.47) | 0.006 (0.12) | −0.116 (−0.52) | 0.058 (0.75) | 0.221 *** (3.92) |
| SIZE | 0.021 *** (3.46) | 0.025 ** (2.39) | 0.027 *** (2.84) | 0.041 (0.88) | −0.003 (−0.16) | 0.029 *** (2.96) |
| DR | −0.147 *** (−5.26) | −0.291 *** (−5.62) | −0.247 *** (−6.46) | −0.786 *** (−6.68) | −0.125 *** (−2.99) | −0.233 *** (−4.73) |
| AGE | 0.001(0.78) | −0.0004(−0.22) | −0.0001(−0.08) | −0.001(−0.11) | 0.004*(1.79) | 0.001(0.27) |
| YEAR | Included | Included | Included | Included | Included | Included |
| *n* | 181 | 182 | 181 | 181 | 181 | 182 |
| Adj. $R^2$ | 0.5809 | 0.6481 | 0.3454 | 0.3832 | 0.5903 | 0.6458 |
| F (Wald) | 227.78 *** | 316.77 *** | 97.33 *** | 9.53 *** | 21.93 *** | 313.63 *** |
| Hausman test | Prob > chi2 = 0.0965 | Prob > chi2 = 0.2984 | Prob > chi2 = 0.0793 | Prob > chi2 = 0.0019 | Prob > chi2 = 0.1637 | Prob > chi2 = 0.1294 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *t*-values are in parentheses.

**Table 11.** Robustness check results of Models (3), (4), (7), (8), (11), and (12).

| Variable | Model (3) | Model (4) | Model (7) | Model (8) | Model (11) | Model (12) |
|---|---|---|---|---|---|---|
| | RE | FE | RE | FE | RE | FE |
| Constant | −0.219 ** (−2.36) | −0.559 * (−1.74) | −0.215 ** (−2.25) | −0.753 ** (−2.59) | −0.226 ** (−2.31) | −0.590 * (−1.76) |
| CEE | 0.263 *** (12.56) | 0.700 *** (18.80) | 0.245 *** (11.36) | 0.774 *** (21.66) | 0.266 *** (12.38) | 0.689 *** (16.95) |
| HCE | 0.021 *** (8.36) | 0.017 *** (3.40) | 0.022 *** (8.56) | 0.015 *** (3.43) | 0.020 *** (7.57) | 0.017 *** (3.11) |
| SCE | 0.008 (2.68) | 0.007 (1.24) | | | 0.012 (1.81) | 0.003 (0.19) |
| INCE | | | 0.00005 * (1.43) | 0.0001 * (1.77) | 0.005 (0.20) | −0.0005 (−0.01) |
| RCE | | | | | −0.0004 * (−0.02) | −0.001 (−0.04) |
| PC | 0.009 (0.36) | −0.048 (−0.62) | 0.008 (0.32) | −0.114 * (−1.67) | 0.013 (0.51) | −0.037 (−0.47) |
| SIZE | 0.010 ** (2.20) | 0.029 * (1.88) | 0.009 ** (2.08) | 0.039 *** (2.82) | 0.010 ** (2.19) | 0.030 * (1.87) |
| DR | −0.154 *** (−8.40) | −0.408 *** (−9.84) | −0.151 *** (−8.09) | −0.439 *** (−11.83) | −0.158 *** (−8.48) | −0.410 *** (−9.30) |
| AGE | 0.001 (0.80) | −0.0004 (−0.17) | 0.0007 (0.82) | −0.002 (−0.74) | 0.001 (0.87) | −0.00004 (−0.02) |
| YEAR | Included | Included | Included | Included | Included | Included |
| *n* | 176 | 177 | 178 | 178 | 171 | 172 |
| Adj. $R^2$ | 0.8597 | 0.9292 | 0.8535 | 0.9379 | 0.8619 | 0.9296 |
| F (Wald) | 1106.26 *** | 156.20 *** | 1083.01 *** | 182.48 *** | 1119.48 *** | 125.90 *** |
| Hausman test | Prob > chi2 = 0.1752 | Prob > chi2 = 0.0468 | Prob > chi2 = 0.1414 | Prob > chi2 = 0.0019 | Prob > chi2 = 0.1521 | Prob > chi2 = 0.0283 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *t*-values are in parentheses.

## 5. Discussion

According to the notion "you can manage what you can measure", firms first need to accurately recognize, measure, and report IC in order to achieve the efficient use of it. Table 12 summarizes the results of three models.

