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Intellectual Capital and Firm Performance across Pakistani Industries

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Abstract

This study sheds light on the differences in intellectual capital (IC) efficiencies across non-financial sectors in Pakistan and determines the relationship between IC and firm performance. The study used sample of 155 non-financial firms from the manufacturing and service industries of Pakistan for the period 2009-2018. This study contributes to IC research by applying modified value-added intellectual capital (MVAIC) model with relationship to firm performance (return on assets and Tobin's Q) of Pakistani non-financial firms which was overlooked by the previous researchers. In addition, to deal with endogeneity, the dynamic panel generalized methods of moments regression is applied to test the relationship between IC and performance. Findings provide evidence that different sectors in non-financial industries manage IC components differently. IC increases both market-based performance and accounting-based performance of Pakistani firms. Among all IC components, human capital efficiency is an important determinant of firm performance. The implications can provide help managers and investors to understand the IC to increase the firm performance.

Keywords: Intellectual capital, MVAIC, Firm performance, Accounting-based performance

JEL classifications: G30; G32

1. Introduction

Intellectual Capital (IC) is a valuable resource that provides competitive advantage and contributes in the firm performance (Chen *et al.*, 2005). Firms in more than 60% of the advanced economies create value through IC resources (Vargas-Hernández & Noruzi, 2010). However, in developing countries, the concept and application of IC are still at an early stage (Khalique *et al.*, 2013). All of these attributes of strategic resources are also described in the IC literature. IC is an intangible strategic resource and directly related with high firm performance (Riahi-Belkaoui, 2003). This is consistent with the resource-based view where it suggests that efficient management of strategic resources like intangible assets enables firms to achieve competitive advantage and high performance (Hsu & Wang, 2012). Either tangible or intangible, strategic resources are more valuable, unreplaceable, untransferable, inimitable therefore ensure the competitiveness and high-level performance.

Effective management of IC mitigates the gap between firm's book value and market value thus has become a key factor to create firm value (Kamukama *et al.*, 2010) however, the value drivers of IC vary across industries (Liang *et al.*, 2011). The literature lacks evidence for evaluation of IC performance across non-financial industries. Among a few studies, Singh and Narwal (2015) reported the difference for IC efficiencies between Indian manufacturing, service, and technology industries. In Pakistan, IC efficiencies are determined for financial sectors using VAIC (Ahmad & Ahmed, 2016). This fact makes non-financial industries appropriate and attractive for IC research.

Taking into account the significance and necessity of IC valuation for non-financial industries, this research is beneficial through the valuation and comparison of IC components in all non-financial sectors with the motive of providing them simple method for understanding and evaluating their performance. Therefore, this study contributes to the existing literature by conducting a comparative analysis of IC performance of non-financial sectors and addresses two research issues: i) Do non-financial industries invest in IC components differently? ii) Does IC (measured by MVAIC) and its components influence both firm's market performance and financial performance?

The remaining sections of this study are categorized as follows. In section 2, literature review, IC measurement, and hypotheses development are discussed. Section 3 presents the research methodology and section 4 discusses the empirical results. Finally, section 5 concludes and provides implications of the study.

2. Literature Review

In the firms' success, the intellectual capital (IC) role is no less important than financial resources. Studies have shown that businesses perform sustainably when they highly invest in intellectual capital. IC increases the firms' market value and efficiency in the long term (Yalama, 2013). Firms can move the economies from the tangible assets-based economy towards an intangible assets-based economy (Fathi *et al.*, 2013). Many scholars are in the consensus that there is no universally acceptable definition of IC (El-Tawy & Tollington, 2012; Engström *et al.*, 2003; Gerpott *et al.*, 2008).

IC scholars and practitioners deeply explored the IC components. Generally, IC is a mix of human capital, structural capital, and relational capital. Human capital is the body of knowledge owned by the organization and lives in the minds of employees (McGregor *et al.*, 2004). In industrialized emerging economies, the value-generating competencies of a workforce are a key resource for commercial success (Morris, 2015). Khalique *et al.* (2013) argued that firms will face big challenges to find efficient human capital that will create structural capital and relational capital. Human capital efficiency is often found positively associated with firm performance (Lu *et al.*, 2021; Sardo & Serrasqueiro, 2017; Tran & Vo, 2020).

Meanwhile, structural capital is defined as the value of knowledge that is left in firm after the employees leave (Roos *et al.*, 1997; Wu & Chou, 2007). It involves all the knowledge stored in the firm infrastructure such as patents, formulas, trademarks, organization procedures, reputation, and research and development (Bontis, 2001; Denicolai *et al.*, 2015; Zéghal & Maaloul, 2010). Relational capital includes the knowledge rooted in the relationships an organization develops with suppliers, customers, competitors, government bodies, or trade associations (Bontis, 1999; Kweh *et al.*, 2014; Yu *et al.*, 2015). Relational capital is also referred as customer capital (Nazari & Herremans, 2007).

