



The intellectual capital efficiency and corporate sustainable growth nexus: comparison from agriculture, tourism and renewable energy sector

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Abstract

In the new situation of Chinese economic development, how to achieve sustainable development of enterprises has become an important issue concerned by managers and investors. This paper selects the listed companies of agriculture, tourism and renewable energy industry as research samples, employs the MVAIC (Modified value-added intellectual coefficient) model and runs the panel data to explore the role of capital employed efficiency, intellectual capital efficiency and its components on corporate sustainable growth. The results show that in the full sample, the capital employed efficiency, intellectual capital efficiency and its components have a significant positive effect on corporate sustainable growth. In the industries samples, the impact of the relationship capital efficiency on corporate sustainable growth of agricultural enterprises is not significant, and the impact of structural capital efficiency on corporate sustainable growth of tourism enterprises is not significant. While there is a significant positive impact of intellectual capital efficiency and its components on corporate sustainable growth of renewable energy enterprises. Based on the conclusions, this paper proposes policy suggestions for promoting the sustainable development of enterprises, aiming to provide theoretical guidance and empirical evidence for managers to invest and develop intellectual capital.

Keywords Intellectual capital efficiency · Capital employed efficiency · Corporate sustainable growth · MVAIC (Modified value-added intellectual coefficient) model

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1 Introduction

With the appearance of the knowledge economy era, knowledge has become an important resource which gradually replacing the tangible capital such as machinery, equipment, raw materials to enhance the competitiveness of enterprises and promote its sustainable growth (Pulic, 1998; Xu & Liu, 2019). The popularity of artificial intelligence makes "innovation" become the source of a country's economic vitality (Lei, 2020). For enterprises, only continuous innovation can maintain its vitality. Compared with other developed countries, China's innovation ability and intellectual capital utilization ability are deficient, which requires Chinese enterprises to tap the potential of intellectual capital, to innovate products, services and management systems constantly and to utilize intellectual capital improving their own sustainable growth ability (Xu & Li, 2019).

On the other hand, the sustainable growth of enterprises has attracted more and more attention from academia and industry (Qiao et al., 2016; Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d; Zaid et al., 2018). The ability of sustainable growth determines the dynamic development trend of enterprise, which not only reflects the potential of the enterprise's survival and development but also affects its future financial performance. Some scholars believe that tangible resources are essential to the growth of enterprises, while the intangible resources with the characteristics of scarcity, non-imitation, and irreplaceability determine whether enterprises can obtain a sustainable competitive advantage (Si et al., 2020; Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d). This would link intellectual capital with the corporate sustainable growth of enterprises closely.

The existing literature has demonstrated that intellectual capital has become key competitiveness of enterprises (Sardo & Serrasqueiro, 2018; Xu & Liu, 2020), contributing to its brand value, financial performance and innovation ability. However, these studies focus on short-term corporate performance or static financial profitability indicators. Nowadays, with the rapid technological upgrading, it is insufficient to evaluate an enterprise performance only by the short-term financial indicators, it is necessary to measure the long-term operation and development ability of the enterprise (Scott, 2013). The evaluation of corporate sustainable growth not only reflect the historical performance of enterprises but also predict the profit expansion of enterprises in the future. If enterprises want to own an excellent efficiency of sustainable growth, they must utilize intangible resources (intellectual capital) to maintain competitive advantage, and adjust the investment in intellectual capital with dynamic changes of the internal and external operating environment.

However, the researchers pay more attention to the definition of intellectual capital concept and measurement methods (Arvan et al., 2016; Rooney & Dumay, 2016). These methods tend to be static analysis, while the utilization of dynamic methods is nascent. In addition, there is little research focus on the relationship between intellectual capital and corporate sustainable growth. Moreover, the majority of literature select high-tech industries as samples to study intellectual capital (Purohit & Tandon, 2015; Xu & Li, 2019) and pay little attention to the traditional industries and emerging industries. The reality is that those enterprises attach importance to technological and knowledge innovation will be interested in the management of intellectual capital. Due to different industries have various requirements for resources, the impact of different resources on the industry will be variety (Wei et al., 2019; Xu & Chen, 2020b; Xu et al., 2020a; Xu et al., 2020b; Xu et al., 2020c; Zhu et al., 2020). Therefore, whether intellectual capital invested in enterprises with high technology products has the corresponding output? Are the outputs significantly different from other industries? Is the intellectual capital of all industries conducive

to improving corporate sustainable growth? There is great practical significance to answer these issues.

