Open Journal of Accounting, 2022, 11, 213-242
https://www.scirp.org/journal/ojacct
ISSN Online: 2169-3412
ISSN Print: 2169-3404

Intellectual Capital Efficiency and Corporate Performance in Jordanian Listed Companies

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How to cite this paper: Sowaity, S. M. A. (2022). Intellectual Capital Efficiency and Corporate Performance in Jordanian Listed Companies. *Open Journal of Accounting, 11,* 213-242.
https://doi.org/10.4236/ojacct.2022.113012

Received: May 13, 2022
Accepted: July 15, 2022
Published: July 18, 2022

Abstract

We examine whether intellectual capital efficiency (IC) shapes the corporate performance of Jordanian listed firms over the period 2009-2018. We document a positive impact of IC on corporate performance that holds across different sectors. Considering the different IC components, we find a positive relationship with corporate performance for both relational capital efficiency (except for the real estate sector) and human capital efficiency (except for the services sector), but find that the impact of structural capital efficiency is mixed. Our evidence points to the fact that Jordanian corporate management has not yet fully exploited the potential of intangible assets.

Keywords

Intellectual Capital Efficiency, Corporate Performance, Profitability, Amman Stock Exchange ASE, VAIC

1. Introduction

In this millennium, fewer people will do physical work and more will do brain work, implying an accumulation of intellectual capital (IC) (Haris et al., 2019) as a resource that allows sustainable acquisition of wealth. Si (2019) added that "traditional material capital is gradually replaced by intellectual capital and the focus of social attention is no longer the traditional factors of production but the lack of knowledge resources". Human capital in particular, considered to be the most important IC component (Aljuboori et al., 2022), is highly influential in improving corporate profitability, as documented by Xu and Feng (2020), who argue that expenditure on staff should be treated as an investment rather than an expense due to its long-term impact. Pulic (2008) has emphasized a strong link between IC efficiency and organizational success in creating competitive advantage. Therefore, it is essential for firms to understand, identify, develop and efficiently utilize IC to strengthen competitiveness.

In this article, we examine whether IC efficiency shapes corporate performance by Jordanian non-financial companies listed on the Amman Stock Exchange (ASE, 2019), with a view to offering novel insights into corporate performance drivers in Jordan, a developing economy. Non-financial manufacturing firms contribute 60% to Jordanian gross domestic product (GDP). Because Jordan has a high ratio of external debt to GDP (around 95%), in an attempt to return to a normalized growth path, the Jordanian government has committed to aggressive reforms in the hope of attracting international investment (Economic Policy Council, 2016). Since Jordan has been identified as a nation with a high level of human capital but a relatively low level of organizational capital (Bontis, 2004), exploring the IC potential for improving Jordanian economic performance is of particular interest.

The empirical literature has documented heterogeneous findings with respect to the impact of IC and its components, namely, human capital (HC), structural capital (SC) and relational capital (RC) on corporate performance in different settings. Theoretically, no consensus has been reached in the academic circles on the impact of IC and its elements on different industries with different performance levels and the research in this field relatively rare and needs follow-up research (Si, 2019). In their study on the influence of IC efficiency on financial performance (proxied by return on assets (ROA), return on equity (ROE) and asset turnover) in the Bangladeshi textile industry over the period 2013-2017, Chowdhury et al. (2018) show that RC efficiency and SC efficiency are influential, while HC efficiency has an insignificant impact. Other studies point to significant linkage between IC (and its components) with corporate performance (see, e.g., Oppong & Pattanayak, 2019; Tarigan et al., 2019; Camfield et al., 2018). In contrast, Oyedokun and Saidu (2018) and Al Momani and Nour (2019) document a non-significant relationship for IC and its components with ROA, and for IC efficiency with ROE, respectively. Mixed and inconclusive evidence has also been reported for many countries, prompting researchers to conduct further studies across time, industries and countries in different economic contexts. We contribute to the growing empirical literature on this topic with additional and holistic evidence for different sectors in a developing economy.

We measure IC efficiency using Pulic's (1998) value-added intellectual coefficient (VAIC) model, widely used in many empirical studies to measure firm IC in different countries and sectors (Xu et al., 2022; Xu & Wang, 2018; Ozkan et al., 2017). To demonstrate the robustness of the analysis, we use different profitability metrics, namely, ROA, ROE, earnings per share (EPS) and net profit margin (NPM), as have been used in previous empirical studies to account for corporate performance (see, Xu et al., 2022; Xu & Feng, 2020; Nuraini et al., 2018; Nadeem et al., 2018; Chowdhury et al., 2018; Suseno et al., 2017; Yilmaz & Acar, 2018; Fazlzadeh, 2017). Using panel regression analyses, we demonstrate a significant positive relationship between IC efficiency and corporate performance for all sectors, independently of the profitability metric used—a result that also holds for the real estate sector, which is a mainly a physical capital-based sector. Furthermore, we document evidence for the crucial role played by HC efficiency in corporate wealth creation. Unexpectedly, despite the evidence for the studied period based on year-wise analyses, Jordanian corporate management is failing to develop an awareness of the critical role played by intangible assets.

This research contributes to the extant literature as follows. First, we show that the IC efficiency contribution to corporate performance varies widely by sector (Makki et al., 2009), which would indicate that results for any particular sector cannot be generalized. Note that Xu & Li (2019) reported that most IC theories are oriented to descriptive purposes, whereas this study focuses on a comparison. Second, we find that dynamic temporal effects have a decisive impact on the relationship between IC efficiency and corporate performance. Third, we consider the real estate sector, a physical capital-based sector, which has been largely overlooked by the research community, despite turbulent performance in recent years (Kardoosh, 2019). Finally, we consider not only the usual ROA and ROE indicators, but also EPS and NPM, thereby reporting more robust evidence on the relationship between IC efficiency and corporate performance. Our empirical results should be of interest for policy makers, and also for managers in terms of reassessing the management of IC resources to sustain business operations over time. Our findings are particularly important for more turbulent economies, including Jordan, where the potential of IC is not fully understood and so is underexploited by management (Sharabati et al., 2010).

The remainder of this study is organized as follows: Section 2 describes a review of the literature and our hypotheses; Section 3 describes the data and methodological design of the study; Section 4 outlines the descriptive statistics and empirical results; and finally, Section 5 contains our discussion, conclusions and recommendations.

2. Literature Review

2.1. Defining and Measuring IC

IC has been the focus of intense debate by researchers (e.g., Aljuboori et al., 2022), and is generally understood as an important driver of firm competitiveness and future value generation (Xu et al., 2022; Xu & Feng, 2020). In a knowledge-based economy, the importance of IC in value creation is attributed to its distinctive characteristics as a main driver of long-term corporate success, wealth, financial performance and sustainability (Xu & Li, 2019; Xu & Wang, 2018; Tarigan et al., 2019; Sardo & Serrasqueiro, 2017; Reboredo & Sowaity, 2022). Therefore, corporate management needs to pay attention to IC and to continuously invest in updating knowledge and staff skills (Haris et al., 2019). Not surprisingly, interest in the impact of IC on corporate performance, including during stress periods like the Covid-19 pandemic, has grown at both the academic and practitioner levels (Albertini & Berger-Remy, 2019; Xu et al., 2022).

However, no standard definition for IC is widely accepted by scholars (Ozkan et al., 2017; Hapsah et al., 2018). Most scholars concentrate on the human dimension, describing IC as encompassing the aggregated experience and professional skills of employees that provide a company with a competitive edge (Edvinsson & Malone, 1997). Another approach for defining IC through the new perspective of value creation e.g., from relying on traditional material capital to relying on knowledge, technology and innovation, thus, IC can be defined as the sum of unique knowledge assets that a firm owns or control to create high value and to promote economic growth (Si, 2019). In summary, IC contains skills and knowledge inside a firm as a vital resource in the current economy (Shubita, 2022).