Recognition of IC in bringing competitiveness to achieve high firm performance raises the need to manage it effectively. IC measurement has remained a difficult task because of its intangible nature (Andrikopoulos, 2005; Berzkalne & Zelgalve, 2014; Kim *et al.*, 2009; Maditinos *et al.*, 2011; Nazari & Herremans, 2007). The traditional accounting-based IC measurement models focused on physical and financial assets which neglect several IC assets (Zéghal & Maaloul, 2010). Traditional accounting-based IC measurement methods are; Economic Value Added (Stewart, 1991), Skandia Value Scheme (Edvinsson & Malone, 1997), Calculated Intangible Value (Luthy, 1998), Intangible Asset Monitor Approach (Sveiby, 1997). Pulic (1998) introduced value-added intellectual capital (VAIC^{TM}) model to overcome the problems faced by traditional accounting-based methods. VAIC^{TM} is capable to assess such efficiency in terms of the resources' ability to create firm value. According to Pulic (1998), there are two important aspects in the VAIC^{TM} model comparative to other models. First, it is an efficient system that monitors the employees' activities towards value creation. Second, it can be applied to unlisted firms which are lack of creating market-based value through IC. Pulic (2000) argued that components of IC including human capital, structural capital and capital employed (or physical capital) generate firms' efficiency and market value. Although Balanced Scorecard Method was also introduced by Kaplan and Norton (2005) but researchers widely accepted Pulic's VAIC^{TM}.

Chan (2009) added that VAIC^{TM} model treats the employees or human capital as significant sources of IC which is consistent with all major IC definitions. Meanwhile, Cabrita (2009) and Sydler *et al.* (2014) stressed that it is worthwhile to examine each component of IC, since firms can better comprehend that systematically how distinct firm's elements interact and combine in order to create wealth. Overall, Pulic's VAIC^{TM} method is simple and straightforward to determine the IC value. It allows the stakeholders to evaluate and examine the efficiency of resources exclusive of the industry standards application (Laing *et al.*, 2010;

Tan *et al.*, 2015).

The derivation of original model developed by Pulic (1998) initiate with an ability of firm to create value-added (VA). Generally, VA is the difference between the revenue and expenses, and it can be represented as;

$$VA = OUT - IN \quad (1)$$

Where, OUT (output) represents the total revenue generated from the sale of products and services. IN (input) is the sum of employee cost, depreciation, and amortization. Notably, one of the key aspects in Pulic's method is that it treats human as value creators. Thus, in this model, labor expenses (employee wages) are counted as an investment not as a cost. The result of VA shows the ability of a firm to create value which is required for the investment in resources such as financial assets, salaries, interests, dividends to investors, and taxes to the state. The more efficient human capital, structural capital, and capital employed result in higher VA. Therefore, all these resources are named as human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE) (Pulic, 2000, 2004). HCE is derived by dividing VA to HC where HC involves wages including total salaries or benefits given to employees.

$$HCE = \frac{VA}{HC} \quad (2)$$

The second component SCE is derived by dividing the structural capital with value-added, where the structural capital (SC) is the result of VA minus HC of a firm.

$$SCE = \frac{SC}{VA} \quad (3)$$

The sum of both HCE and SCE is known as intellectual capital efficiency (ICE).

$$ICE = HCE + SCE \quad (4)$$

According to Pulic, human capital and structural capital cannot perform without the financial or physical capital therefore capital employed efficiency (CEE) is added in ICE. Capital employed efficiency is obtained by dividing value-added with capital employed, where, capital employed (CE) is the net book value of assets. CEE shows how much new value has been created by investing in the business (Pulic, 2000). As one of the components of VAIC™, CEE served as a pointer to value-added efficiency of capital employed (Firer & Williams, 2003). Therefore, employment of this resource and its information in value creation is necessary (Pulic, 1998, 2008). CEE takes physical and financial capital into account to calculate the efficiency of capital employed (Hejazi *et al.*, 2016; Kamath, 2007).

$$CEE = \frac{VA}{CE} \quad (5)$$

Overall VAIC™ is the aggregate of HCE, SCE and CEE. The complete deviation of Pulic's VAIC™ is as follows;

$$VAIC^{TM} = ICE + CEE \quad (6)$$

Several studies adopting the original VAIC^{TM} model found mixed results for the relationship between IC and firm performance. For example, Mehri *et al.* (2013) conducted a study on 92 Malaysian listed firms throughout 2006-2010 and found that HCE, SCE, CEE, and VAIC were significantly and positively related with all measures of firm performance (asset turnover, return on assets, return on equity and market-to-book ratio). In India, Singh and Narwal (2015) conducted a study on 300 listed manufacturing firms from 2003 to 2012. Using OLS regression, they found mixed results where HCE was significantly and positively related with ROA only. CEE was significantly and positively related with ROA and MB. SCE was insignificant with ROA and MB. To provide robust results Nadeem *et al.* (2017) conducted dynamic panel investigation on 571 Australian listed firms using generalized methods of moments (GMM). Their results revealed the significant and positive relationship between HCE, SCE, CEE and two proxies of firm performance namely ROA and ROE.