To contribute to the existing literature, this paper selects three industries with different characteristics as samples, traditional industries such as agriculture companies, emerging industries such as tourism companies, high-tech industries such as renewable energy companies. Second, this paper examines whether there is a significant correlation between intellectual capital and corporate sustainable growth, and demonstrates the impact of the components of intellectual capital on corporate sustainable growth of the three types industries. We provide guidelines for enterprises concentrating their capital investment in the most valuable component of intellectual capital for their sustainable development. Finally, this paper also reveals the relationship between traditional capital such as capital employed and corporate sustainable growth. It will lead to enterprise not only strengthen the management of intellectual capital but also develop capital employed appropriately. The rest of this paper is organized as follows, the second section is literature review and hypotheses, the third section is methodology, the fourth section is results and discussion, conclusions and suggestions are presented in the final section.

2 Literature review and hypothesis

2.1 Intellectual capital

Since the 1990s, academia and industry have begun to discuss intellectual capital. For the composition of intellectual capital, it is the sum of all the things that can create value, such as knowledge, experience, corporate culture, internal and external relations (Pulic, 2000; Sardo & Serrasqueiro, 2018; Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d). For the earnings of intellectual capital, it is the sum of all the expertise that can improve the competitive advantage of the enterprise. For the invisibility of intellectual capital, it is all intangible assets that can increase enterprise value and create profits beyond its book value (Sardo & Serrasqueiro, 2017). For the components of intellectual capital, it includes human capital, structural capital and relational capital (Nimtrakoon, 2015). Yet, the concept of intellectual capital has not been defined consistently in academia up to now. Intellectual capital was used initially in the research at the enterprise level (Ling, 2013), and then gradually extended to regional intellectual capital (Wang et al., 2013), national intellectual capital (Lu et al., 2014), as well as green intellectual capital proposed by the requirements of sustainable development. Based on the connotation of intellectual capital, it combines different research objects and purposes to form specific definitions suitable for various fields.

The existing literature usually divided the concept of intellectual capital into two-components, three-components, four-components and five-components (Asiaei & Jusoh, 2015; Guerrero-Baena et al., 2015; Ulum et al., 2014; Xu et al., 2017). The two-components include human capital and structural capital. The three-components include human capital, structural capital and relational capital. The four-components include human capital, process capital, innovation capital and relational capital. The five-components include human capital, structural capital, innovation capital, process capital and customer capital. Although there are many criteria to divide the components of intellectual capital, there is no significant difference in the understanding of the essence of intellectual capital among

these scholars. The specific measurement methods could be employed according to the research purpose and objects.

Although the importance of intellectual capital has aroused widespread concern in academic and industry (Arvan et al., 2016; Demartini & Trucco, 2016; Secundo et al., 2016), there are still no specific requirements for the disclosure of intellectual capital in enterprises at present. Only a few indicators measured intellectual capital such as copyright, patents, trademarks have been reflected in the accounting statements, which makes evaluating the intellectual capital accurately become a problematic issue. Scholars have proposed a variety of methods to measure intellectual capital (Tsou et al., 2016; Xu et al., 2017), which can be divided into four categories: Direct Intellectual Capital Methods (DIC); Market Capitalization Methods (MCM); Return on Assets Method (ROA); Scoreboard Methods (SC).

2.2 Corporate sustainable growth

Higgins (1981) believes that the assets, liabilities and equity of enterprise in financial statements will increase according to the growth of product sales. Only the proportion of debt increase is balanced with the percentage of equity increase; the enterprise will not fall into the situation of insolvency. Therefore, enterprises should ensure that their capital structure and financial policies remain unchanged to achieve sustainable growth. Some scholars define sustainable corporate growth as the sustained growth of sales and profits under the same economic policy and external environment (Buffa et al., 2018; Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d; Zaid et al., 2018). The ability of enterprises to have sustainable growth is not only the guarantee to achieve their long-term business goals, but also the physical requirement of the sustainable development of the national economy (Kaygusuz, 2019).

Some enterprises regard the growth rate of sales or the rapid expansion of enterprise-scale as their development goals. This blind high-speed growth is short-lived and unsustainable (Wang et al., 2018). The rapid growth exceeding the resource load capacity of the enterprise may cause the financial and credit crisis, while the slow growth will reduce the operating efficiency. The company with a growth rate that deviates from sustainable growth will eventually fall into the dilemma of "unsustainable growth" (Buffa et al., 2018). The corporate sustainable growth includes the ability of the enterprise-scale from small to large and the comprehensive competitiveness from weak to strong. It not only requires the enterprise to have the growth ability but also needs this ability to be sustainable. Stakeholders and investors want the enterprise operating for a long time. This situation required the enterprise should consider not only the increase of short-term profits but also the growth rate and development of enterprises in the long term (Anbarasan & Sushil, 2018).