**Table 12.** Summary of three models.

| Model | IC Component | Financial Performance | |
|---|---|---|---|
| | | ROA | ROE |
| Original VAIC | HCE | Positive | Positive |
| | SCE | Insignificant | Insignificant |
| | CEE | Positive | Insignificant |
| AVAIC | HCE | Positive | Positive |
| | INCE | Positive | Positive |
| | CEE | Positive | Insignificant |
| MVAIC | HCE | Positive | Positive |
| | SCE | Insignificant | Insignificant |
| | INCE | Insignificant | Insignificant |
| | RCE | Negative | Insignificant |
| | CEE | Positive | Insignificant |

In the three IC measurement models, HCE has a positive and significant effect on ROA and ROE. This provides evidence that HC is a significant determinant in generating firm value, consistent with HC theory. In the knowledge economy, HC is expected to create efficient processes and new products or services [33]. However, Lee and Mohammed [4] found that HC has a negative but insignificant impact on agricultural firms' ROA in Malaysia.

In the original VAIC and MVAIC models, SC is not observed to be optimally managed in the agricultural listed companies. If a firm has poor systems and procedures to track employees' action, SC will not reach its fullest potential. Due to the low level of agricultural modernization, the utilization of SC is still considered as a burden by Chinese agricultural listed companies. This result is also in line with some studies of previous researchers [11,17,18,21]. Bontis et al. [31] argued that SC such as organizational structure, hardware, software, and all capabilities is a guarantee for employees to improve productivity. Conversely, in order to enhance profitability, Malaysian agricultural firms may exhibit a tendency to employ physical and structural capitals [4]. Fei [19] found a positive correlation between human and structural capital and the development capability of agricultural listed companies in China.

The original VAIC model fails to address innovation and relational capitals. The AVAIC model shows that the existence of INCE can increase profit. However, the results of the MVAIC model reveal that INC does not relate to financial performance. The inconsistent results deserve for further research. It should be pointed out that the AVAIC model is not applicable to firms without R&D activities. Agricultural sector is an industry with relatively low levels of R&D investment [1,68]. Most Chinese agricultural companies are experiencing slow growth due to inefficient resource management and technological discontinuities [68]. At present, compared with advanced international companies, the independent innovation ability of Chinese agricultural companies still lags far behind [18]. If a firm ignores INC that is valuable, rare, and inimitable, it will not bring more profit [38]. Lu et al. [35] suggested that investment in INC allows firms to enhance their performance. However, Scafarto et al. [15] claimed that R&D investment adversely affect corporate performance in a sample of global agribusiness companies. A study by Xu and Liu [32] showed that INC in the form of R&D has a significant and negative impact on ROA in the Korean manufacturing sector. Bayraktaroglu et al. [45] also found a non-significant relationship between INC and financial performance measured through ROA.

In the MVAIC model, there is a negative relationship between RCE and ROA. The impact of RCE on ROE is negative but insignificant. In other words, these companies use their RC in an inefficient way. Employing the MVAIC model, Zhang et al. [22] found that RC has no impact on financial performance and sustainable growth of Chinese agricultural listed companies. However, a study by Scafarto et al. [15] showed that RC has a direct and positive effect on the performance of international agribusinesses. Xu and Wang [69] pointed out that Chinese agricultural companies have begun to increase the investment in INC and RC.

The three models demonstrate the impact of CEE on ROA. The results show that agricultural listed companies have a relatively better utilization of capital employed in financial performance improvement. This study is consistent with the findings of Lee and Mohammed [4], Xu and Wang [17], and Zhang et al. [22]. In addition, CEE has no effect on the ROE indicator. It is undeniable that agricultural companies cannot be limited to physical assets such as land, but should utilize advanced technology and adopt lean production, thus enhancing the firms' performance.

In summary, physical capital and HC are resources that agricultural companies have to possess for their operation and development. The results between the three models justify the need for further studies in IC measurement. The ultimate determinant of the excellence of the IC measurement method is the possibility of its common use and acceptance in practice. The MVAIC model seems to provide a better result with a comprehensive measurement of IC efficiency.

## 6. Conclusions

The purpose of the present study is to determine the impact of IC and its components on financial performance in China's agricultural sector. The VAIC model, the AVAIC model, and the MVAIC model are used to measure the IC performance of Chinese agricultural listed companies. The present analysis is conducted on data of a sample of 35 agricultural companies listed on the Shanghai and Shenzhen stock exchanges from 2013 to 2019. The empirical results, which are based on multiple regression analysis, clearly suggest that agricultural companies' IC is vital for their performance improvement. When IC is classified into major components, HC is the most important as compared to structural, relational, and innovation capitals. In addition, we find that the MVAIC model with the inclusion of INC and RC can be viewed as a more comprehensive measure of IC efficiency.