Despite wider acceptability of VAIC^{TM} model, a few authors have also pointed out limitations regarding the VAIC^{TM} application in IC measurement. Stahle *et al.* (2011) criticized the Pulic's VAIC^{TM} by describing theoretical misperceptions and analysing calculation methods. In addition, they tested the hypothesis for correlation of Pulic's VAIC^{TM} with market value to find the inconsistency in results with previous studies. They find that VAIC^{TM} model focuses only on capital investment and firm's labor expense rather than IC. The critical validity problem is the "perfect superimposition" between the calculation of HCE and SCE. Generally, higher HC should lead to higher HCE value while calculations in the VAIC^{TM} model result in lower HC and higher HCE. In calculations of VA, the amortization and depreciation are independent of VA. Calculation of SC (VA-HC) shows that value creation is created by both IC and SC variables which makes challenging to compare the capital-intensive industries or countries with capital poor ones because of differences in their cost. Broadly, according to them, Pulic's VAIC^{TM} is just another measure of operational efficiency and does not measure IC.

Andriessen (2004) also raised similar critiques such as use of labor cost to represent human capital (HC), effect of HC and structural capital (SC) are inverse to each other and value creation may because of the synergy between IC components which is unobservable in the model. In addition, empirical results by Maditinos *et al.* (2011) also raised the criticism on effectiveness of VAIC^{TM} particularly when they found relationship between HCE and performance (ROE). They raised questions regarding VAIC^{TM} reliability: "*Does the VAIC methodology properly describes the business reality (therefore, IC has no impact on market value, financial performance, etc.), or does it need improvements/adjustments in order to better mirror the business landscape?"* Furthermore, they linked their questions/ criticism with the context of previous research. According to them, VAIC^{TM} better fits in developing economies rather than developed economies because it is based on fundamental accounting measures. Therefore, emerging and developing economies provide ideal settings for its implementation. However, such economies are based on tangible assets rather than intangible assets; thus, it all provides a reason for the negative relationship between VAIC^{TM} and performance. Conclusively, this study declared VAIC^{TM} as an inefficient method of IC

measurement like other tools.

Iazzolino and Laise (2013) provided methodological and theoretical critical review on Pulic's VAIC™ model. They stressed that accounting terms used in Pulic's model are re-interpreted relative to the Skandia Value Scheme and not related to the knowledge management. On the other side, in comparison of several IC measurement models Starovic and Marr (2003) conclude that Pulic's VAIC™ may be a combination of ideas to provide practical solution. Thus, Pulic's VAIC™ is not a final tool to measure or manage IC. Likewise, Britto *et al.* (2014) argued that the original VAIC™ model should be modified. Several studies suggested to consider relational capital in original VAIC™ model (Maji & Goswami, 2016; Nazari & Herremans, 2007; Ulum *et al.*, 2014).

Due to the contrasting results of the studies and in line with the criticism on Pulic's VAIC™, researchers suggested to consider the modification in IC measurement to produce more precise and accurate results (Ahmad & Ahmed, 2016; Joshi *et al.*, 2013). Hejazi *et al.* (2016) argued that the combination of human capital, structural capital, and relational capital within the framework of intellectual capital becomes the key resource for value creation. Compared to VAIC™, the MVAIC includes a new variable which is relational capital. Hence, MVAIC consider four factors which are human capital, structural capital, relational capital (Brinker, 1998; Stewart, 1997) and capital employed. Sveiby (1997) employed the term of external structure (relational capital), internal structure (structural capital), and individual competence (human capital) for all three components of IC.

Ulum *et al.* (2014) defined marketing expenses as proxy of relational capital and derived the relational capital efficiency (RCE) similar to calculation of SCE (marketing expenses to VA). Thus, adding relational capital in the original VAIC™ model MVAIC is derived and it is as follows;

$$RCE = RC/VA \tag{6}$$

$$ICE = HCE + SCE + CEE \tag{6}$$

$$MVAIC = ICE + RCE \tag{6}$$

Where RCE is the relational capital efficiency and RC is proxied as marketing costs measured by selling, general and admin expanses.

Meanwhile, studies by Sydler *et al.* (2014) and Scafarto *et al.* (2016) showed that relational capital is positively associated with firm performance. Researchers agree that Pulic's VAIC™ allows comparison across industries. Amir and Lev (1996) found that the biotechnology, telecommunications, and software industries highly invest in structural capital and research and development to create IC value. For high-tech firms, human capital effect on firm performance was not direct but it indirectly affects firm values through the investment in structural capital and relational capital (Kamukama *et al.*, 2010; Liang *et al.*, 2011). In contrast, Nimtrakoon (2015) provided evidence that technology firms in ASEAN countries highly invest in human capital and structural capital to create overall IC value. In another study by Majumder *et al.* (2021), it is noted that construction sector highly invested in capital

employed and human capital to increase firm performance. Literature review revealed the lack of research on comparison of IC efficiencies (using MVAIC) in the non-financial sector. In Pakistan, Ahmad and Ahmed (2016) measured IC performance of financial industries only thus leaving the gap to explore the IC performance in the Pakistani non-financial sector. Thus, *H1* is developed to compare the investment levels in IC components across non-financial industries in Pakistan

The first hypothesis is posited below:

H1. Different industries invest differently in MVAIC, HCE, SCE, RCE and CEE.