Interest in how to measure IC has spurred the development of several metrics (Xu & Li, 2019). On the basis of the financial, physical and human capital in an organization, scholars have achieved a consensus on IC components, i.e., HC, SC and RC (Aljuboori et al., 2022; Xu & Wang, 2018). Thus, whereas financial capital, associated with the productive capacity of an organization, refers to the net value of assets and physical capital, IC refers to the science and knowledge included in SC and HC, respectively (Lee & Lin, 2018); however, SC and HC without employed capital, i.e., RC, fail to capture the value creation process (Bontis, 2004). Those three IC components are at the core of Pulic's VAIC model (1998), developed to measure IC efficiency in firms, and widely used in studies related to IC (Firer & Williams, 2003). The VAIC is easy to compute, offers comparability across sectors, companies and countries (Tarigan et al., 2019), and yields objective and verifiable data, as it is directly derived from audited and reliable financial statements.

2.2. Defining and Measuring Corporate Performance

Corporate performance can be defined as the capacity of an organization to efficiently and effectively exploit its available resources to achieve profitability, growth and productivity (Taouab & Issor, 2019). Reasons for corporate performance measurement, as identified by Kamath (2015), are as follows: 1) to help organizations formulate and assess strategy execution and management compensation; 2) to communicate accessible and trusted indicators to stakeholders; and 3) to motivate staff to adopt the most appropriate organizational behaviors that strengthen their loyalty and responsibility. Corporate performance is usually measured using profitability indicators, mainly, ROA, ROE, EPS and NPM (see, e.g., Oppong & Pattanayak, 2019; Tarigan et al., 2019; Camfield et al., 2018).

2.3. IC and Corporate Performance: Hypothesis Development

Previous research has explored the association between IC efficiency and corporate performance. Xu et al. (2022) have documented a significant impact of IC on profitability, even during the Covid-19 pandemic period. Sharif and Elsayed (2015) argue that IC efficiency is a critical prerequisite for sustained corporate performance. Makki et al. (2009) show, in a study of Pakistani listed firms, that IC efficiency contributes significantly to EPS, and this evidence was further corroborated by Suhendra (2015). Sumedrea (2013) evidenced a significant link between IC efficiency and profitability as reflected in ROA, ROE and revenue growth, while Ahangar (2011) supported an informative link between IC efficiency and corporate performance proxied by ROA and revenue growth. Al Momani and Nour (2019), however, document an insignificant relationship with ROE for VAIC and its components except for RC, while Saleh (2015) document a positive relationship between IC efficiency and all its components with financial performance, except for ROE.

In light of the above, since a significant association exists between IC efficiency and corporate performance in different contexts, IC efficiency could be a major determinant of corporate performance for Jordanian non-financial listed firms. The more a firm makes efficient use of all its resources in creating value, the more profitable it will be. We accordingly propose hypothesis H1 regarding the potential aggregate impact of IC efficiency on corporate performance as follows:

***Hypothesis H*1.** *IC efficiency has a significant impact on ROA, ROE, EPS and NPM.*

It is also important to investigate the individual impact of each VAIC component on corporate performance, given that investors place different values on HC, SC and RC (Xu & Wang, 2018).

Recently, Xu et al. (2022), in a study set in the China and Pakistan, evidenced a significant positive relationship of HC, SC and RC efficiency with ROA and ROE, even in times of crisis such as the Covid-19 pandemic. Sardo and Serrasqueiro (2017), in a study of non-financial listed firms in 14 western European countries, reported that IC efficiency is an important resource for value creation, and that HC is a key factor in firm wealth. RC efficiency and SC efficiency positively impact short-run and long-run corporate performance, respectively; Ozkan et al. (2017), in a study of Turkish listed firms, find a significant positive relationship between RC efficiency and ROA, but negligible effects regarding HC and SC efficiency, while Suseno et al. (2017), in their study of the Bank of Perkreditan Rakyat in Malaysia, found that SC and HC efficiency have no influence on ROA, while RC efficiency has a significant effect on overall corporate performance. Nuraini et al. (2018), in their study of Sharia banking companies in Indonesia over three years, found a positive significant impact of VAIC on ROA, ROE and revenue growth. Xu and Wang (2018), in a study of listed Korean manufacturing firms during 2012-2016, document a positive impact of HC and RC efficiency and a negative effect of SC on corporate performance. Similarly, Yilmaz and Acar (2018) reported a significant effect for HC and RC on financial performance for Turkish listed companies over the period of 2011-2014. In contrast, few studies have reported no relationship between corporate performance and SC (e.g., Suseno et al., 2017), HC (e.g., Mohammad & Ismail, 2009) and RC (e.g., Hashim et al., 2015). The above evidence would suggest that most studies report mixed findings for the differential impact of the three VAIC components on corporate performance. Accordingly, to further explore this relationship, we propose the following hypothesis:

Hypothesis H2. *HC, SC and RC each have a significant impact on ROA, ROE, EPS and NPM.*

3. Research Design

3.1. Data and Sampling

The data sample includes yearly information on all non-financial manufacturing, services and real estate companies listed on the Amman Stock Exchange (ASE, 2019) over the decade 2009-2018. **Table 1** summarizes the sampling process and the included sectors. Included were companies with audited annual financial statements uploaded to the ASE official website (http://www.ase.com.jo/) and meeting predefined parameters as follows: 1) continuous activity during the study period and stocks traded publicly; 2) not delisted from the ASE by the Jordan Securities Commission (JSC) during the study period; and 3) fiscal year for

Table 1. Included/excluded Jordanian listed firms.

Sector	Total	Excluded	Included	Full sample % included/total listed	Sub-sample % included/total selected	# Obs.
Included[a]						
Manufacturing	47	5	42	40%	89%	420
Services	77	26	51	49%	66%	510
Real estate	33	22	11	11%	33%	110
Subtotal	157	53	104			1040
Banking*	15	15	0			0
Insurance*	21	21	0			0
Subtotal	36	36	0			
Total listed Firms	193	89	104			

	Margin of error (ME) for sample selection at the 95% confidence level					
	Manufacturing	ME	Services	ME	Real estate	ME
Full sample	42 of 104	11.73%	51 of 104	9.84%	11 of 104	28.08%
Sub-sample	42 of 47	4.99%	51 of 77	8.03%	11 of 33	24.50%

*Banking and insurance firms (36) are totally excluded due to a different reporting structure that means they are not comparable with non-financial firms. The total listed firms trading at the ASE were 193 as the data collection process started. [a]Only non-financial firms are included that met the study predefined criteria.

annual reporting ending on 31 December.

Of the 193 public ASE-listed companies at the beginning of 2019, 104 were included in the sub-sample as meeting the inclusion criteria, yielding 1040 annual observations. Included as valid for statistical analysis were companies as follows: 42 (of 47) manufacturing companies investing in the pharmaceutical and medical, chemical, paper, food and beverages, tobacco and cigarettes, mining and extraction, engineering and construction, electrical and textiles sectors; 51 (of 77) services companies investing in healthcare, education, hotels and tourism, transportation, technology and communication, media, utilities and energy, commercial and diversified financial services sectors; and 11 (of 33) real estate companies investing in land and construction activities.

3.2. Research Variables and Models

Although corporate performance may be measured using market-based information, we use accounting-based measures, given that the main goals in any organization are growth and profitability (Sumedrea, 2013). Accordingly, we use four profitability metrics: ROA, ROE (following Nadeem et al., 2018; Xu & Wang, 2018; Oyedokun & Saidu, 2018; Chowdhury et al., 2018; Radic, 2018; Gogan et al., 2016; Ozkan et al., 2017, among others), EPS (following Saleh, 2015; Fazlzadeh, 2017; Suhendra, 2015), and NPM (following Yilmaz & Acar, 2018; Nuryaman, 2015).

The independent variables used are the VAIC components as a proxy for IC efficiency (see, e.g., Tarigan et al., 2019; Yilmaz & Acar, 2018; Radic, 2018; Oyedokun & Saidu, 2018; Ozkan et al., 2017). VAIC reflects value-added per monetary unit invested in a resource: the higher the coefficient the greater the company capacity to efficiently apply IC to improving performance (Pulic, 2008; Sumedrea, 2013). This aggregate indicator, signaling IC involvement in value creation, thus reflects overall efficiency in deploying a firm's resources. Based on the theory of Trinity, IC consists of human capital HC, structural capital SC and relational capital RC (Si, 2019). Thus, The three VAIC components are as follows: a) HC, measured in terms of dollar expenditure on staff costs (including salaries, bonuses, training, etc), captures the knowledge, professional skills, experience, innovativeness, commitment and competence of a firm's employees (Xu & Feng, 2020; Xu & Wang, 2018; Sarea & Alansari, 2016); b) SC reflects the non-human capital in an organization, including IT systems, databases, routines, organizational charts, procedures, guidelines, systems, processes, policies, strategies and overall infrastructures (Sardo & Serrasqueiro, 2017); and c) RC reflects the physical and financial capital employed in the value creation process (Nuryaman, 2015).

