Intellectual capital and firm performance in Australia

Martin Clarke
Deloitte, Auckland, New Zealand, and
Dyna Seng and Rosalind H. Whiting
Department of Accountancy and Finance, University of Otago, Dunedin, New Zealand

Abstract

Purpose – This study aims to examine the effect intellectual capital (IC) has on firm performance of Australian companies.

Design/methodology/approach – Quantitative data are collected for Australian companies listed between 2004 and 2008. IC is measured using Pulic's value added intellectual coefficient (VAIC) and its components (human, structural and capital employed efficiencies (HCE, SCE, CEE)). Direct and moderating relationships between VAIC, HCE, SCE, and CEE and four measures of performance are statistically analysed.

Findings – The results suggest that there is a direct relationship between VAIC and performance of Australian publicly listed firms, particularly with CEE and to a lesser extent with HCE. A positive relationship between HCE and SCE in the prior year and performance in the current year is also found. However evidence also suggests the possibility of an alternative moderating relationship between the IC components of HCE and SCE with physical and financial capital (CEE) which impacts on firm performance.

Research limitations/implications – There are some missing data and some transgression of the assumptions of OLS regression.

Originality/value – This paper presents the first study of the IC relationship with firm performance in Australia. Inconclusive results from prior studies in developing countries suggested the need for a study from a developed country such as Australia. The paper is also the first to investigate whether IC moderates the relationship between CEE and firm performance.

Keywords Intellectual capital, Firm performance, Australia, Organizational performance, Knowledge economy

Paper type Research paper

1. Introduction

Internationally, manufacturing and retail economies are being replaced with a "knowledge-based, fast-changing and technologically intensive economy" (Canibano *et al.* 2000, p. 102). For many firms in this modern economy, intellectual, not physical capital is their most important asset. Marr *et al.* (2003) argue that a firm's value is often partly based on the intangible intellectual capital (IC) that it possesses. Therefore we would intuitively expect the efficiency of IC utilisation to have a direct influence on the performance of firms, thereby constituting an issue of practical interest to managers and shareholders (Tan *et al.* 2008) and an important area for research.

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However, the empirical investigation of the relationship between firm performance and IC is not without its difficulties. No universally accepted method of measuring IC exists (Zambon, 2004), thereby making quantitative testing of the relationship challenging. There are a few quantitative studies but none of these use Australian data, which is surprising as IC reporting disclosure in Australia is well described (e.g. Guthrie *et al.*, 2006). Accordingly the purpose of this study is to quantitatively examine the effect IC has on Australian firm performance and whether IC interacts with the tangible assets to affect its firm performance.

Based on a Taiwanese study by Chen *et al.*(2005) this study uses the quantitative measure, value added intellectual coefficient (VAIC) developed by Pulic (1998) as a measure of IC efficiency. Data is collected for Australian publicly listed firms between 2004 and 2008 and analysed using regression and ANOVA. Prior VAIC studies have also investigated the direct relationship between IC and performance, but not a moderating effect of firm's IC on the relationship between tangible assets and firm performance. By using Australian data in a study of this moderating relationship, the study contributes to the body of knowledge concerned with the practical implications of firms' IC.

The paper is organised as follows. The following section discusses the prior IC literature, focusing on the relationship between IC efficiency (VAIC) and firm performance, and the IC literature within Australia. The hypotheses to be tested and the method used to test those hypothesized relationships are described in the next sections. The results are then outlined, discussed and some conclusions are offered.

2. Literature review

Although increasing in importance as economies change to being knowledge- and technology-based (Canibano *et al.*, 2000), a universal definition for the intangible IC is elusive (Zambon, 2004). However, the following description is widely used in the accounting literature. In its first "Annual Intellectual Capital Report", the Swedish firm Skandia defined IC as "the possession of knowledge, applied experience, organizational technology, customer relationships, and professional skills" (Edvinsson, 1997, p. 368). These characteristics were later categorised into three IC components; human, internal structural, and relational capital. Human capital (HC) refers to employee's education and skills, and is the "extent of professionalism" (Vergauwen *et al.*, 2007, p. 1172) and the effectiveness and efficiency of staff to improve the productivity of the firm. Internal structural capital consists of internally developed IC, capturing the effectiveness of the firm's policies and processes, the positive nature of the working environment, and the innovation produced by the firms' research and development teams (Guthrie and Petty, 2000). Internal structural capital therefore includes items such as strategy, patents, and brand names. Finally relational capital captures relationships with third parties, such as customers and suppliers (Bontis, 2001).

Traditional accounting disclosures fail to address the shift towards reliance on IC and its components (Bozzolan *et al.*, 2003). Zambon (2004, p. 154) argues that annual accounts should recognise "any event that is likely to affect a firm's current financial position or its future performance". Arguably, IC fulfils this criterion, but other recognition criteria hinder IC's disclosure. In Australia, to record IC on the balance sheet, IC must fulfil the definition and recognition criteria specified in AASB 138. Recognition requirements include that the asset must be "capable of being separated or divided from the entity", "it is probable that the expected future economic benefits… will flow to the entity", and "the cost of the asset can be measured reliably". These requirements are consistent with international standards, yet the criteria are rarely met by IC and so IC is hardly ever disclosed quantitatively in the accounts.