In an efficient market, efficient IC management increases market values thus IC should contribute to increase firm performance (Riahi-Belkaoui, 2003). Relative to accounting-based measure of firm performance, market-based performance captures information available to investors (Deeds *et al.*, 1998) and reflects the market perception of the expected future performance of the companies (Dubofsky & Varadarajan, 1987; Wisner & Eakins, 1994). A few researchers examined the relationship for IC and firm performance using market-based and accounting-based measures of firm performance. Studies produced mixed findings.

Ahmad and Ahmed (2016) conducted study on 78 firms in Pakistani financial sector, found that HCE and SCE are significant and positively related with earning per share. SCE positively influence return on assets, negatively influence return on equity and earning per share. Considering 26 Pakistani banks, Haris *et al.* (2019) did not find any relationship between IC components and any measure of firm performance. Study of Castro *et al.* (2021) also provided different results for influence of IC and its components on return on assets, market-to-book ratio and Tobin's q of 7 Colombian banks. Except HCE, all components negatively influenced the firm performance measures.

Studies based on modified VAIC model often found no association between relational capital and firm performance (Bayraktaroglu *et al.*, 2019; Nimtrakoon, 2015; Restuti *et al.*, 2019; Sardo & Serrasqueiro, 2017). For Chinese firms in the cement sector, Majumder *et al.* (2021) employed MVAIC method to determine the IC and firm performance relationship for the period of 2009-2018. They employed both accounting performance and market performance measures and produced mixed results based on different proxies of firm performance: HCE and CEE positively while SCE and RCE negatively influenced all measures of firm performance namely, ROA, net profit (NP) and MB. The study failed to prove relationship between MVAIC and all firm performance measures. In addition, Hussain and Mehar (2021) reported that SCE, RCE and CEE influenced ROA in manufacturing firms. Based on the mixed findings, the second hypothesis is proposed as follows:

H2.1 Human capital efficiency is significantly related with market performance.

H2.2 Structural capital efficiency is significantly related with market performance.

H2.3 Capital employed efficiency is significantly related with market performance.

H2.4 Relational capital efficiency is significantly related with market performance.

H2.5 MVAIC is significantly related with market value.

Additionally, drawing from the previous findings for IC and accounting performance, the third hypothesis is posited as follows:

H3.1 Human capital efficiency is significantly related with accounting performance.

H3.2 Structural capital efficiency is significantly related with accounting performance.

H3.3 Capital employed efficiency is significantly related with accounting performance.

H3.4 Relational capital efficiency is significantly related with accounting performance.

H3.5 MVAIC is significantly related with accounting performance.

3. Method

This study used a modified VAIC approach to determine the relationship between IC and firm performance in all Pakistani non-financial firms, for the period 2007-2016. Data were collected from datastream for all the variables. Data for all financial firms and non-financial firms with missing observations (for variables of interest) were excluded which left 199 firms for the analysis. 44 firms with negative VA were removed. Based on the idea by Chu *et al.* (2011) that "the negative sign is carried through in all subsequent indexes, which does not generate meaningful analysis". Some other studies like Bayraktaroglu *et al.* (2019) and Zéghal and Maaloul (2010) have also excluded observations with negative VA. Negative VA reflect that firms are spending (input) more than their revenue (output). Finally, 155 firms from 14 manufacturing and services industries, were left for the analysis.

To measure firm performance, we choose two indicators: Tobin's Q (TQ) as a market-based performance and return on asset (ROA) as accounting-based performance. TQ is the sum of market value of equity and book value of debt to book value of assets (Chadha & Sharma, 2015; Sherif & Elsayed, 2016). As both types of performance measures have advantages and disadvantages, and in order to enhance the quality of any research output, this study incorporated both sets of measures. As the main objective of this study is to analyse the relationship between IC and firms' performance, we developed following regression models:

Model 1:

$$TQ_{it} = \alpha_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 LEV_{it} + \beta_6\, SG_{it} + \beta_7\, FS_{it} + \beta_8\, FA_{it} + \varepsilon_{it} \quad (10)$$

Model 2:

$$TQ_{it} = \alpha_0 + \beta_1 MVAIC_{it} + \beta_2 LEV_{it} + \beta_3\, SG_{it} + \beta_4\, FS_{it} + \beta_5\, FA_{it} + \varepsilon_{it} \quad (11)$$