The theoretical contributions of this paper include the following aspects. Firstly, this study might help to have a deeper understanding of IC measurement by comparing the use of the conventional VAIC model, the AVAIC model, and the MVAIC model in China's agricultural sector as the research setting. Secondly, it could be used as a guide in improving managers' competencies regarding the important role of IC within firms.

In such an era when innovation is paid great attention, IC plays an increasingly important role in the development of enterprises. This paper's findings suggest several implications for practice. First, agricultural companies should put IC in a strategic position, establish the concept of IC, and strengthen its management. Second, they should increase the investment in IC and take full advantage of the unique resources in the process of value generation. Third, managers should give full play to the subjective initiative and creativity of HC by introducing innovative talents, implementing employee training according to the business needs, constructing differentiated incentive systems, and creating a good environment for employees. Fourth, according to the changes in the internal and external environment, management should adjust their SC, improve the organizational system, and establish good corporate culture and a standardized operation process. Fifth, such companies should control sales expenses, design optimal R&D strategies, build strong R&D capabilities, and master the core technology of the industry. Finally, listed agricultural companies should control the blind expansion of enterprise scale in order to avoid the diseconomy of scale and reduce financial risks.

This paper has the following limitations that should be addressed. The sample size is relatively small, being based only on agricultural listed companies in China, which may restrict the conclusions of the results. Future studies should be encouraged to include other industries. In addition, future researchers could conduct similar studies in other emerging markets.

**Author Contributions:** Conceptualization, J.X.; methodology, J.X.; software, J.X.; validation, J.X. and Y.Z.; formal analysis, J.X.; data curation, J.X.; writing—original draft preparation, J.X. and Y.Z.; writing—review and editing, J.X. and Y.Z.; supervision, J.X.; project administration, J.X.; funding acquisition, J.X. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Scientific Research Foundation for High-level Talents of Qingdao Agricultural University (grant number 6631120701) and the Soft Science Research of Ministry of Agriculture and Rural Affairs (grant number 2018019).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** No new data were created or analyzed in this study. Data sharing is not applicable to this article.

**Acknowledgments:** We would like to thank the editors and the anonymous reviewers for their valuable comments and suggestions on earlier drafts.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Komnenic, B.; Tomic, D.; Tomic, G. Measuring Efficiency of Intellectual Capital in Agriculture Sector of Vojvodina. Available online: https://www.researchgate.net/publication/46535793_Measuring_efficiency_of_intellectual_capital_in_agriculture_sector_of_Vojvodina (accessed on 19 July 2021).
2. Barney, J. Firm Resources and Sustained Competitive Advantage. *J. Manag.* **1991**, *17*, 99–120. [CrossRef]
3. Kristandl, G.; Bontis, N. Constructing a definition for intangibles using the resource based view of the firm. *Manag. Decis.* **2007**, *45*, 1510–1524. [CrossRef]
4. Lee, S.P.; Mohammed, S. Intellectual capital on listed agricultural firms' performance in Malaysia. *Int. J. Learn. Intellect. Cap.* **2014**, *11*, 202–221. [CrossRef]
5. Xu, J.; Wang, B. Intellectual Capital, Financial Performance and Companies' Sustainable Growth: Evidence from the Korean Manufacturing Industry. *Sustainability* **2018**, *10*, 4651. [CrossRef]
6. Xu, J.; Haris, M.; Yao, H. Should Listed Banks Be Concerned with Intellectual Capital in Emerging Asian Markets? A Comparison between China and Pakistan. *Sustainability* **2019**, *11*, 6582. [CrossRef]
7. Xu, J.; Li, J.S. The impact of intellectual capital on SMEs' performance in China: Empirical evidence from non-high-tech vs. high-tech SMEs. *J. Intellect. Cap.* **2019**, *20*, 488–509. [CrossRef]
8. Xu, J.; Wang, B. Intellectual Capital Performance of the Textile Industry in Emerging Markets: A Comparison with China and South Korea. *Sustainability* **2019**, *11*, 2354. [CrossRef]
9. Xu, J.; Li, J. The interrelationship between intellectual capital and firm performance: Evidence from China's manufacturing sector. *J. Intellect. Cap.* **2020**. [CrossRef]
10. Xu, X.L.; Chen, H.H.; Zhang, R.R. The Impact of Intellectual Capital Efficiency on Corporate Sustainable Growth-Evidence from Smart Agriculture in China. *Agriculture* **2020**, *10*, 199. [CrossRef]
11. Ovechkin, D.; Romashkina, G.; Davydenko, V. The Impact of Intellectual Capital on the Profitability of Russian Agricultural Firms. *Agronomy* **2021**, *11*, 286. [CrossRef]
12. Xu, J.; Liu, F. Nexus between Intellectual Capital and Financial Performance: An investigation of Chinese Manufacturing Industry. *J. Bus. Econ. Manag.* **2021**, *22*, 217–235. [CrossRef]
13. Osinski, M.; Selig, P.M.; Matos, F.; Roman, D.J. Methods of evaluation of intangible assets and intellectual capital. *J. Intellect. Cap.* **2017**, *18*, 470–485. [CrossRef]
14. Kozera, M. Intellectual capital in agriculture–Measurement and determinants. *Oeconomia* **2011**, *10*, 83–95.
15. Scafarto, V.; Ricci, F.; Scafarto, F. Intellectual capital and firm performance in the global agribusiness industry: The moderating role of human capital. *J. Intellect. Cap.* **2016**, *17*, 530–552. [CrossRef]