There are three types of indicators to measure the corporate sustainable growth in the existing literature. The first type is established under the financial accounting criteria, it represented by the static sustainable growth model of Higgins (1981) and the dynamic sustainable growth model of Van Horne (1988). The second type is employed through cash flow, it represented by the sustainable growth model of Rappaport (1978) and sustainable growth model of Colley et al. (2002). The third type is performed by principal component analysis and factor analysis (Xu & Chen, 2020a), this type uses financial indicators (such as corporate profitability, solvency, operating capacity and development capacity) to calculate a comprehensive index of sustainable growth model.

2.3 Intellectual capital and corporate sustainable growth

Lots of researches have studied the impact of intellectual capital and its components on corporate sustainable growth.

From the perspective of resource-based theory, scholars believe that although capital employed is still an essential resource in the process of production and operation, and intellectual capital has gradually become a necessary capital element and driving force for the sustainable growth of enterprises (Nimtrakoon, 2015). From the perspective of dynamic capability, the market competition is extremely fierce in the dynamic environment (Sardo & Serrasqueiro, 2018; Singh & Rao, 2016). Only by continually developing the new skills and technologies that competitors cannot imitate, can enterprises establish their dynamic capability to achieve sustainable profits. This dynamic capability that can facilitate enterprises to achieve sustainable competitiveness is the corporate sustainable growth ability (Xu & Liu, 2019). This ability will be influenced by factors such as talents of entrepreneurs, internal and external resources, organizational capacity, learning ability (Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d). These four factors belong to the intellectual capital of an enterprise and ultimately determine corporate sustainable growth.

Scholars have performed empirical studies in many industries (Ariff et al., 2016; Crema & Verbano, 2016; Delgado-Verde et al., 2016), and they believe that capital employed and intellectual capital have a positive impact on corporate sustainable growth. Some researchers have found that among the components of intellectual capital, human capital has the most significant positive impact on corporate sustainable growth, and has become one of the main driving forces in the sustainable growth of enterprises (Rossi et al., 2016). However, other scholars found that the effects of structural capital and relational capital on corporate sustainable growth are not significant (Bontis et al., 2000).

Whether it is human capital, structural capital or relational capital, it should have the most contribution to corporate sustainable growth. The human capital, such as senior management team, is an essential strategic source of an enterprise. It has a significant positive correlation with the growth ability of the enterprise (Meles et al., 2016). Meanwhile, a variety of internal and external social capital of senior management team members could promote enterprises maintaining a steady increase in sales. Technological innovation is also one of the most important contents of intellectual capital. Enterprises could perform a reasonable R&D investment to achieve maximum input–output efficiency, enhancing the competitiveness of the enterprise and the ability of sustainable development (Xu et al., 2019c; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2019d).

2.4 Proposed hypotheses

The capital employed is the financial basis for sustainable development of enterprise and the guarantee for its survival in the market competition. The value-added efficiency of capital employed affects not only the realization of financial goals such as net profit growth but also the implementation of an enterprise operating strategy. Only when the suitable operating policy is implemented smoothly, can the enterprise achieve its business goal and sustainable growth. Besides, the investment in the components of intellectual capital such as human capital and structural capital is also inseparable from the support of capital employed (Yaseen et al., 2016). Based on the analysis above, this paper proposes the following hypothesis:

H1 There is a significant positive effect of capital employed on corporate sustainable growth.

Intellectual capital is an inevitable factor to improve the survival probability of enterprises in the market and maintain its competitive advantage (Jardon, 2015). The sustainable growth ability includes not only the financial performance with continuous improvement but also the organizational structure with constant enhancement. Intellectual capital, as a strategic resource, is the product of a long-term accumulation of knowledge and various resources (Hsu et al., 2014; Tsui et al., 2014). It plays an indispensable role in the sustainable development of enterprises and creates more excess profits for enterprises. Therefore, this paper proposes the following hypothesis:

H2 There is a significant positive effect of intellectual capital on corporate sustainable growth.

Human capital is the most critical components of intellectual capital (Mehralian et al., 2013). It is the value-added knowledge, experience, technology and processes come from the enterprise employees. The knowledge and skills of talents are indispensable dynamic capital for enterprise innovation. Employees with sufficient knowledge reserves and rich experience can significantly improve the production efficiency of the enterprise. The ability of employees to capture new information could support enterprises to innovate the existing technology continually. The high sensitivity of managers and employees to the market is beneficial for enterprises to seize the market opportunities, gain competitive advantage, and improve their profitability and market share.

Structural capital refers to the organizational ability in the corporate governance of hardware, software, database, organizational structure and patent that support the production of employees (De Luca et al., 2020). It can transform human capital into structural assets, and make such assets belong to the organization. The level of structural capital determines the ability of enterprises to integrate knowledge, accelerates the speed of technological innovation, enables enterprises to gain competitiveness in a dynamic environment and promote the sustainable growth of enterprises (Kianto et al., 2017).