Dependent variables are the four-profitability metrics, namely, ROA, ROE, EPS and NPM.

Finally, the control variables, related to internal factors that affect the book value of a firm's assets (e.g., Tarigan et al., 2019; Forte et al., 2017): financial leverage (LEV), to control for indebtedness, and firm size (SIZE), to control for the firm's size effect. Several studies have documented that a higher debt ratio means a higher risk of bankruptcy, indicating that debt is an important factor affecting firm value and performance (Agustinus & Rachmadi, 2008). Firm size is scaled by the natural logarithm for total net assets for firm *i* in fiscal year *t* (see Ajidi & Aderemi, 2014; Sharif & Elsayed, 2015, among others). While some studies have documented that large firms are more fragile than small ones (Agustinus & Rachmadi, 2008), Radic (2018) reported that firm size has no impact on firm profitability. Dependent, independent and control variables and their calculations are described in **Table C14** (**Appendix C**).

Given the nature of the dataset, we use panel analysis consisting of time-unit observations. Accordingly, the following multivariate panel models, exemplified by ROA, are established to test our hypotheses H1 and H2:

$$\mathrm{ROA}_{i,t} = \alpha_i + \beta_1\mathrm{IC}_{i,t} + \beta_2\mathrm{Size}_{i,t} + \beta_3\mathrm{Lev}_{i,t} + \beta_4\sum\mathrm{YEARS} + \varepsilon_{i,t} \tag{1}$$

$$\begin{aligned}\mathrm{ROA}_{i,t} = {} & \alpha_i + \beta_1\mathrm{REC}_{i,t} + \beta_2\mathrm{SCE}_{i,t} + \beta_3\mathrm{HCE}_{i,t} + \beta_4\mathrm{Size}_{i,t} + \beta_5\mathrm{Lev}_{i,t} \\ & + \beta_6\sum\mathrm{YEARS} + \varepsilon_{i,t}\end{aligned} \tag{2}$$

where α_i is a constant that accounts for fixed effects, and $\varepsilon_{i,t}$ denotes the stochastic component for firm *i* and time *t*. Parameters β_1 in Equation (1) and β_1, β_2, and β_3 in Equation (2) account for the impact on corporate performance of the efficiency of VAIC's three components, labelled RCE, SCE and HCE); parameters β_2 and β_3 in Equation (1) and β_4 and β_5 in Equation (2) account for the effects of the control variables (LEV and SIZE); and parameters β_4 in Equation (1) and β_6 in Equation (2) are time dummy variables, to account for temporal effects. If β_1 in Equation (1) and β_1, β_2 and β_3 in Equation (2) are significantly different from zero, then hypotheses H1 and H2 hold, respectively.

4. Empirical Results

4.1. Descriptive Statistics

To mitigate the impact of outliers, all variables are winsorized at the 5% level; note that the SIZE variable is not controlled for outliers because it is measured by the natural logarithm. Likewise, the normality, stationarity, autocorrelation and heteroskedasticity of all variables are checked by running the relevant statistical tests (see results in **Appendix C**).

Table 2 reports descriptive statistics of the analyzed variables, the mean VAIC value is 3.6757, suggesting that added value is positively generated from integration of all the IC components, while standard deviation (SD) of 3.0898 points to great variability between firms. The highest (2.8594) and lowest (0.1327) means occur for HC and RC. The high mean for HC signals the crucial and predominant role of human resources in adding value. As for the control variables, the mean LEV value is 0.2740, implying that about one third of assets are financed by creditors, while the mean SIZE value is 7.5046, with low dispersion between firms. Regarding the profitability metrics, mean values for ROA, ROE, EPS and NPM are 0.02, 0.03, 0.08 and 0.02, respectively, indicating that all the sampled firms are profitable and performing reasonably well, while SD values of 0.06, 0.10, 0.17 and 0.31 for ROA, ROE, EPS and NPM, respectively, point to great performance variability between firms.

Tables 3-5 report summary descriptive statistics for firms included in the

Table 2. Descriptive statistics for the sample.

	Mean	Min	Max	SD	Skewness	Kurtosis	# Obs.
Independent variables							
VAIC	3.6757	−0.3064	12.6096	3.0898	1.5450	5.1041	1040
RC	0.1327	−0.0181	0.3926	0.1075	0.8605	3.1457	1040
SC	0.5644	−0.3224	1.5160	0.4025	0.0649	3.7169	1040
HC	2.8594	−0.7995	11.3493	2.7857	1.7168	5.7891	1040
Dependent variables							
ROA	0.0217	−0.1150	0.1446	0.0622	−0.1587	3.0722	1040
ROE	0.0318	−0.2138	0.2208	0.1024	−0.4476	3.3625	1040
EPS	0.0820	−0.1880	0.5730	0.1746	1.1791	4.4808	1040
NPM	0.0179	−0.8980	0.5271	0.3077	−1.3689	5.4383	1040
Control variables							
LEV	0.2740	0.2215	0.7881	0.0072	0.7459	2.7323	1040
SIZE	7.5046	5.3013	9.9848	0.5571	0.7370	4.2019	1040

Note. The sample includes annual data for ASE-listed firms for the period 2009-2018.

Table 3. Descriptive statistics for the manufacturing sector.

	Mean	Min	Max	SD	Skewness	Kurtosis	# Obs.
VAIC	3.3394	−0.3064	12.6096	2.8281	1.653	5.917	420
RC	0.1385	−0.0181	0.3926	0.0977	0.672	3.252	420
SC	0.5167	−0.3224	1.5160	0.4244	0.182	3.541	420
HC	2.5371	−0.7995	11.3493	2.4645	1.864	7.052	420
ROA	0.0179	−0.1150	0.1447	0.0669	−0.1468	2.6229	420
ROE	0.0183	−0.2138	0.2208	0.1080	−0.4700	2.9971	420
EPS	0.0814	−0.1880	0.5730	0.1884	1.1135	4.1139	420
NPM	0.0009	−0.8980	0.5271	0.269	−1.2347	6.3594	420
LEV	0.3347	0.0072	0.7881	0.2690	0.442	2.421	420
SIZE	7.4349	6.3508	9.9848	1.232	5.073	4.2019	420

Note. The sample includes annual data for ASE-listed manufacturing firms for the period 2009-2018.

Table 4. Descriptive statistics for the services sector.

	Mean	Min	Max	SD	Skewness	Kurtosis	# Obs.
VAIC	3.8899	−0.3064	12.6096	3.1143	1.6251	5.2177	510
RC	−0.1454	−0.0180	0.3925	0.1147	0.8219	2.7735	510
SC	0.5807	−0.3224	1.5160	0.3606	0.0235	4.3331	510
HC	3.0763	−0.7995	11.3493	2.8514	1.7765	5.7424	510
ROA	0.0286	−0.1150	0.1446	0.0586	−0.1963	3.4814	510
ROE	0.0503	−0.2138	0.2208	0.0973	−0.4236	3.5434	510
EPS	0.0997	−0.1880	0.5730	0.1710	1.0906	4.1829	510
NPM	0.0685	−0.8980	0.5271	0.2865	−1.5694	6.4379	510
LEV	0.2714	0.0072	0.7887	0.2290	2.9631	2.421	510
SIZE	7.5989	5.3013	9.2549	0.5543	0.5905	4.1573	510

Note. The sample includes annual data for ASE-listed services firms for the period 2009-2018.

Table 5. Descriptive statistics for the real estate sector.