16. Kozera, M. The Impact of Intellectual Capital Efficiency on the Profitability of Agricultural Enterprises. In *The Essence and Measurement of Organizational Efficiency*; Dudycz, T., Osbert-Pociecha, G., Brycz, B., Eds.; Springer Proceedings in Business and Economics; Springer: Cham, Switzerland, 2016. [CrossRef]
17. Xu, J.; Wang, B.H. Intellectual capital and financial performance of Chinese agricultural listed companies. *Custos Agronegocio Line* **2019**, *15*, 273–290.
18. Yang, X.-W.; Yang, X.-D.; Yang, Z.-Y. Impact of intellectual capital of China's agricultural listed companies on enterprise growth. *Taiwan Agric. Res.* **2015**, *32*, 71–76. (In Chinese)
19. Fei, R.M. Research on the Influence of Intellectual Capital on Development Ability in A-share Agricultural Listed Companies. Master's Thesis, Hunan University of Science and Technology, Xiangtan, China, 2018.
20. Kozera-Kowalska, M. Intellectual Capital: ISVA, the Alternative Way of Calculating Creating Value in Agricultural Entities—Case of Poland. *Sustainability* **2020**, *12*, 2645. [CrossRef]
21. Ivanovic, T.; Maksimovic, G.; Mandaric, M.; Radivojevic, N.; Jovic, M. The impact of intellectual capital on the financial performance of agricultural enterprises: Evidence from the West Balkans Counties. *Custos Agronegocio Line* **2021**, *17*, 350–376.
22. Zhang, L.; Jin, Z.-J.; Xu, J. The impact of intellectual capital on financial performance and sustainable development of agricultural listed companies. *J. Qingdao Agric. Univ.* **2021**, *33*, 40–45. (In Chinese)
23. Stewart, T.A. Brainpower: How intellectual capital is becoming America's most valuable asset. *Fortune* **1991**, *6*, 44–60.
24. Marzo, G. The market-to-book value gap and the accounting fallacy. *J. Intellect. Cap.* **2013**, *14*, 564–581. [CrossRef]
25. Bassi, L.J. Harnessing the power of intellectual capital. *Train. Dev.* **1997**, *51*, 25–30.
26. Xu, J.; Shang, Y.; Yu, W.; Liu, F. Intellectual Capital, Technological Innovation and Firm Performance: Evidence from China's Manufacturing Sector. *Sustainability* **2019**, *11*, 5328. [CrossRef]
27. Vidyarthi, H. Dynamics of intellectual capitals and bank efficiency in India. *Serv. Ind. J.* **2019**, *39*, 1–24. [CrossRef]
28. Ahangar, R.G. The relationship between intellectual capital and financial performance: An empirical investigation in an Iranian company. *Afr. J. Bus. Manag.* **2011**, *5*, 88–95.
29. Royal, C.; O'Donnell, L. Differentiation in financial markets: The human capital approach. *J. Intellect. Cap.* **2008**, *9*, 668–683. [CrossRef]
30. Bontis, N. Intellectual capital: An exploratory study that develops measures and models. *Manag. Decis.* **1998**, *36*, 63–76. [CrossRef]
31. Bontis, N.; Keow, W.C.C.; Richardson, S. Intellectual capital and business performance in Malaysia industries. *J. Intellect. Cap.* **2000**, *1*, 85–100. [CrossRef]