Relationship capital includes relationships among social stakeholders, customer, supplier and brand effects (Allameh Sayyed, 2018). These relationships provide a platform for enterprises exchanging information and ideas with outside to achieve mutual benefit and win-win results. When the level of relational capital is high, enterprises can effectively deal with the relationship between customers and suppliers. In this situation, the enterprise could maintain communication with upstream and downstream, cooperation with suppliers and customers to reduce operating costs. Relationship capital could also enhance the ability of the enterprise to resist external risks and maintain its competitive advantage. In this case, stakeholders would give a better evaluation score which is beneficial to the long-term development of enterprises.

To sum up, this paper proposes the following hypothesis:

H2a There is a significant positive effect of human capital on corporate sustainable growth.

H2b There is a significant positive effect of structural capital on corporate sustainable growth.

H2c There is a significant positive effect of relationship capital on corporate sustainable growth.

3 Methods

3.1 Data source

This paper selects the enterprises in the agriculture, tourism and renewable energy sector of the A-share listed companies in Shanghai and Shenzhen stock exchanges of China from 2009 to 2018 as the research samples. We employ the following criteria to filter the samples:

- (1) Excluding the samples of listed companies that issue B shares, H shares or other overseas tradable shares at the same time;
- (2) Excluding the ST and * ST companies.
- (3) Excluding samples of outliers with negative or zero value such as management expenses, sales expenses, payments to employees and cash paid for employees.
- (4) Eliminate the samples with missing data.

To eliminate the influence of extreme values, we adopt the Winsorize method to process all data. All samples come from RESSET database, Sina Finance and www.cninfo.com.cn. The analysis is performed by Stata 15 software.

3.2 Variables

3.2.1 Dependent variable

Corporate sustainable growth represents the comprehensive ability of quantitative and qualitative change of an enterprise in the long-term. It means evaluating corporate sustainable growth should base on the pre-determined business development goals. Therefore, to measure corporate sustainable growth, we follow the steady-state model proposed by Van Horne (1988). The model equation is as follows:

$$SGR_{i,t} = \frac{(P \times A \times T \times R)_{i,t}}{(1 - P \times A \times T \times R)_{i,t}} \quad (1)$$

In Eq. (1), SGR, i , t , P , A , T , and R represent the corporate sustainable growth, company, year, profit margin, asset turnover ratio, equity multiplier, and retention rate, respectively.

3.2.2 Independent variables

This paper employs the modified value-added intellectual coefficient (MVAIC) model to evaluate the intellectual capital of enterprises (Nimtrakoon, 2015; Ulum et al., 2014), the model equation is as follows:

$$MVAIC_{i,t} = CEE_{i,t} + ICE_{i,t} \quad (2)$$

$$ICE_{i,t} = HCE_{i,t} + SCE_{i,t} + RCE_{i,t} \quad (3)$$

$$CEE_{i,t} = VA_{i,t}/CE_{i,t} \quad (4)$$

$$HCE_{i,t} = VA_{i,t}/HC_{i,t} \quad (5)$$

$$SCE_{i,t} = SC_{i,t}/VA_{i,t} \quad (6)$$

$$RCE_{i,t} = RC_{i,t}/VA_{i,t} \quad (7)$$

In Eqs. (2)–(7), CEE, ICE, HCE, SCE, RCE, and VA represent the capital employed efficiency, intellectual capital efficiency, human capital efficiency, structural capital efficiency, relational capital efficiency, and value-added of a particular company, respectively. CE is capital employed proxied by the equity of owner, HC is human capital proxied by salaries of employees, SC is structural capital proxied by management expenditures, RC is relational capital proxied by sales expenditures.

3.2.3 Control variables

Following the existing literature (Xu et al., 2018), this paper adopts the natural logarithm of the total assets as control variable of enterprise size, the calculation is as follows:

$$SIZE_{i,t} = \ln(\text{Total assets}) \quad (8)$$

In addition, the difference in leverage (LEV) will lead to considerable differences in enterprise performance. Therefore, this paper takes leverage as a control variable.

3.3 Modeling

Based on the analysis above, this paper constructs models to explore the relationship between intellectual capital and corporate sustainable growth as follows:

$$SGR_{i,t} = a + a_1 CEE_{i,t} + a_2 ICE_{i,t} + a_3 SIZE_{i,t} + a_4 LEV_{i,t} + \varepsilon_{i,t} \quad (9)$$

$$SGR_{i,t} = \beta + \beta_1 CEE_{i,t} + \beta_2 HCE_{i,t} + \beta_3 SCE_{i,t} + \beta_4 RCE_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 LEV_{i,t} + \varepsilon_{i,t} \quad (10)$$

where, Model (9) examines the impact of capital employed efficiency (CEE) and intellectual capital efficiency (ICE) on corporate sustainable growth (SGR), while Model (10) further explores the specific impact of intellectual capital components on corporate sustainable growth (SGR).