Model 3:

$$ROA_{it} = \alpha_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 LEV_{it} + \beta_6\, SG_{it} + \beta_7\, FS_{it} + \beta_8\, FA_{it} + \varepsilon_{it} \quad (12)$$

Model 4:

$$ROA_{it} = \alpha_0 + \beta_1 MVAIC_{it} + \beta_2 LEV_{it} + \beta_3\, SG_{it} + \beta_4\, FS_{it} + \beta_5\, FA_{it} + \varepsilon_{it} \quad (13)$$

Where TQ is Tobin's Q and ROA is return on assets as proxies of firms' performance respectively. Three control variables namely, leverage (LEV), sales growth (SG), and firm size (FS) are added in the empirical model. LEV is the ratio total debt divided by total equity and SG is the dividing the difference between current year's sales and previous year's sales by previous year's sales. FS is calculated natural logarithm of firm sales. FA is defined as total years since listing of firm. Table 1 summarizes measurement of all the variables.

4. Results

Table 3 provides information on descriptive statistics, including the observations, mean, minimum, maximum, and standard deviation of all variables. The mean value of TQ variable 1.167 indicate that Pakistani firms' average market value is about 1 time greater than their book value. Relatively, a low mean value of ROA (0.071) implies that firms faced challenges to make profit during the study period. For independent variables, the mean value of MVAIC is 6.514 reveals that sampled firms, on average, created PKR 6.514 value against every PKR 1.00. Among all IC components HCE is strong component in creating IC value. The mean value of HCE is 5.017 compared to the 0.477 (CEE), 0.757 (SCE), and 0.263 (RCE). This findings support the previous studies that human capital is a significant driver to create IC value in developing economies compared to other components (Majumder *et al.*, 2021; Nimtrakoon, 2015).

Table 1. Variables Measurement

Variables	**Labels**	**Measurements**
Dependent Variable		
Tobin's Q	TQ	$\frac{\text{Market value of equity + book value of debt}}{\text{Book value of assets}}$
Return on asset	ROA	$\frac{\text{Net profit}}{\text{Total assets}}$
Independent Variables		
Human Capital Efficiency	HCE	VA/ HC VA= Value Added (Sales revenue-Cost of goods sold) HC=Human Capital (Total salaries, wages, and benefits given to employees by a firm)
Structural Capital Efficiency	SCE	SC/ VA SC= Structural Capital (Organization policies, patents, brand names)
Rational Capital Efficiency	RCE	RC/ VA RC=Relational capital (Selling, general and administrative expenses)[1]
Capital Employed Efficiency	CEE	VA/ CE CE= Capital Employed (Book value of firm's physical assets and financial assets)
Modified Value-Added Intellectual Capital	MVAIC	MVAIC = HCE + SCE + CEE + RCE
Control Variables		

[1] Datastream field 01101 defines selling general and administrative expenses includes marketing and advertising expenses. Selection of this measure is consistent with previous modified VAIC studies.

Leverage	LEV	$\frac{\text{Total Debt}}{\text{Total Equity}}$
Sales Growth	SG	$\frac{\text{Current year's Sales} - \text{previous year's sales}}{\text{Previous year sales}}$
Firm Size	FS	Natural logarithm of firm sales
Firm Age	FA	Total years since listing of firm

Table 2. Descriptive statistics

Variable	Obs.	Mean	Min	Max	Std. Dev
TQ	1550	1.167	-13.748	10.250	1.019
ROA	1550	0.071	-0.247	0.446	0.085
HCE	1550	5.017	-0.767	25.486	3.553
SCE	1550	0.757	-0.138	4.189	0.207
RCE	1550	0.263	-2.470	2.274	0.218
CEE	1550	0.477	-15.893	30.532	1.139
MVAIC	1550	6.514	-10.325	36.721	3.800
LEV	1550	1.183	-8.766	15.704	1.572
SG	1550	0.149	-0.910	15.476	0.560
FS	1550	15.662	11.063	20.895	1.431
FA	1550	16.319	1.000	28.000	4.760

Three components HCE, SCE and RCE represent the value created by investment on employees' skills and knowledge, organizations' structure and relational networks which explains their intangible nature. CEE is the financial and physical capital. Notably, the sum of mean values of HCE, SCE, and RCE is higher than mean of CEE (0.477) which suggests that Pakistani firms are creating more IC value through intangible components instead from tangible components i.e., CEE. This result is consistent with the findings that firms operating in less developed economies create more value via intangible assets rather than physical capital (Majumder *et al.*, 2021; Pulic, 2004; Zéghal & Maaloul, 2010). Additionally, Table 2 reveals descriptive statistics of four control variables leverage (LEV), sales growth (SG), firm size (FS), firm age (FA). The higher mean value of leverage mean shows that Pakistani firms use 118% of debt financing. Sales growth, on average is very low with mean value of 0.149.