	Mean	Min	Max	SD	Skewness	Kurtosis	# Obs.
VAIC	3.9663	−0.3064	12.6096	3.7723	0.9595	2.9280	110
RC	0.0516	−0.0181	0.3926	0.0668	0.9595	2.9280	110
SC	0.6706	−0.3224	1.5160	0.4726	−0.1995	2.8352	110
HC	3.0846	−0.7995	11.3493	3.4623	1.0702	3.2022	110
ROA	0.0037	−0.1150	0.1446	0.0548	0.0892	4.0287	110
ROE	−0.0024	−0.2138	0.2208	0.0863	−0.5314	4.5514	110
EPS	−.0042	−0.1800	0.1200	0.0743	−0.7781	3.4947	110
NPM	−0.1519	−0.8980	0.5271	0.4457	−0.6111	2.1635	110
LEV	0.0548	0.0072	0.3310	0.0731	2.1051	6.8844	110
SIZE	7.3338	6.2759	8.2714	0.5453	−0.1765	2.0258	110

Note. The sample includes annual data for ASE-listed real estate firms for the period 2009-2018.

manufacturing, services and real estate sectors, respectively; these have fairly similar mean VAIC values (3.3394, 3.8899, and 3.9663, respectively) that are also close to the value for the full sample. Moreover, the mean VAIC values indicate that the value added from IC efficiency in all the sectors exceeds the costs incurred in terms of physical and financial capital. The highest mean value in all sectors is for HC (2.5371, 3.0763, 3.0846), consistent with the fact that human resources make the highest contribution to added value. Mean values for RC are 0.1385, −0.1454 and 0.0516, and for SC are 0.5167, 0.5807 and 0.6706, for the manufacturing, services and real estate sectors, respectively; thus, in the manufacturing and real estate sectors, the value added exceeds the costs incurred, while the services sector struggles to add value from physical capital. Overall, the three sectors succeed in adding value from investing in SC. Mean LEV values for the manufacturing, services and real estate sectors are 0.3347, 0.2714 and 0.0548, respectively; thus, around one third of assets in manufacturing and services are funded by creditors, compared to only 5% for the real estate sector. Average SIZE values in the manufacturing, services and real estate sectors are 7.4349, 7.5989 and 7.3338, respectively, with a dispersion that varies by sector.

Regarding sectors, mean values for ROA, ROE, EPS and NPM are, respectively, 0.02, 0.02, 0.08, and 0.0009 for the manufacturing sector; 0.03, 0.05, 0.10 and 0.07 for the services sector, and 0.004, −0.002, 0.003 and −0.15 for the real estate sector values that point to differences in corporate performance between sectors. ROA values, positive and moderate across all sectors, reflect moderate profitability; ROE values are low, and even negative for the real estate sector; EPS values are satisfactory for the manufacturing and services sectors, but poor for the real estate sector; and finally, NPM values are poor except for the services sector.

Finally, a Spearman correlation matrix analysis shows that the ROA, ROE, EPS and NPM profitability indicators are significantly and positively correlated with VAIC and its components at the 1% level for the entire sample of industries, thereby initially confirming a strong impact of IC efficiency on corporate value creation (see **Appendix C**).

4.2. Regression Results

Tables 6-9 report evidence on the impact of IC and its components considering the ROA, ROE, EPS and NPM profitability indicators, respectively, for the sample overall and for each sector.

Table 6 shows that IC efficiency has a significant positive impact on ROA. This result is consistent with hypothesis H1, corroborates evidence for other countries (e.g., Xu et al., 2022; Tarigan et al., 2019; Nadeem et al., 2018; Xu & Wang, 2018; Nuraini et al., 2018; Radic, 2018; Tasawar & Roszaini, 2017; Kurfi et al., 2017; Murwaningsari & Ardy, 2018; Isanzu, 2016; Gogan et al., 2016; Ozkan et al., 2017; Sardo & Serrasqueiro, 2017), but contradicts other reported evidence (e.g., Oyedokun & Saidu, 2018; Vladimir et al., 2016; Nuryaman, 2015). An insignificant relationship is observed between SIZE and ROA (except for the manufacturing sector), indicating that smaller firms have an edge over larger firms in deploying their IC to generate profits. As for LEV, this has a significant negative effect on the ROA for the whole sample and for the manufacturing sector, but an insignificant effect for the remaining sectors.

Table 7 presents evidence on the VAIC components. RC and HC are significant at the 1% level in all the sectors, whereas results are mixed for SC, which is insignificant for the whole sample and the services sector, but, at the 1% level, is

Table 6. Regression results for the impact of IC efficiency on ROA.

	ROA			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−0.088 (0.432)	−0.204*** (0.002)	−0.008 (0.917)	0.118 (0.433)
VAIC	0.013*** (0.000)	0.011*** (0.000)	0.017*** (0.000)	0.011*** (0.000)
SIZE	0.010 (0.490)	0.030*** (0.002)	−0.003 (0.714)	−0.022 (0.271)
LEV	−0.075*** (0.004)	−0.125*** (0.000)	−0.027 (0.237)	0.016 (0.896)
Poolability	$F(9, 103)$ **2.21	χ^2 (9) **17.20	$F(9, 50)$ *1.87	χ^2 (9) 2.84
Year effect	*Yes*	*Yes*	*Yes*	*No*
Breusch and Pagan LM test	x^2 (1) = 1157.66*** GLS applied	x^2 (1) = 309.78*** GLS applied	x^2 (1) = 650.53*** GLS applied	x^2 (1) = 35.52*** GLS applied
Hausman Test	x^2 (12) = 32.23*** FE	x^2 (12) = 9.32 RE	x^2 (12) = 1.46*** FE	x^2 (12) = 1.04 RE
R-squared	0.3714	0.3963	0.3656	0.4029
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	14.09***	303.15***	10.11***	104.18***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

Table 7. Regression results for the impact of RC, SC and HC on ROA.

	ROA			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−0.352*** (0.000)	−0.229*** (0.000)	−0.313*** (0.000)	−0.219 (0.445)
RC	0.551*** (0.000)	0.412*** (0.000)	0.641*** (0.000)	0.595*** (0.000)
SC	0.007 (0.101)	0.023*** (0.005)	0.007 (307)	−0.018** (0.030)
HC	0.007*** (0.000)	0.008*** (0.000)	0.006*** (0.008)	0.005*** (0.006)
SIZE	0.039*** (0.001)	0.025*** (0.003)	0.032*** (0.002)	0.025 (0.515)
LEV	−0.046*** (0.016)	−0.062*** (0.010)	−0.046*** (0.006)	0.139 (0.190)
Poolability	F (9, 103) 1.17	χ^2 (9) *15.38	F (9, 50)1.49	F (9, 10) ***22.67
Year effect	No	Yes	No	Yes
Breusch and Pagan LM test	x^2 (1) 806.87*** GLS applied	x^2 (1) = 166.48*** GLS applied	x^2 (1) = 459.49*** GLS applied	x^2 (1) = 82.32*** GLS applied
Hausman Test	x^2 (14) 60.03*** FE	x^2 (14) = 20.05 RE	x^2 (14) = 148.55*** FE	x^2 (5) = 11.54** FE
R-squared	0.6998	0.7245	0.7003	0.8699
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	47.65***	671.56***	63.92***	841.83***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

significantly positive for the manufacturing sector and negatively significant for the real estate sector. Hypothesis H2 is therefore supported, given the significant relationship for RC, SC and HC efficiency with ROA for the whole sample and its components, with the exception of SC for the whole sample and the services sector. This evidence is corroborated by other studies (e.g., Xu et al., 2022; Nadeem et al., 2018; Xu & Wang, 2018; Nuraini et al., 2018; Radic, 2018; Murwaningsari & Ardi, 2018; Isanzu, 2016; Gogan et al., 2016; Ozkan et al., 2017; Kozera, 2015; Sharif & Elsayed, 2015; Sumedrea, 2013; Ahangar, 2011; Chen et al., 2005; Saleh, 2015; Fathi et al., 2013), but is also contradicted (e.g., Oyedokun & Saidu, 2018; Vladimir et al., 2016; Hashim et al., 2015; Nuryaman, 2015). There is also a significant positive relationship between SIZE and ROA and a significant negative effect of LEV on ROA (in both cases, except for the real estate sector).