4 Case study

4.1 Descriptive and correlation analysis

As shown in Table 1, for agriculture companies, the mean of SGR is in the middle of the three industries, which is 0.113. The mean of ICE is 16.196, which is larger than that of CEE. Among the three components of intellectual capital, the mean of HCE is the largest, which is 14.595. The mean of SCE and RCE are 0.705 and 0.296, respectively. For tourism companies, the mean of SGR is the smallest among the three industries, while the mean of RCE is the largest among the three industries. The reason could be that tourism enterprise

Table 1 Descriptive analysis

Variables	Samples	Mean	S.D	Min	Max	Skewness	Kurtosis
SGR	Full	0.123	0.096	0.001	0.304	0.596	2.204
	Agricultural	0.113	0.107	0.001	0.304	0.684	2.116
	Tourism	0.1	0.082	0.001	0.304	0.833	2.985
	Renewable	0.149	0.103	0.001	0.304	0.262	1.721
CEE	Full	0.142	0.088	0.021	0.3	0.392	2.087
	Agricultural	0.115	0.096	0.021	0.3	0.78	2.257
	Tourism	0.128	0.078	0.021	0.3	0.462	2.463
	Renewable	0.161	0.092	0.021	0.3	0.177	1.771
ICE	Full	15.143	11.961	3.894	41.086	1.195	3.098
	Agricultural	16.196	12.283	3.894	41.086	0.93	2.581
	Tourism	11.299	9.069	3.894	41.086	2.227	7.553
	Renewable	19.261	13.309	3.894	41.086	0.565	1.829
HCE	Full	13.266	12.531	1.517	40.513	1.186	3.099
	Agricultural	14.595	12.93	1.517	40.513	0.849	2.449
	Tourism	9.269	9.489	1.517	40.513	2.232	7.632
	Renewable	17.511	13.972	1.517	40.513	0.558	1.838
SCE	Full	0.826	0.689	0.118	2.249	0.964	2.665
	Agricultural	0.705	0.736	0.118	2.249	1.257	3.15
	Tourism	0.825	0.686	0.118	2.249	1.036	2.771
	Renewable	0.846	0.684	0.118	2.249	0.847	2.506
RCE	Full	0.492	0.463	0.021	1.414	0.873	2.422
	Agricultural	0.296	0.33	0.021	1.414	1.633	5.229
	Tourism	0.511	0.49	0.021	1.414	0.825	2.173
	Renewable	0.502	0.444	0.021	1.414	0.802	2.47
SIZE	Full	21.093	1.498	18.474	23.439	- 0.202	2.19
	Agricultural	19.047	1.12	18.474	22.137	1.842	4.953
	Tourism	20.552	1.158	18.474	23.439	- 0.429	3.155
	Renewable	21.911	1.575	18.474	23.439	0.149	2.033
LEV	Full	0.425	0.167	0.178	0.681	0.02	1.755
	Agricultural	0.433	0.183	0.178	0.681	0.002	1.622
	Tourism	0.389	0.165	0.178	0.681	0.296	1.842
	Renewable	0.465	0.158	0.178	0.681	- 0.263	1.956

Table 2 Correlation analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) SGR	1.000							
(2) CEE	0.52***	1.000						
(3) ICE	0.422**	0.297*	1.000					
(4) HCE	0.47***	0.35**	0.481	1.000				
(5) SCE	0.304*	0.282*	− 0.06**	− 0.176	1.000			
(6) RCE	0.167*	0.154	− 0.136*	− 0.233*	0.515	1.000		
(7) SIZE	0.061**	0.053*	− 0.151	− 0.114	− 0.303*	− 0.023	1.000	
(8) LEV	− 0.128*	0.141*	− 0.012*	− 0.02**	0.075	− 0.01**	0.143*	1.000

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 Groupwise heteroskedasticity and serial correlation test

Test	SGR	<i>P</i> -value
Doornik-Hansen LM	389.44	0.284
Pesaran CD test	26.852	0.489
Wald Test	14.752	0.774

is a service industry which requires to serve tourist and customer. For renewable energy companies, the mean of SGR is the largest among the three industries, which is 0.149. The mean of HCE and SCE is the largest in the three industries, which is 17.511 and 0.846, respectively. The reason could be that renewable energy enterprises belong to the high-tech industry, and its development depends on factors such as education level and vocational skills.

From the correlation analysis results in Table 2, it can conclude that the independent variable of CEE, ICE and its components, as well as the control variable of SIZE, have a positive correlation with the dependent variable of SGR with the different significance. The control variable of LEV has a negative correlation with SGR. Therefore, it is necessary to further explore the effects of multiple independent variables on the dependent variable through regression analysis.