32. Xu, J.; Liu, F. The Impact of Intellectual Capital on Firm Performance: A Modified and Extended VAIC Model. *J. Competitiveness* **2020**, *12*, 161–176. [CrossRef]
33. Ge, F.; Xu, J. Does intellectual capital investment enhance firm performance? Evidence from pharmaceutical sector in China. *Technol. Anal. Strateg. Manag.* **2021**, *33*, 1006–1021. [CrossRef]
34. Liu, S.; Yu, Q.; Zhang, L.; Xu, J.; Jin, Z. Does Intellectual Capital Investment Improve Financial Competitiveness and Green Innovation Performance? Evidence from Renewable Energy Companies in China. *Math. Probl. Eng.* **2021**, *2021*, 1–13. [CrossRef]
35. Lu, Y.; Tian, Z.; Buitrago, G.A.; Gao, S.; Zhao, Y.; Zhang, S. Intellectual Capital and Firm Performance in the Context of Venture-Capital Syndication Background in China. *Complexity* **2021**, *2021*, 1–17. [CrossRef]
36. Xu, J.; Zhang, Y. Exploring the Nonlinear Effect of Intellectual Capital on Financial Performance: Evidence from Listed Shipping Companies in China. *Complexity* **2021**, *2021*, 9004907. [CrossRef]
37. Zhang, L.; Yu, Q.; Jin, Z.; Xu, J. Do Intellectual Capital Elements Spur Firm Performance? Evidence from the Textile and Apparel Industry in China. *Math. Probl. Eng.* **2021**, *2021*, 7332885. [CrossRef]
38. Soewarno, N.; Tjahjadi, B. Measures that matter: An empirical investigation of intellectual capital and financial performance of banking firms in Indonesia. *J. Intellect. Cap.* **2020**, *21*, 1085–1106. [CrossRef]
39. Pulic, A. VAICTM—An accounting tool for IC management. *Int. J. Technol. Manag.* **2000**, *20*, 702–714. [CrossRef]
40. I Maditinos, D.; Chatzoudes, D.; Tsairidis, C.; Theriou, G. The impact of intellectual capital on firms' market value and financial performance. *J. Intellect. Cap.* **2011**, *12*, 132–151. [CrossRef]
41. Pulic, A. Do we know if we create or destroy value? *Int. J. Entrep. Innov. Manag.* **2004**, *4*, 349–359. [CrossRef]
42. Chen, M.-C.; Cheng, S.; Hwang, Y. An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance. *J. Intellect. Cap.* **2005**, *6*, 159–176. [CrossRef]
43. Nadeem, M.; Dumay, J.; Massaro, M. If You Can Measure It, You Can Manage It: A Case of Intellectual Capital. *Aust. Account. Rev.* **2019**, *29*, 395–407. [CrossRef]
44. Tripathy, T.; Gil Alana, L.A.; Sahoo, D. The effect of intellectual capital on firms' financial performance: An empirical investigation in India. *Int. J. Learn. Intellect. Cap.* **2015**, *12*, 342–371. [CrossRef]
45. Bayraktaroglu, A.E.; Calisir, F.; Baskak, M. Intellectual capital and firm performance: An extended VAIC model. *J. Intellect. Cap.* **2019**, *20*, 406–425. [CrossRef]
46. Gan, K.; Saleh, Z. Intellectual capital and corporate performance of technology-intensive companies: Malaysia evidence. *Asian J. Bus. Account.* **2008**, *1*, 113–129.
47. Phusavat, K.; Comepa, N.; Sitko-Lutek, A.; Ooi, K.-B. Interrelationships between intellectual capital and performance: Empirical examination. *Ind. Manag. Data Syst.* **2011**, *111*, 810–829. [CrossRef]