To estimate the IC and firm performance relationship, we performed some basic diagnostic test. First, we performed Pearson pairwise correlation analysis. According to Kennedy (2008), multicollinearity exist between two variables when the correlation coefficient is greater than 0.70. Results in table 3 reveal that MVAIC and HCE are highly correlated. Xu and Li (2020) also reported high correlation between MVAIC and HCE for Chinese firms. MVAIC and HCE are not estimated in the same equation therefore multicollinearity cannot affect our results. Table 3 reveals that all IC components are significantly correlated with ROA. HCE has no significant correlation with TQ. Relatively CEE is strongly correlated with TQ by coefficient of 0.445 implying the significance of financial capital in improving firm's market value. Further, we also performed variance inflation factor (VIF) to identify the multicollinearity. Un-tabulated results show the highest VIF 1.21, which is less than 10

suggesting the absence of multicollinearity in our dataset (Wooldridge, 2015).

Table 3. Correlation matrix

	TQ	ROA	HCE	SCE	CEE	RCE	MVAIC	LEV	SG	FS	FA
TQ	1										
ROA	0.039	1									
	0.130										
HCE	-0.007	0.218*	1								
	0.781	0.000									
SCE	-0.284*	0.265*	0.427*	1							
	0.000	0.000	0.000								
CEE	0.445*	0.147*	0.019	-0.235*	1						
	0.000	0.000	0.462	0.000							
RCE	-0.106*	-0.191*	-0.133*	-0.211*	-0.029	1					
	0.000	0.000	0.000	0.000	0.263						
MVAIC	0.106*	0.252*	0.956*	0.371*	0.303*	-0.087*	1				
	0.000	0.000	0.000	0.000	0.000	0.001					
LEV	0.049	-0.311*	0.003	0.003	-0.040	0.031	-0.007	1			
	0.055	0.000	0.893	0.919	0.119	0.219	0.791				
SG	0.002	0.051*	0.073*	0.100*	0.359*	-0.073*	0.178*	0.049	1		
	0.930	0.046	0.004	0.000	0.000	0.004	0.000	0.053			
FS	-0.113*	0.241*	0.216*	0.243*	-0.008	-0.119*	0.2061*	-0.042	0.035	1	
	0.000	0.000	0.000	0.000	0.759	0.000	0.000	0.096	0.163		
FA	-0.025	0.036	-0.164*	-0.101*	-0.013	0.126*	-0.155*	-0.164*	-0.088*	0.215*	1
	0.331	0.152	0.000	0.000	0.600	0.000	0.000	0.000	0.001	0.000	

As previously stated, there are three main hypotheses developed. The first hypothesis is concerned with comparison for IC efficiencies i.e., MVAIC, HCE, SCE, and RCE across non-financial industries. The second hypothesis is to investigate the relationships between IC and market-based performance. The last hypothesis is to examine the relationships between IC and financial performance. All hypothesis tests are described as follows.

Prior studies indicated that intellectual capital efficiency is not the same across different industries (Clarke *et al.*, 2011; Joshi *et al.*, 2013; Singh & Narwal, 2015). To test the first hypothesis non-parametric Kruskal-Wallis one-way ANOVA test is applied. This test compares the differences among the mean ranks in order to evaluate whether the differences among the groups are statistically significant (Siegel, 1988). The K-W statistics provided by the Kruskal-Wallis test indicate that among all groups, one group is significantly different from one of the other groups. Table 4 demonstrates the results for difference for IC across industries.

In table 4, industries are ordered based on MVAIC mean ranks. Higher mean ranks in industries imply that firms in these industries tend to generate more IC value compared to those with lower mean ranks. The K-W statistics in Table 4 prove that the investment levels in IC components (HCE, SCE, RCE, and CEE) and MVAIC are significantly different among industries. It is noticed that non-financial sectors create IC efficiency through different levels of investment in IC components. Six industries; i) food products, ii) manufacturing, iii) chemicals, chemical products & pharmaceuticals, iv) mineral products, v) information and

communication services and vi) paper, paper board and products highly invest in RCE relative to other IC components to create IC value. Four industries; i) motor vehicles, trailer and auto-parts, ii) electrical machinery and apparatus, iii) textiles and iv) other services sectors highly invest in CEE to create IC value. Cement and sugar industries invest in HCE while fuel and energy, coke and refined petroleum products invest in SCE to create overall IC value. These findings indicate that Pakistani industries invest in IC components differently in order to create IC value thus, supporting research hypothesis 1.