4.2 Regression analysis in full samples

To avoid the issues such as the distribution of residual, groupwise heteroskedasticity and serial correlation, we perform the Doornik-Hansen LM, Pesaran CD and Wald Test. These test results are shown in Table 3, which indicates that there are no cross-sectional correlation and groupwise heteroscedasticity in the model. Meanwhile, due to the panel data is run in this paper, we first decide which models (such as the random effect model, fixed-effect model and pooled OLS model) should be employed. The pooled OLS (ordinary least square) regression is suitable for situations where independent variables can explain all the deviations of the dependent variable. While many factors affect the corporate sustainable growth, such as the year effect and the size of the company, thus the pooled OLS model is not suitable for this paper. Second, we employ the Hausman test to decide whether the random effect model or fixed-effect model should be adopted. As shown in Table 4, the results

Table 4 Hausman Test

	Model (9)	Model (10)
<i>F</i> value	2.99	2.85
<i>P</i> value	0.008	0.001
Test results	Fixed effect	Fixed effect

show that the *P* values of Model (9) and Model (10) are 0.008 and 0.001, respectively. Therefore, the fixed-effect model should be adopted for regression analysis.

As shown in Table 5, the regression coefficients of CEE and ICE have a significant positive impact on SGR at the level of 1% in Model (9), which validates the hypotheses of H1 and H2. Meantime, the regression results also show that the contribution of capital employed to corporate sustainable growth is larger than that of intellectual capital. The Model (10) runs a regression analysis on the components of intellectual capital and corporate sustainable growth. The results show that HCE, SCE, RCE have a significantly positive impact on SGR (HCE: $\beta = 0.0835$, $P < 1\%$; SCE: $\beta = 0.0047$, $P < 5\%$; RCE: $\beta = 0.0033$, $P < 5\%$), which validates the hypotheses of H2a, H2b, H2c.

Theoretically, the sustainable growth of modern enterprises should rely more on the utilization of intellectual capital than on capital employed. However, the regression coefficient values of the three components of intellectual capital are much smaller than that of capital employed in this paper. The results indicate that in all enterprises,

Table 5 Regression results in full samples

SGR	Model (9)	Model (10)
CEE	0.9369*** (0.0256)	0.9075*** (0.0278)
ICE	0.0013*** (0.0002)	
SIZE	0.0025** (0.0023)	0.0046* (0.0024)
LEV	− 0.0031* (0.0139)	− 0.0024 (0.0140)
HCE		0.0835*** (0.0002)
SCE		0.0047** (0.0034)
RCE		0.0033** (0.0058)
_cons	0.0257 (0.0501)	0.0749 (0.0534)
Year control	Yes	Yes
Industry control	Yes	Yes
R^2	0.6373	0.6395
Adj. R^2	0.510	0.512

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the components of intellectual capital have a few influences on corporate sustainable growth at present. On the other hand, the coefficient of HCE is the largest among the three components of intellectual capital. It suggests that enterprises have gradually realized the importance of an excellent employee and senior executives. Many enterprises will spend a lot of capital employed to train employees and improve staff skills.

Structural capital should play a higher role in enterprises. The development of high-tech enterprises still has to rely on innovation and R&D projects. However, the results in this paper are not reaching desirability. The reasons could be that some high-tech enterprises are in the growth stage and eager to pursue innovative achievements. Therefore, these companies fail to the construction of infrastructure and corporate culture.

With the increasingly fierce market competition, national policies and the international environment are also continually changing. If the enterprises can maintain splendid relations with suppliers and customers, they will be able to face the uncertainty calmly. Therefore, the relationship capital should play a more critical role in the following situations: one is to utilize excellent external relations to help the enterprise operating and growing. The other is to improve the ability of enterprise resisting risks. The results show that the coefficient of RCE is only 0.0033, indicating that managers in most enterprises in China have not effectively employed relational capital to serve corporate sustainable growth.

4.3 Regression analysis in industries samples

As shown in Table 6, for agricultural enterprises, CEE and ICE, HCE, SCE have a significant positive impact on SGR, validating the hypothesis of H1, H2, H2a, H2b. However, the relationship between RCE and SGR is not significant, which means the hypothesis of H2c is not supported. The results are consistent with the operational characteristics of agricultural enterprises which belong to the primary industry and have not a strong demand for external relations. Development of these enterprises mainly depends on the provision of agricultural products and technology. Therefore, the effect of relational capital on corporate sustainable growth is not significant.

For tourism enterprises, CEE and ICE, HCE, RCE have a significant positive impact on SGR, validating the hypothesis of H1, H2, H2a, H2c. However, the relationship between SCE and SGR is not significant, which means the hypothesis of H2b is not supported. The results are also consistent with the operational characteristics of tourism enterprises which belong to the service industry. The main business of these enterprises is to provide services for customers and tourists. Meanwhile, tourism companies require employees with professional knowledge and its development mainly depends on the provision of services. Therefore, the effect of structural capital on corporate sustainable growth is not significant.