Table 8 shows that the impact of IC on ROE is significantly positive at the 1% level, thereby supporting hypothesis H1 on the importance of IC for corporate performance as reflected in the ROE. Previous research both confirms this evidence (e.g., Xu et al., 2022; Shubita, 2022; Tarigan et al., 2019; Nadeem et al., 2018; Nuraini et al., 2018; Tasawar & Roszaini, 2017; Murwaningsari & Ardy, 2018; Isanzu, 2016; Gogan et al., 2016; Ozkan et al., 2017; William et al., 2017) and contradicts it (e.g., Al Momani & Nour, 2019; Vladimir et al., 2016; Radic, 2018).

Table 8. Regression results for the impact of IC efficiency on ROE.

	ROE			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−0.364*** (0.003)	−0.687*** (0.001)	−0.427*** (0.000)	0.128 (0.612)
VAIC	0.020*** (0.000)	0.016*** (0.000)	0.025*** (0.000)	0.016*** (0.000)
SIZE	0.046*** (0.006)	0.098*** (0.002)	0.049*** (0.000)	−0.026 (0.424)
LEV	−0.134*** (0.002)	−0.287*** (0.000)	−0.006 (0.859)	0.071 (0.726)
Poolability	F (9,103) *1.88	F (9, 41) *1.97	F (9, 50) **2.35	χ^2 (9) 2.5
Year effect	Yes	Yes	Yes	No
Breusch and Pagan LM test	x^2 (1) 922.42*** GLS applied	x^2 (1) 213.61*** GLS applied	x^2 (1) 530.98*** GLS applied	x^2 (1) = 27.35*** GLS applied
Hausman Test	x^2 (12) 47.03*** FE	x^2 (12) 20.71** FE	x^2 (12) = 47.28*** FE	x^2 (12) = 0.46 RE
R-squared	0.3228	0.4112	0.2959	0.3473
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	10.97***	20.27***	6.36***	74.52***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

We find a significant positive relationship between SIZE and ROE (except for the real estate sector), indicating that larger firms have an edge in deploying their IC to add value for shareholders. LEV has a significant negative effect on the ROE only for the whole sample and the manufacturing sector.

Table 9 indicates that all IC components have a significantly positive impact on ROE, with the exception of SC for the real estate sector. This result confirms that the IC components contribute greatly to ROE, and therefore to profitability for shareholders, and also underlines the important role of HC and organizational capital in enhancing ROE. Those results support hypothesis H2, except for SC in the real estate sector, where high investment in organizational infrastructure leads to reduced ROE, and shareholder discontent regarding the level of expenditure on internal infrastructure. The regression results also point to a significant positive relationship between SIZE and ROE (except for the real estate sector), a significant negative effect of LEV on ROE in the whole sample and in the manufacturing sector, and an insignificant effect for the other two sectors; this would suggest that total indebtedness reduces investment in IC, ultimately negatively affecting shareholder payouts.

Tables 10-13 report regression results for the impact of IC efficiency and of

Table 9. Regression results for the impact of RC, SC and HC on ROE.

	ROE			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−0.794*** (0.000)	−0.913*** (0.000)	−0.885*** (0.000)	−0.442 (0.377)
RC	0.883*** (0.000)	0.772*** (0.000)	0.955*** (0.000)	0.992*** (0.000)
SC	0.013* (0.087)	0.026** (0.049)	0.018* (0.096)	−0.030*** (0.021)
HC	0.009*** (0.000)	0.011*** (0.002)	0.009* (0.064)	0.005** (0.042)
SIZE	0.093*** (0.000)	0.113*** (0.001)	0.101** (0.000)	0.053 (0.435)
LEV	−0.087*** (0.001)	−0.162*** (0.010)	−0.033 (0.174)	0.231 (0.107)
Poolability	F (9, 103) 1.02	F (9, 41) 0.44	F (9, 50)** 2.80	F (9, 10)*** 13.40
Year effect	No	No	Yes	Yes
Breusch and Pagan LM test	x^2 (1) = 831.03*** GLS applied	x^2 (1) = 102.67*** GLS applied	x^2 (1) 454.86*** GLS applied	x^2 (1) = 59.13*** GLS applied
Hausman Test	x^2 (14) = 87.11*** FE	x^2 (14) 38.86*** FE	x^2 (14) 80.83*** FE	x^2 (5) = 18.01 FE
R-squared	0.6203	0.6810	0.5580	0.7851
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	43.12***	42.56***	37.09***	189.03***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

Table 10. Regression results for the impact of IC efficiency on EPS.

	EPS			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−0.590*** (0.009)	−0.802*** (0.001)	−0.843*** (0.002)	0.385* (0.066)
VAIC	0.021*** (0.000)	0.018*** (0.000)	0.029*** (0.000)	0.011*** (0.000)
SIZE	0.087*** (0.005)	0.124*** (0.000)	0.114*** (0.001)	−0.075** (0.041)
LEV	−0.193*** (0.001)	−0.290*** (0.000)	−0.067 (0.468)	−0.500*** (0.012)
Poolability	F (9,103)1.00	χ^2 (9)14.00	F (9, 50) 0.79	χ^2 (9)5.99
Year effect	No	No	No	*No*
Breusch and Pagan LM test	x^2 (1) 1323.58*** GLS applied	x^2 (1) = 342.77*** GLS applied	x^2 (1) 777.28*** GLS applied	x^2 (1) = 25.77*** GLS applied
Hausman Test	x^2 (12) = 19.02* FE	x^2 (12) = 1.82 RE	x^2 (12) = 20.04* FE	x^2 (12) = 0.85 RE
R-squared	0.1763	0.4013	0.1794	0.4789
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	9.08***	154.21***	3.91***	65.00***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

Table 11. Regression results for the impact of RC, SC and HC on EPS.

	EPS			
	Full sample	**Manufacturing**	**Services**	**Real estate**
Intercept	−1.052*** (0.000)	−1.007** (0.024)	−1.465*** (0.000)	0.237 (0.178)
RC	0.932*** (0.000)	0.718*** (0.004)	1.180*** (0.000)	0.247 (0.102)
SC	0.029** (0.026)	0.036 (0.115)	0.059*** (0.006)	−0.034*** (0.009)
HC	0.009*** (0.006)	0.013*** (0.004)	0.004 (0.619)	0.011*** (0.000)
SIZE	0.136*** (0.000)	0.136** (0.030)	0.183*** (0.000)	−0.034 (0.134)
LEV	−0.145*** (0.009)	−0.206** (0.036)	−0.094 (0.292)	−0.325** (0.033)
Poolability	F (9, 103) 0.77	F (9, 41) 1.06	F (9, 50) 1.19	χ^2 (9)*** 30.54
Year effect	No	No	No	Yes
Breusch and Pagan LM test	x^2 (1) = 760.85*** GLS applied	x^2 (1) = 55.35*** GLS applied	x^2 (1) = 586.30*** GLS applied	x^2 (1) = 24.41*** GLS applied
Hausman Test	x^2 (14) = 22.29* FE	x^2 (14) 25.25** FE	x^2 (14) = 26.96*** FE	x^2 (5) = 7.23 RE
R-squared	0.3300	0.3528	0.3355	0.6286
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	17.35***	26.59***	8.07***	786.99***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

IC components on EPS and NPM.

Table 10 reports empirical estimates that show that VAIC is significantly and positively associated with EPS, supporting hypothesis H1 for both the whole sample and the three sectors. This evidence is consistent previous empirical research (see Suhendra, 2015; Felizardo et al., 2017; Saleh, 2015). We also find a significant positive relationship between SIZE and EPS in the whole sample and its components (except for the real estate sector), while LEV has a significantly negative effect on profitability for the whole sample and the manufacturing and real estate sectors, and a non-significant negative effect for the services sector.

Table 11 shows that the IC components are significantly positive for the whole sample, and have a mixed effect for the individual sectors. Thus, at the 1% level, RC is significant for all sectors except real estate, SC is significant for the services and real estate sectors and HC is significant for the manufacturing and real estate sectors, but insignificant for the services sector. Hence, hypothesis H2 in relation to EPS is generally supported by our data, with some few exceptions depending on the component and the sector.

Table 12 reports a significantly positive effect at the 1% level for the whole sample and also for the manufacturing, services and real estate sectors. This evidence in support of hypothesis H1 implies that IC efficiency improves corporate profitability, i.e., across all sectors, greater IC investment leads to greater profitability.