Table 4. Kruskal-Wallis ANOVA Test for industry mean ranks for IC and components

No.	Sectors	N	MVAIC	HCE	SCE	RCE	CEE
1	Food Products	100	1106.68	1051.75	929.13	1164.18	1107.62
2	Cement	100	1105.02	1114.11	1009.26	541.21	757.51
3	Fuel & Energy	70	1089.01	1131.10	1272.74	168.30	592.96
4	Coke and Refined Petroleum Products	50	893.58	906.30	1285.22	562.78	674.18
5	Sugar	140	834.84	854.68	811.56	693.84	667.79
6	Manufacturing	130	794.85	786.70	803.28	958.86	769.29
7	Chemicals, Chemical Products & Pharmaceuticals	260	773.03	727.23	703.34	1041.79	952.45
8	Mineral Products	30	759.93	689.47	672.30	1026.17	837.93
9	Information and Communication Services	30	754.47	816.50	820.87	955.73	620.23
10	Motor Vehicles, Trailers and Auto-parts	160	715.44	727.26	673.92	754.29	825.85
11	Electrical Machinery and Apparatus	40	665.80	688.10	602.10	1079.15	424.60
12	Textiles	390	596.01	613.28	662.92	631.59	724.48
13	Paper, Paperboard and Products	30	400.67	469.47	406.17	552.17	252.50
14	Other Services	20	387.45	380.70	324.50	635.75	808.75
		1550	K-W Stat. 253.658***	K-W Stat. 236.822***	K-W Stat. 280.0126***	K-W Stat. 444.207***	K-W Stat. 195.134***

To investigate the relationship between IC and firm performance, all models are estimated using dynamic panel generalized methods of moments (GMM). The dynamic panel technique controls the necessary firm-specific fixed effects which may explain the IC and firm performance. Moreover, unlike the previous cross-country or cross-firm studies, the GMM controls for the potential endogeneity of independent variables. This weakness may produce the biased standard errors and coefficient estimates which possibly produce inaccurate. Unlike traditional OLS, fixed effect and random effect estimations, GMM estimator uses firm's historical values as valid instruments to account for endogeneity (Wintoki *et al.*, 2012). In estimation, the lagged value of dependent variables is treated as endogenous.

In addition, the dynamic panel GMM estimator developed by Arellano and Bond (1991) solve the econometric problems such as solving autocorrelation and heteroscedasticity through

differencing, thus produce consistent results (Baltagi, 2008). The Hansen (1982) J test assesses the instruments' validity and confirms absence of first-order autocorrelation. According to the null hypothesis, the over-identifying instruments are uncorrelated with the error term. The previous studies (Nadeem *et al.* (2017) and Tran and Vo (2020)) also used dynamic GMM for IC and firm performance relationship. Table 6 presents the results of dynamic panel GMM estimations for four models.

In table 6, the results of Hansen J test and autocorrelation test indicate that instruments used in the estimations are valid thus, the results of the difference GMM estimator are robust to interpret our empirical results. The positive and significant lagged values of dependent variables (for all models) prove the dynamic relationship between the current year's performance and past year's performance.

Table 6. Dynamic panel GMM estimation results

	Dependent variable: TQ		**Dependent variable: ROA**	
	Model 1 ***H2.1 – H2.4***	**Model 2** ***H2.5***	**Model 3** ***H3.1-H3.4***	**Model 4** ***H3.5***
Variable	**Coeff. (p)**	**Coeff. (p)**	**Coeff. (p)**	**Coeff. (p)**
Lag	0.189*** *(0.000)*	0.138*** *(0.000)*	0.412*** *(0.000)*	0.454*** *(0.000)*
HCE	0.019*** *(0.016)*	-	0.102*** *(0.006)*	-
SCE	-1.752*** *(0.000)*	-	-0.659 *(0.105)*	-
RCE	-2.178*** *(0.000)*	-	2.302*** *(0.000)*	-
CEE	0.400*** *(0.000)*	-	-0.396*** *(0.000)*	-
MVAIC	-	0.155*** *(0.000)*	-	0.050*** *(0.000)*
LEV	0.187** *(0.039)*	0.949*** *(0.000)*	0.180** *(0.038)*	0.102*** *(0.000)*
SG	-0.274*** *(0.000)*	0.488** *(0.024)*	0.937*** *(0.000)*	0.406*** *(0.000)*
FS	-0.043 *(0.621)*	0.049 *(0.791)*	-0.157 *(0.353)*	0.008 *(0.887)*
FA	-0.002 *(0.891)*	0.136*** *(0.000)*	-0.1567** *(0.045)*	0.019*** *(0.006)*
Hansen stat. (*p*)	0.430	0.661	0.644	0.219
2nd order serial correlation (*p*)	0.263	0.773	0.763	0.995
Instruments	43	40	43	40

Notes: Terms are defined as Coeff., coefficient; Lag, lagged firm performance, TQ, Tobin's Q; ROA, return on asset; HCE, human capital efficiency; SCE, structural capital efficiency; RCE, relational capital efficiency; CEE, capital employed efficiency; MVAIC, modified value-added intellectual capital; LEV, leverage, SG, sales growth; FS, firm size; FA, firm age; Constant, constant variable. For Hansen stat and 2nd order serial correlation, P-values are given. With coefficients, values in parenthesis are *p* values. *** represents significance at *1%*, ** significance at *5%*, * significance at *10%*.