For renewable energy enterprises, CEE and ICE, HCE, SCE and RCE all have a significant positive impact on SGR, validating the hypothesis of H1, H2, H2a, H2b, H2c. Among the components of intellectual capital, the coefficient of HCE is the largest, which is 0.0209 ($P < 0.01$), followed by SCE with 0.0153 ($P < 0.01$), and the coefficient of RCE is the smallest. In renewable energy enterprises, human capital makes an enormous contribution to corporate sustainable growth. Therefore, they should pay attention to the investment of human capital to enhance the ability of sustainable growth. Meanwhile, they should also pay attention to the role of relational capital in the sustainable growth of enterprises.

Table 6 Regression results in industries sample

SGR	Agricultural		Tourism		Renewable	
	Model	Model	Model	Model	Model	Model
	(9)	(10)	(9)	(10)	(9)	(10)
CEE	1.2155*** (0.1225)	1.2017*** (0.1343)	0.8820*** (0.0353)	0.8566*** (0.0402)	0.9915*** (0.0406)	0.9553*** (0.0443)
ICE	0.0003** (0.0009)		0.0017*** (0.0003)		0.0009*** (0.0004)	
SIZE	0.0333** (0.0123)	0.0311** (0.0138)	0.0075*** (0.0027)	0.0078*** (0.0027)	0.0035** (0.0041)	0.0029** (0.0047)
LEV	− 0.0220 (0.0562)	− 0.0180* (0.0706)	− 0.0154 (0.0164)	− 0.0079* (0.0170)	− 0.0205* (0.0243)	− 0.0237* (0.0240)
HCE		0.0092** (0.0009)		0.0118*** (0.0003)		0.0209*** (0.0004)
SCE		0.0055** (0.0127)		0.0051 (0.0044)		0.0153*** (0.0058)
RCE		0.0075 (0.0327)		0.0073** (0.0075)		0.0090** (0.0092)
_cons	− 0.6746** (0.2465)	− 0.6256** (0.2758)	0.1360** (0.0588)	0.1441** (0.0600)	− 0.1106 (0.0908)	0.0387 (0.1058)
Year control	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.5319	0.54329	0.4983	0.4990	0.5556	0.5620
Adj. R ²	0.471	0.458	0.472	0.471	0.530	0.536

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Discussion

To verify the robustness of the results, we adopt the proxy variable to re-perform the regression analysis. This paper employs the sustainable growth model (SGR1) proposed by Higgins to replace the SGR and introduce it into the Model (9) and Model (10). The regression results are shown in Table 7. Using the SGR1 proposed by Higgins as the dependent variable, the significance of the results has not changed. For agricultural enterprises, the relationship between RCE and SGR1 is still not significant; For tourism enterprises, the relationship between SCE and SGR1 is also not significant; For renewable energy enterprises, ICE and all its components have a significant positive correlation with SGR1. Therefore, there is no significant difference between the robustness check results and the previous regression results.

6 Policy and managerial implications

Intellectual capital is an indispensable capital in the process of corporate sustainable growth, especially for renewable energy enterprises. Knowledge and innovation are not only the core of sustainable growth but also the concentrated embodiment of the

Table 7 Robustness check results

SGR1	Agricultural		Tourism		Renewable	
	Model	Model	Model	Model	Model	Model
	(9)	(10)	(9)	(10)	(9)	(10)
CEE	0.3970*** (0.3053)	0.4423*** (0.3148)	0.1014** (0.0793)	0.1153** (0.0906)	0.3351*** (0.0727)	0.3241*** (0.0809)
ICE	0.0025** (0.0021)		0.0014** (0.0007)		0.0008 (0.0007)	
SIZE	0.0247** (0.0306)	0.0432** (0.0323)	0.0051* (0.0061)	0.0048* (0.0062)	0.006*** (0.0073)	0.008*** (0.0086)
LEV	− 0.0081* (0.1402)	− 0.0409* (0.1654)	− 0.0379** (0.0370)	− 0.0325** (0.0382)	− 0.0754* (0.0436)	− 0.0695* (0.0438)
HCE		0.0214*** (0.0022)		0.0245*** (0.0007)		0.0206*** (0.0007)
SCE		0.0154** (0.0297)		0.0095 (0.0099)		0.0181*** (0.0106)
RCE		0.0801 (0.0766)		0.0152** (0.0169)		0.0125** (0.0168)
_cons	0.5647 (0.6144)	0.9667 (0.6464)	− 0.0006 (0.1321)	0.0082* (0.1350)	0.1861 (0.1626)	0.0469* (0.1930)
Year control	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.491	0.4068	0.311	0.325	0.409	0.494
Adj. R ²	0.429	0.375	0.295	0.303	0.388	0.441

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

competitiveness advantage. The three components of intellectual capital promote each other and are indispensable. A sound management system and corporate culture will make employees have a sense of belonging and improve their enthusiasm for work. Enterprises can continuously improve and innovate their products through customer feedback. Therefore, enterprises should strengthen the management of intellectual capital and establish a reasonable evaluation system of intellectual capital.