Table 12. Regression results for the impact of IC efficiency on NPM.

	NPM			
	Full sample	Manufacturing	Services	Real estate
Intercept	−1.071*** (0.000)	−0.811*** (0.001)	−1.324*** (0.002)	0.397 (0.766)
VAIC	0.065*** (0.000)	0.042*** (0.000)	0.091*** (0.000)	0.069*** (0.000)
SIZE	0.119*** (0.002)	0.102*** (0.005)	0.140*** (0.005)	−0.114 (0.513)
LEV	−0.330*** (0.000)	−0.338*** (0.005)	−0.325*** (0.004)	−0.221 (0.835)
Poolability	F (9,103) *1.77	χ^2 (9) **20.51	F (9, 50) 1.31	χ^2 (8) *** 8080
Year effect	yes	Yes	No	yes
Breusch and Pagan LM test	x^2 (1) 730.14*** GLS applied	x^2 (1) = 246.82*** GLS applied	x^2 (1) 218.06*** GLS applied	x^2 (1) = 34.87*** GLS applied
Hausman Test	x^2 (12) 39.41*** FE	x^2 (12) 3.91 RE	x^2 (12) 73.24*** FE	x^2 (12) 2.6 RE
R-squared	0.3083	0.3416	0.3408	0.4300
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	10.21***	85.76***	4.44***	59.81***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

This result is consistent with empirical evidence reported by Yilmaz and Acar (2018), but contradicts evidence reported by Nuryaman (2015).

Table 13 shows that the IC components have different impacts on NPM. RC is significantly positive at the 1% level for all sectors and at the 10% level for the real estate sector; in contrast, SC is significantly negative at the 5% level for the whole sample and for the services and real estate sectors, while HC is significant at the 1% level for the whole sample. This evidence implies that RC and HC increase profitability, with HC playing a predominant role. Therefore, except for SC in the manufacturing sector, hypothesis H2 supports a significant relationship for RC, SC and HC efficiency with NPM for the whole sample and for each sector. This evidence is consistent with Haris et al. (2019) and Yilmaz and Acar (2018), but contradicts evidence reported by Nuryaman (2015).

5. Conclusions and Policy Implications

This study investigates whether IC and its three components (HC, SC and RC) are related to corporate performance by Jordanian ASE-listed non-financial companies over the period 2009-2018. Our main findings are as follows:

1) The significantly positive association between IC and corporate performance

Table 13. Regression results for the impact of RC, SC and HC on NPM.

	NPM			
	Full sample	Manufacturing	Services	Real estate
Intercept	−1.299*** (0.000)	−.837*** (0.001)	−1.880*** (0.001)	−1.173 (0.230)
RC	1.139*** (0.000)	0.757*** (0.004)	1.878*** (0.000)	1.263* (0.068)
SC	−0.085*** (0.011)	−0.042 (0.211)	−0.101 ** (0.062)	−.255*** (0.000)
HC	0.075*** (0.000)	0.057 *** (0.000)	0.092 *** (0.000)	.077 *** (0.000)
SIZE	0.137*** (0.001)	0.087*** (0.009)	0.166 *** (0.004)	0.111 (0.401)
LEV	−0.204*** (0.012)	−0.173 (0.152)	−0.381*** (0.000)	0.835 (0.270)
Poolability	F (9,103)0.55	χ^2 (9) 15.22	F (9, 50)0.51	χ^2 (9)***70.67
Year effect	No	No	No	Yes
Breusch and Pagan LM test	x^2 (1) 792.64*** GLS applied	x^2 (1) 270.28*** GLS applied	x^2 (1) 302.72*** GLS applied	x^2 (1) = 50.55*** GLS applied
Hausman Test	x^2 (14) 51.96*** FE	x^2 (14) = 3.16 RE	x^2 (14) 208.11*** FE	x^2 (14) = 7.76 RE
R-squared	0.5462	0.5231	0.6119	0.4569
Groups	104	42	51	11
Observations	1040	420	510	110
F-test	14.35***	191.75***	11.90***	111.52***

P-values in parentheses: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. The poolability test shows the time-unit effect on the dependent variable (Vijayamohanan, 2017). F-stat results reflect regression model reliability in prediction as ***, ** and * at the 1%, 5% and 10% significance level. FE, fixed effect; RE, random effect.

supports the fact that IC efficiency has strong potential to become a new source of wealth and sustainable competitive advantage for Jordanian listed companies.

2) Evidence is mixed regarding the impact of individual IC components on corporate performance in different sectors. Results for the whole sample evidence a significant association with all the profitability indicators used (ROA, ROE, EPS and NPM). Unlike Sharabati et al. (2013), we find a significant correlation between HC efficiency and corporate performance.

3) Firm size is significantly and positively associated with corporate performance, except in the real estate sector, indicating that larger firms can take advantage of economies of scale in investing in IC efficiency to improve corporate performance.

4) Corporate indebtedness has a significant negative impact on corporate performance, indicating that debt acts as an impediment for firms to invest in IC, which in turn negatively affects profitability.

Regarding Point 3, possible explanations for the absence of a relationship between corporate performance and size for the real estate sector are as follows: a) although larger firms can raise barriers to newcomers, they have no advantage in using their economies of scale to invest in IC to improve profitability; b) poor asset management efficiency in large firms may act as an impediment to investing in IC. The Jordanian real estate sector may also have particular features, e.g., it may suffer from mismanagement or there may be a high percentage of slack assets that do not add value. Furthermore, the sample maybe does not represent the whole sector. In summary, the fact that the Jordanian real estate sector is struggling to add value merits further investigation.

The empirical evidence reported here has some important implications: a) the ROA and ROE indicators are more strongly correlated with IC efficiency than the EPS and NPM measures; b) IC efficiency is demonstrated to be an important strategic asset for better corporate performance, which in turn improves sustainability and competitiveness; c) the positive association between HC and all the profitability indicators (except for EPS in the services sector) demonstrates that the listed companies successfully motivate and exploit staff potential in leveraging firm revenues and profits; and d) the positive correlation between RC and corporate performance indicates that the listed companies successfully deploy their physical capital in improving IC efficiency. Finally, mixed results are obtained for the impact of SC in the studied sectors; in the real estate sector, SC has a negative or insignificant impact, implying that organizations lack the required resources or/and that somehow mismanage investment in organizational capital.

Policy implications can be summarized as follows:

1) Jordanian companies, to sustain competitive advantage, need to develop strategies aimed at investing more in and leveraging IC and at aligning IC with strategic goals. There is still room for IC efficiency to improve profitability, and in view of the decreasing trend in IC efficiency, Jordanian companies need to award IC high priority.

2) IC is again confirmed as a firm's hidden value that exerts significant impact on the creation of added value, yet this is not reflected in traditional financial statements. It is recommended that IC be legally disclosed for public scrutiny.

3) Organizational systems, reflected in the SC of the listed companies, show deficiencies concerning policies, programs, procedures, corporate culture, databases and other organizational capital that would significantly enhance corporate performance. Greater attention needs to be paid to developing strategies to correct and support internal business procedures.

4) A ranking of firms—especially large corporations—in the management, measurement and reporting of IC would be useful for both regulators and investors.

5) More emphasis could be placed on human resource policies due to the impact in creating added value in corporations, including investment in continuous training for human resource managers.

6) Government intervention is required through tax incentives related to intangibles which would boost the drive towards a knowledge-based economy.

7) The Jordanian real estate sector requires corrective actions to tackle mismanagement and poor value-adding capacity.

Finally, some limitations on the evidence reported in this study are as follows: a) although this study used year-firm fixed and random effects, we did not fully control for other unobservable or omitted corporate or market variables that might influence the results (the endogeneity issue); b) the scope of the study is limited to ten years (2009-2018) and to just three economic sectors; and c) the choice of the VAIC model (see Stahle et al. (2011) for VAIC limitations) to measure IC efficiency might impact results and inferences, as different measurement methods have different properties. However, further research is required to investigate and explain potential reverse causality i.e., that good financial performance leads to an increase in IC efficiency.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix C

This section describes the diagnostic checks for the full study sample and its three sub-samples.