Model 1 and model 2 show the mixed results for relationship between IC components and market value. In model 1, HCE, SCE, RCE and CEE are significantly related with TQ at 1 percent thus supporting hypothesis *H2.1* to *H2.5*. Among all four components, the CEE (*coeff. 0.400*) is strongly and positively related with TQ followed by HCE (*coeff. 0.019*) which is consistent with the findings of Nimtrakoon (2015). This implies that financial capital is more important than other IC components. However, SCE and RCE negatively influence TQ implying that a 1 percent decrease in SCE and RCE is associated with 1.752 percent and 2.178 percent increase in firms' market-based performance respectively. This result is consistent with the findings of Gigante (2013), Buallay (2017) and Sardo and Serrasqueiro (2017). This indicates that in Pakistani firms the structural capital and relational capital is effective. This is because firms are not making investment decisions based on the stock price but they examine the present value of expected profits generated from the investment in structural capital. In control variables, LEV is significantly and positively while SG is significantly and negatively related with TQ. In model 2, MVAIC shows the positive impact on TQ suggesting that overall IC management increases the firms' market value. This result supports the resource-based view and support findings by previous empirical studies (Nadeem *et al.*, 2017; Sardo & Serrasqueiro, 2017). In control variables, LEV, SG and FA are significantly and positively related with TQ.

In Model 3, with ROA, coefficient of HCE remained positive. Coefficient of SCE remained negative (-0.659) and weak as significant at 10 percent. Coefficient of RCE changed to positive (2.302) and coefficient of CEE changed to negative (-0.496). Influence of RCE is stronger among all IC components. For individual components of IC, our GMM results partially contrast with the findings of Nadeem *et al.* (2017) where they find positive association between SCE, CEE and ROA. In control variables, LEV and SG are significantly and positively related with ROA while FA is significantly and negatively related with ROA. In model 4, the MVAIC shows significant positive impact on ROA. However, the MVAIC coefficient size is smaller (0.050) than model 2 (0.155) which indicates that IC has stronger influence to increase firm's market value than accounting-based performance. In control variables, LEV, SG and FA are significantly and positively related with ROA. Overall findings imply that IC increases performance of Pakistani firms and among all components human capital has played significant role.

5. Discussion

Intellectual capital efficiency derives from the investment in four components (human capital efficiency, structural capital efficiency, relational capital efficiency and capital employed efficiency). Investment in IC components varies across industries. This study is among the first to compare the IC efficiencies across 14 non-financial industries through Kruskal-Wallis ANOVA test. Findings suggest that all 14 industries invest in IC components differently to create IC value. Six industries invest higher in relational capital, four industries invest higher in physical capital. Only four industries highly invest in human capital and structural capital.

Since the relational capital is among the basic components of intellectual capital (Sveiby, 1997), this study modified the existing VAIC^{TM} model and added relational capital.

Additionally, the modified value-added intellectual capital (MVAIC) is adopted with firms' market-based performance (TQ) and traditional accounting-based performance (ROA) which is not tested by researchers using Pakistani data. The relationship of firm performance with human capital efficiency, structural capital efficiency, relational capital efficiency, capital employed efficiency and MVAIC is analysed through the difference generalized methods of movement (GMM) method for listed Pakistani non-financial firms from 2009 to 2018.

Findings revealed that IC is an important determinant and play strong role in increasing both market-based performance and accounting-based performance of Pakistani firms. However, the influence of individual IC components on different measures of performance. Structural capital efficiency and relational capital efficiency significantly and negatively influence the TQ indicating that firms are not taking efficiently managing their networks. Our evidence also support the facts reported by World Intellectual Property Organization (WIPO) that Pakistani firms rank lower because of poor management of intellectual property rights (WIPO, 2016). The significant positive influence of human capital efficiency and capital employed efficiency on TQ implies that firms which efficiently utilise physical capital as well as skills and knowledge of its people experience the increase in market performance. On the other hand, significant negative influence of capital employed efficiency and significant positive influence of relational capital efficiency and human capital employed efficiency on ROA suggest that skilled and knowledge of people along with good customer relationships leads to increased accounting-based firm performance. Among all IC components, human capital efficiency is a strong determinant of performance in Pakistani non-financial firms. Significant and positively impact of MVAIC on firm performance suggest that non-financial firms must focus on IC if they wish to improve their performance.

This study is among the first in Pakistan that adopted MVAIC model to compare the IC efficiencies across all non-financial sectors and find the influence of IC on market-based performance and accounting-based performance. These findings leave several practical implications for the policymakers and finance managers to understand and increase the investment in IC components which would increase the business performance of Pakistani non-financial firms. Consideration of IC as an important factor in enhancing firm performance will help to develop further business strategies. Pakistani firms might need high investment in human capital, since higher investment in employees would create increased knowledge assets to the firm and therefore greater firm performance. The results of the study can help industrial regulators to critically evaluate IC and its components to increase performance. Moreover, this research is important for CEOs, shareholders and financial managers to obtain information about IC.

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