For agricultural enterprises, as the Chinese agricultural industry has begun to transform from the decentralized production model to the centralized production model (Li et al., 2020a; Li et al., 2020b; Liu & Xu, 2021). Therefore, the enterprises should separate management modes in the R&D, management, and operation stage. By speeding up the improvement of agricultural enterprises' information management and process, constructing corporate culture, and enhancing the centripetal force of employees, the agricultural enterprise could accelerate the transformation to maturity and internationalization. Besides, agricultural enterprises should maintain bright cooperative relations with stakeholders, including customers, suppliers, research institutions, and the government. All these ways could pursue the high efficiency of R&D technology, a broader market, and a mature supply chain to promote the enterprise's sustainable development.

For tourism enterprises, resource allocation should be tended to relationship capital and human capital. It should establish a sound management system, improve the internal operating mechanism, and enhance relationship capital efficiency. Further, the tourism

enterprises should pay more attention to human capital's role from externally hiring or internally training marketing, management, and other professionals, integrating high-quality human resources, and stimulating human capital's sustainable effectiveness. Enterprises should also implement employee training, job performance evaluation, career planning, and other activities to improve employee loyalty and reduce operation risk (Li et al., 2020a; Li et al., 2020b; Xu et al., 2020a; Xu et al., 2020b; Xu et al., 2020c). These methods could form an internal promotion channel and improve the internal incentive mechanism, attracting external talents, reducing the turnover rate, and maintaining tourism employees' stability. Meanwhile, the enterprises should maintain a better relationship with other stakeholders and maximize all parties' value to make structural capital promoting the sustainable development of tourism enterprise.

For renewable energy enterprises, they face challenges from domestic and international competitors (Xu et al., 2019c, 2020a; Xu et al., 2019a; Xu et al., 2019b; Xu et al., 2020b; Xu et al., 2020c; Xu et al., 2019d). Therefore, the enterprises should first adhere to industrialization development and concentrate on the allocation of advantage resources. It should gradually form some renewable energy industry clusters with high visibility and competitiveness to provide high value-added products and services. Secondly, the enterprises should focus on human capital cultivation and strengthen the internal structure capital construction. It should also improve the construction of human capital's contract environment and remove the institutional obstacles to human resources flow, especially high-level human resources. Finally, managers need to consider the synergistic and complementary role of the constituent components of intellectual capital and feed the in-depth communication and collaborative innovation of human capital and structural capital. They should especially strive to create heterogeneous human capital and structural capital to improve enterprises' sustainable profitability.

7 Conclusions and future research directions

7.1 Conclusions

This paper analyzes the relationship between intellectual capital and corporate sustainable growth. The results show that capital employed has a significant positive effect on corporate sustainable growth. Its contribution to corporate sustainable growth is more significant than that of intellectual capital, indicating that capital employed is still the most critical resource for sustainable growth in modern enterprises.

This study supports the positive effect of intellectual capital on corporate sustainable growth. No matter in the full samples or industries samples, intellectual capital has a significant positive impact on corporate sustainable growth, which verifies the proposed hypothesis.

The three components of intellectual capital also have a significant positive impact on corporate sustainable growth, in which human capital has the most significant effect on corporate sustainable growth, followed by structural capital. In contrast, relationship capital has the smallest contribution to corporate sustainable growth. The current research results also show that human capital has the most significant impact on enterprise performance. It means that enterprises attach importance to their internal human capital. On other hand, structural capital is the platform for intellectual capital to play its role, provides the necessary environment and guarantee for human capital, and links human capital and

non-human capital. From the regression results of different industries, it can see that the relationship capital of tourism and renewable energy enterprises has a significant contribution to corporate sustainable growth. In contrast, the contribution of relationship capital in agricultural enterprises is not significant.

7.2 Future research directions

This paper only studies the effects of the three components of intellectual capital on corporate sustainable growth but does not discuss the more specific factors in each kind of components. Therefore, the suggestions may not be precise. Besides, in terms of control variables, this study only employs enterprise size, financial leverage, year and industry characteristics as control variables. At the same time, many factors are affecting corporate sustainable growth, such as enterprise age, equity concentration. Future studies should take into account more control variables to expand the research method.

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Declarations

Conflicts of Interest The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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