The Shapiro Wilk test provides evidence that the data is not normally distributed and, as a result, evidence of the Spearman's correlation is presented to show dependence among variables (Tables C1-C8). However, no evidence is

Table C1. Spearman's correlation matrix for the whole sample.

	ROA	ROE	EPS	REVGR	NPM
VAIC	0.630***	0.601***	0.535***	0.203***	0.639***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RC	0.689***	0.661***	0.608***	0.213***	0.483***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SC	0.285***	0.266***	0.229***	0.067***	0.303***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HC	0.675***	0.649***	0.583***	0.224***	0.708***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	−.118***	0.003	−0.025	0.041	−0.259***
	(0.000)	(0.930)	(0.428)	(0.192)	(0.000)
SIZE	0.124***	0.213***	0.234***	0.094**	0.113***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)

Note: ***, ** and * represents statistical significance at 1%, 5% and 10% levels, respectively.

Table C2. Spearman Correlation matrix for Normality, Multicollinearity test/whole sample.

	VAIC	RC	SC	HC	LEV	SIZE	VIF
VAIC	1.000						1.11
RC	0.215***	1.000					1.01
	(0.000)						
SC	0.693***	−0.172***	1.000				1.04
	(0.000)	(0.000)					
HC	**0.920*** **	0.273***	0.547***	1.000			1.13
	(0.000)	(0.000)	(0.000)				
LEV	−0.135***	0.169***	−0.188***	−0.136***	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)			
SIZE	0.263***	0.033	0.163***	0.273***	0.144***	1.000	
	(0.000)	(0.286)	(0.000)	(0.000)	(0.000)		
Shapiro-Wilk	0.000	0.000	0.000	0.000	0.000	0.000	

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively. Spearman correlation is used due to non-normality of data distribution.

Table C3. Spearman's correlation matrix for the manufacturing sector.

	ROA	ROE	EPS	REVGR	NPM
VAIC	0.736***	0.704***	0.608***	0.244***	0.741***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RC	0.677***	0.689***	0.620***	0.215***	0.574***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SC	0.431***	0.403***	0.335***	0.151**	0.429***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
HC	−0.801***	0.772***	0.678***	0.280***	0.827***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	−0.393***	−0.311***	−0.346***	−0.045	−0.421***
	(0.000)	(0.000)	(0.000)	(0.361)	(0.000)
SIZE	0.147***	0.147***	0.212***	0.132**	0.193***
	(0.003)	(0.003)	(0.000)	(0.007)	(0.000)

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

Table C4. Spearman's correlation matrix for Normality and Multicollinearity test/ manufacturing sector.

	VAIC	RC	SC	HC	LEV	SIZE	VIF
VAIC	1.000						1.14
RC	0.299***	1.000					1.05
	(0.000)						
SC	0.688***	−0.063	1.000				1.04
	(0.000)	(0.196)					
HC	**0.900*** **	0.384***	0.510***	1.000			1.18
	(0.000)	(0.000)	(0.000)				
LEV	−0.355***	−0.174***	−0.276***	−0.396***	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)			
SIZE	0.243***	– 0.008	0.163***	0.254***	0.109**	1.000	
	(0.000)	(0.869)	(0.001)	(0.000)	(0.026)		
Shapiro-Wilk	0.000	0.000	0.000	0.000	0.000	0.000	

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively. Spearman correlation is used due to non-normality of data distribution.

found of high correlation between explanatory variables except in the case of VAIC and HC, with Spearman's correlation values of 0.920, 0.900, 0.944 and 0.892 for the whole sample and manufacturing, services and real estate sectors,

Table C5. Spearman's correlation matrix for the services sector.

	ROA	ROE	EPS	REVGR	NPM
VAIC	0.499***	0.478***	0.445***	0.153**	0.514***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
RC	0.695***	0.614***	0.569***	0.189***	0.404***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SC	0.209***	0.201***	0.202***	0.030	0.251***
	(0.000)	(0.000)	(0.000)	(0.504)	(0.000)
HC	0.510***	0.497***	0.463**	0.172***	0.559***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	0.023	0.151	0.110***	0.086	−0.295***
	(0.603)	(0.001)	(0.013)	(0.054)	(0.000)
SIZE	−0.086*	0.275***	0.282***	0.093*	−0.029
	(0.053)	(0.000)	(0.000)	(0.039)	(0.518)

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

Table C6. Spearman's correlation matrix for Normality and Multicollinearity test/ services sector.

	VAIC	RC	SC	HC	LEV	SIZE	VIF
VAIC	1.000						1.12
RC	0.087***	1.000					1.01
	(0.050)						
SC	0.785***	−0.224***	1.000				1.03
	(0.000)	(0.000)					
HC	0.944***	0.100**	0.688***	1.000			1.17
	(0.000)	(0.023)	(0.000)				
LEV	−0.028	0.204***	−0.057	0.037	1.000		
	(0.530)	(0.000)	(0.201)	(0.410)			
SIZE	0.271***	0.033	0.161***	0.210***	0.352***	1.000	
	(0.000)	(0.455)	(0.000)	(0.000)	(0.00)		
Shapiro-Wilk	0.000	0.000	0.000	0.000	0.000	0.000	

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively. Spearman correlation is used due to non-normality of data distribution.

respectively. However, this is not a problem as they are not included in the same equation. Results for multicollinearity analysis using the variance inflation factor (VIF) show no multicollinearity among variables. A VIF value of less than 2.5 reflects the robustness of the study model in explaining the effect on the dependent

Table C7. Spearman's correlation matrix for the real estate sector.

	ROA	ROE	EPS	REVGR	NPM	VIF
VAIC	0.750***	0.755***	0.708***	0.218**	0.725***	1.11
	(0.000)	(0.000)	(0.000)	(0.022)	(0.000)	
RC	0.854***	0.856***	0.764***	0.256**	0.742***	1.01
	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	
SC	0.001	0.017***	−0.013	−0.016	0.015	1.04
	(0.992)	(0.000)	(0.890)	(0.868)	(0.879)	
HC	0.851***	0.854***	0.808***	0.220**	0.841***	1. 09
	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)	
LEV	0.017	0.011**	−0.050	0.082	0.050	
	(0.861)	(0.911)	(0.601)	(0.395)	(0.605)	
SIZE	0.025	0.033	0.053	−0.058	−0.027**	
	(0.798)	(0.732)	(0.584)	(0.546)	(0.000)	

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

Table C8. Spearman's correlation matrix for Normality and Multicollinearity test/real estate sector.

	VAIC	RC	SC	HC	LEV	SIZE	VIF
VAIC	1.000						1.11
RC	0.676***	1.000					1.01
	(0.00)						
SC	0.351***	−0.102	1.000				1.04
	(0.000)	(0.290)					
HC	0.892***	.793***	0.104***	1.000			1.09
	(0.000)	(0.000)	(0.281)				
LEV	−0.199**	0.124	−0.181*	−0.174*	1.000		
	(0.037)	(0.196)	(0.058)	(0.070)			
SIZE	0.231**	−0.088	0.234**	0.197**	−.959***	1.000	
	(0.015)	(0.360)	(0.014)	(0.039)	(0.000)		
Shapiro-Wilk	0.000	0.000	0.040	0.000	0.000	0.002	

Notes: ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively. Spearman correlation is used due to non-normality of data distribution.

variable.

In panel data with time series based on more than ten years, there is always the possibility of non-stationarity shocks that affect the long-term equilibrium of the series (Oppong & Pattanayak, 2019). Evidence from a Levin-Lin-Chu panel unit root test to check for data stationarity, reported in **Table C9**, indicates that all variables are stationary in all sectors except the SC variable in the real estate sector. However, this is not a problem for this study based on only ten years because, in panel series, there are only effects when the period is more than ten years.

Finally, the Wooldridge test for autocorrelation is run, as some models suffer from autocorrelation in the whole sample and its sub-samples. Moreover, the Breusch-Pagan LM test is applied to examine the heteroskedasticity problem, with some of the models having this problem. To ensure valid statistical inference given problems of heteroskedasticity and autocorrelation in the models, cluster-robust standard errors are estimated, as this estimator produces heteroskedasticity-consistent standard errors that are robust and so appropriate for balanced panel data. Tables C10-C13 report results for those tests before treatment.