48. Mondal, A.; Ghosh, S.K. Intellectual capital and financial performance of Indian banks. *J. Intellect. Cap.* **2012**, *13*, 515–530. [CrossRef]
49. Joshi, M.; Cahill, D.; Sidhu, J.; Kansal, M. Intellectual capital and financial performance: An evaluation of the Australian financial sector. *J. Intellect. Cap.* **2013**, *14*, 264–285. [CrossRef]
50. Nimtrakoon, S. The relationship between intellectual capital, firms' market value and financial performance: Evidence evidence from the ASEAN. *J. Intellect. Cap.* **2015**, *16*, 587–618. [CrossRef]
51. Dzenopoljac, V.; Janošević, S.; Bontis, N. Intellectual capital and financial performance in the Serbian ICT industry. *J. Intellect. Cap.* **2016**, *17*, 373–396. [CrossRef]
52. Ozkan, N.; Cakan, S.; Kayacan, M. Intellectual capital and financial performance: A study of the Turkish Banking Sector. *Borsa Istanb. Rev.* **2017**, *17*, 190–198. [CrossRef]
53. Smriti, N.; Das, N. Impact of Intellectual Capital on Business Performance: Evidence from Indian Pharmaceutical Sector. *Pol. J. Manag. Stud.* **2017**, *15*, 232–243. [CrossRef]
54. Chowdhury, L.A.M.; Rana, T.; Akter, M.; Hoque, M. Impact of intellectual capital on financial performance: Evidence from the Bangladeshi textile sector. *J. Account. Organ. Chang.* **2018**, *14*, 429–454. [CrossRef]
55. Smiriti, N.; Das, N. The impact of intellectual capital on firm performance: A study of Indian firms listed in COSPI. *J. Intellect. Cap.* **2018**, *19*, 935–964. [CrossRef]
56. Tran, D.B.; Vo, D.H. Should bankers be concerned with Intellectual capital? A study of the Thai banking sector. *J. Intellect. Cap.* **2018**, *19*, 897–914. [CrossRef]
57. Forte, W.; Matonti, G.; Nicolò, G. The impact of intellectual capital on firms' financial performance and market value: Empirical evidence from Italian listed firms. *Afr. J. Bus. Manag.* **2019**, *13*, 147–159.
58. Kasoga, P.S. Does investing in intellectual capital improve financial performance? Panel evidence from firms listed in Tanzania DSE. *Cogent Econ. Financ.* **2020**, *8*, 1802815. [CrossRef]
59. Petković, M.; Knežević, G.; Pavlović, V. Where did the competitive advantage of French wineries come from? Insight in the effect of intellectual capital structure on financial performances. *Custos Agronegocio Line* **2020**, *16*, 462–480.
60. CSMAR. Available online: https://www.gtarsc.com (accessed on 28 August 2021).
61. Wind. Available online: https://www.wind.com.cn/en/edb.html (accessed on 28 August 2021).
62. Pal, K.; Soriya, S. IC performance of Indian pharmaceutical and textile industry. *J. Intellect. Cap.* **2012**, *13*, 120–137. [CrossRef]
63. Zhang, X.-B.; Duc, T.P.; Mutuc, E.B.; Tsai, F.-S. Intellectual Capital and Financial Performance: Comparison with Financial and Pharmaceutical Industries in Vietnam. *Front. Psychol.* **2021**, *12*, 595615. [CrossRef]
64. Weqar, F.; Khan, A.M.; Raushan, M.A.; Haque, S.M.I. Measuring the Impact of Intellectual Capital on the Financial Performance of the Finance Sector of India. *J. Knowl. Econ.* **2021**, *12*, 1134–1151. [CrossRef]
65. Liu, L.J.; Xu, J.; Shang, Y. Determining factors of financial performance of agricultural listed companies in China. *Custos Agronegocio Line* **2020**, *16*, 297–314.
66. Victoria, M.C.M.; Sánchez-Val, M.M.; Lario, N.A. Comparison of the Financial Behaviour of Agri-Food Cooperatives with Non-Cooperatives from a Static and Dynamic Perspective: An Empirical Application to Spanish Companies. Available online: http://www.aeca1.org/xviiicongresoaeca/cd/123i.pdf (accessed on 28 August 2021).
67. Tiwari, R. Nexus between intellectual capital and profitability with interaction effects: Panel data evidence from the Indian healthcare industry. *J. Intellect. Cap.* **2021**. [CrossRef]
68. Gao, Q.; Zhang, C. Analysis of innovation capability of 125 agricultural high-tech enterprises in China. *Innov.—Manag. Policy Pract.* **2011**, *13*, 278–290. [CrossRef]
69. Xu, J.; Wang, J.J. Research on value creation of intellectual capital of agricultural listed companies—A case study of Shandong Denghai Seeds Co., Ltd. *J. Anhui Agric. Sci.* **2020**, *48*, 250–252. (In Chinese)