Table C9. Panel unit root test results for variables.

	Whole sample		Manufacturing		Services		Real estate	
	Adjusted t-stat	**P-value**	**Adjusted t-stat**	**P-value**	**Adjusted t-stat**	**P-value**	**Adjusted t-stat**	**P-value**
ROA	−15.416	0.000***	−11.306	0.000***	−9.825	0.000***	−10.699	0.000***
ROE	−16.249	0.000***	−7.285	0.000***	−16.172	0.000***	−4.158	0.000***
EPS	−15.413	0.000***	−5.863	0.000***	−13.566	0.000***	−52.149	0.000***
REVGR	−16.483	0.000***	−7.516	0.000***	−10.504	0.000***	−7.057	0.000***
NPM	−52.847	0.000***	−11.066	0.000***	−13.444	0.000***	−5.552	0.000***
VAIC	−11.596	0.000***	−9.410	0.000***	−7.570	0.000***	−1.451	0.073*
RC	−9.739	0.000***	−6.364	0.000***	−5.486	0.000***	−5.805	0.000***
SC	−11.690	0.000***	−8.700	0.000***	−10.360	0.000***	0.815	**0.792**
HC	−13.355	0.000***	−10.258	0.000***	−8.565	0.000***	−2.613	0.004***
LEV	−11.728	0.000***	−4.177	0.000***	−11.023	0.000***	−5.681	0.000***
SIZE	−28.193	0.000***	−9.831	0.000***	−4.560	0.000***	−36.652	0.000***

Notes: Levin-Lin-Chu panel unit root test including the adjusted t-statistic and P-value. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively. When the P-value is significant in panel unit root testing, this indicates that the variables are stationary.

Table C10. Autocorrelation and heteroskedasticity test for ROA.

		ROA							
		Whole sample		**Manufacturing**		**Services**		**Real estate**	
VAIC	Wooldridge Autocorrelation	$F(1, 103)$ = 7.228	0.084	$F(1, 41)$ = 9.743	0.003	$F(1, 50)$ = 19.545	0.000	$F(1, 10)$ = 0.015	0.904
	Breusch-Pagan	x^2 (1) = 2.94	0.086	x^2 (1) = 2.29	0.1304	x^2 (1) = 2.66	0.103	x^2 (1) = 1.02	0.312
RC SC HC	Wooldridge Autocorrelation	$F(1, 103)$ = 50.00	0.000	$F(1, 41)$ = 22.129	0.000	$F(1, 50)$ = 19.987	0.000	$F(1, 10)$ = 21.331	0.001
	Breusch-Pagan	x^2 (1) = 1.32	0.251	x^2 (1) = 3.64	0.0565	x^2 (1) = 0.52	0.471	x^2 (1) = 0.12	0.732

Table C11. Autocorrelation and heteroskedasticity test for ROE.

		ROE							
		Whole sample		Manufacturing		Services		Real estate	
VAIC	Wooldridge Autocorrelation	$F(1, 103) = 7.228$	0.084	$F(1, 41) = 9.743$	0.003	$F(1, 50) = 19.545$	0.000	$F(1, 10) = 0.015$	0.904
	Breusch-Pagan	$x^2 (1) = 0.09$	0.758	$x^2 (1) = 2.37$	0.124	$x^2 (1) = 0.06$	0.813	$x^2 (1) = 0.80$	0.371
RC SC HC	Wooldridge test Autocorrelation	$F(1, 103) = 50.00$	0.000	$F(1, 41) = 22.129$	0.000	$F(1, 50) = 19.987$	0.000	$F(1, 10) = 21.331$	0.001
	Breusch-Pagan	$x^2 (1) = 6.44$	0.011	$x^2 (1) = 1.52$	0.2176	$x^2 (1) = 0.09$	0.769	$x^2 (1) = 10.23$	0.001

Table C12. Autocorrelation and heteroskedasticity test for EPS.

		EPS							
		Whole sample		Manufacture		Service		Real state	
VAIC	Wooldridge Autocorrelation	$F(1, 103) = 7.228$	0.084	$F(1, 41) = 9.743$	0.003	$F(1, 50) = 19.545$	0.000	$F(1, 10) = 0.015$	0.904
	Breusch-Pagan	$x^2 (1) = 82.90$	0.000	$x^2 (1)= 22.61$	0.000	$x^2 (1) = 15.49$	0.000	$x^2 (1) = 2.66$	0.103
RC SC HC	Wooldridge Autocorrelation	$F(1, 103) = 50.00$	0.000	$F(1, 41) = 22.129$	0.000	$F(1, 50) = 19.987$	0.000	$F(1, 10) = 21.331$	0.001
	Breusch-Pagan	$x^2 (1) = 69.95$	0.000	$x^2 (1) = 5.62$	0.018	$x^2 (1) = 39.52$	0.000	$x^2 (1) = 2.56$	0.0.111

Table C13. Autocorrelation and heteroskedasticity test for NPM.

		NPM							
		Whole sample		Manufacturing		Services		Real estate	
VAIC	Wooldridge Autocorrelation	$F(1, 103) = 7.228$	0.084	$F(1, 41) = 9.743$	0.003	$F(1, 50) = 19.545$	0.000	$F(1, 10) = 0.015$	0.904
	Breusch-Pagan	$x^2 (1) = 0.09$	0.769	$x^2 (1) = = 1.21$	0.271	$x^2 (1) = 14.5$	0.000	$x^2 (1) = 1.06$	0.303
RC SC HC	Wooldridge Autocorrelation	$F(1, 103) = 50.00$	0.000	$F(1, 41) = 22.129$	0.000	$F(1, 50) = 19.987$	0.000	$F(1, 10) = 21.331$	0.001
	Breusch-Pagan	$x^2 (1)61.67$	0.000	$x^2 (1) = 8.62$	0.003	$x^2 (1) = 62.25$	0.000	$x^2 (1) = 0.24$	0.627

Table C14. Description and measurement of variables.

Variable	Label	Definition and measurement
Value Added (VA)	VA = Output-Input VA = IN + HC + D + A + T + I IN = net income after tax HC = staff costs D = depreciation A = amortization T = taxes I = interests	Output refers to net revenues generated Input refers to expenses incurred excluding staff benefits.
Relational Capital (RC)	Total net tangible assets	Capital that enables HC and SC to create added value (Nuryaman, 2015). Refers to capital employed equal to the book value of net total assets.
Human Capital (HC)	All costs invested in staff	Knowledge possessed by staff. Refers to wages, salaries, bonuses, social security expenses, insurance, end-of-service benefits and any other renumeration.
Structural Capital (SC)	SC = VA-HC	Knowledge possessed by the firm. Excludes staff costs from VA to determine the value added by structural elements
RC Efficiency (RCE)	RCE = VA/CE	RCE coefficient describing the value-value-created by each dollar spent on capital employed
HC Efficiency (HCE)	HCEVA/HC	HCE coefficient describing the value added generated by each dollar spent on HC
SC Efficiency (SC) Intellectual Capital Efficiency (IC) Value-added Intellectual Coefficient VAIC	SCE = SC/VA ICE = RCE + HCE + SCE VAIC = RCE + HCE + SCE	SCE coefficient describing the value added generated by SC. ICE coefficient describing the value created by intangible asset efficiency. Overall value-added efficiency generated by intellectual coefficient proxied by IC. A greater VAIC represents greater efficiency in IC employed, and thus greater value generated to the firm (Yang, 2019).
Firm Size	SIZE = (Log TA)	Firm size, to control for the effect of large and small firms on the regression model. Calculated by taking the logarithm for total net assets (TA).
Firm Leverage	LEV = (TD/TA)	Company indebtedness, to control for the effect of debt on the regression model. Calculated by dividing total debts (TD) by total net assets.
Return on Assets	ROA = Net Income/Total assets	
Return on Equity	ROE = Net Income/Total Net Equity	
Earnings Per Share	$EPS = \frac{\text{Net Income}}{\text{Total outstanding common shares}}$	
Net Profit Margin	$NPM = \frac{\text{Net Income}}{\text{Total Revenues}}$	