Disclosure can however be voluntary and non-quantitative, occurring in sections of the annual report other than the financial statements. If IC is linked to firm performance, firms and investors would benefit from this disclosure. However other barriers to disclosure exist such as the cost of obtaining information on intangibles, or the perceived loss of competitive advantage with disclosure (Vergauwen *et al.*, 2007). Should a firm wish to disclose quantitative figures, measurement remains a difficulty. Rarely can a market price be determined for IC, and the cost of creating IC is often difficult to measure (Zambon, 2004). The paucity of published disclosure on firms' IC provides a challenge to accounting researchers who wish to investigate the link between IC and firm performance.

One quantifiable and relatively easily obtainable measure for IC that has been used in the investigation of that relationship is the value added intellectual coefficient (VAIC). VAIC was developed by Pulic in 1998 (Pulic, 1998). Taking a stakeholder perspective, VAIC is offered as a measure of the efficiency with which a firm uses its physical, financial and intellectual capital to enhance stakeholder value. Stakeholders include shareholders, employees, and customers, through to debtors and the government (Riahi-Belkaoui, 2003). The VAIC index consists of the sum of three component ratios; i.e. human capital efficiency (HCE), structural capital efficiency (SCE, which includes both internal and relational capital efficiency), and capital employed efficiency (CEE, composed of physical and financial capital efficiency) (Nazari and Herremans, 2007). Together HCE and SCE constitute IC efficiency (ICE). Further discussion of the calculation of the measure is presented in Section 4.2.2.

Three problems arise with most IC measures: first, the required information is unavailable to those outside the firm; second, the information is often qualitative and based on judgements and finally the information cannot be translated into quantitative dollar values. VAIC does not suffer from these issues as it uses only publicly available, quantitative, and audited information (e.g. wage expenses, which are considered to be an investment in human capital (HC), rather than a cost) (Chan, 2009a). However, VAIC is not without its limitations as the information it uses cannot be exclusively attributed to intangible assets, and "noise" still exists within the numbers (Brennan, 2001; Zambon, 2004). Nevertheless, VAIC has been used in a number of the studies discussed below which investigate the relationship between IC and firm performance.

In general, these studies find a positive relationship between IC (or some of its components) and performance, although the exact nature of this relationship varies (see Table I). For example, Mavridis (2004) found that Japanese banks with the greatest performance were those who were most efficient in the use of their HC, whereas efficiency in physical assets utilisation was less important. Bontis *et al.* (2000), however, found a positive relationship between financial performance and structural capital (SC) in Malaysian firms, and observed that investment in HC has an indirect effect on performance through SC. A German study, Bollen *et al.* (2005) found that all components of IC have an indirect relationship with performance acting through intellectual property. Cohen and Kaimenakis's (2007) results from a study of smaller European firms show that "hard" IC[1] is positively significantly related to profits,

Study	Source/sample	Important findings/ significant relationships	Conclusions
Surveys/questionnaires			
Bontis *et al.* (2000)	Malaysian firms 107 Students in Kuala Lumpur and Seremban	+ relationship between performance and SC + relationship between SC and relational capital + relationship between relational capital and HC + relationship between SC and HC, only in non–service firms	Investment in IC, specifically SC, can result in greater competitive advantage. Investment in either HC or Relational Capital will cause flow-on effects to performance through SC
Bollen *et al.* (2005)	41 German pharmaceuticals companies	+ relationship between all 3 IC components and intellectual property + relationship between performance and intellectual property	IC and each component (SC, HC and relational capital) have at least an indirect impact on performance, through intellectual property
Tovstiga and Tulugurova (2007)	20 Russian SIEs (SIEs have below 180 employees)	HC is the most important IC component for competitive advantage External environment is less important in determining competitiveness	IC is the most important factor in determining competitive advantage in Russian SIEs and can overcome external influences
Questionnaires and financial data			
Cohen and Kaimenakis (2007)	52 Greek SMEs Advertising, information technology, and consultancy sectors IC information from questionnaires of CEOs Performance = Profit and sales per employee	+ relationship between Hard IC and Profits + relationship between Functional IC and Sales per employee No relationship between Soft IC and Performance	While there may be a time-lag between soft IC and performance, the results show that hard and functional IC are both related to performance
Financial data only			
Mavridis (2004)	141 Japanese banks between 2000 and 2001 Performance = (VAIC − SCE) and VA	+ relationship between VA, and Physical Capital and HC Banks with highest performance have high HC but not high physical capital	HC is important for a bank's performance, however physical assets are less important
Al–Twaijry (2009)	384 listed Japanese manufacturers	Investments in intangibles don't necessarily lead to future growth Investments in intangibles are effected by a number of factors, including size, dividends, cash flows, and growth, but not company age Investments in intangibles grew between 2001 and 2005	While investing in intangible assets doesn't lead directly to future growth, these investments are effected by a number of variables

Table I.
Prior studies investigating the relationship between IC and performance

while “functional” IC[2] is positively significantly related to sales per employee. No relationship is found between “soft” IC[3] and performance. However, Cohen and Kaimenakis (2007) recognise that there may be a time-lag between investment in IC and increases in performance for which they did not control. Time-lag issues are addressed in this study.

Unfortunately the aforementioned studies are rarely directly comparable, differing in their measures of both IC and performance. Using VAIC, which provides a standard measure of IC efficiency, partially alleviates this problem. A number of studies in a range of countries investigate the relationship between VAIC and performance (Firer and Williams, 2003; Chen *et al.*, 2005; Shiu, 2006a, b; Tan *et al.*, 2007; Chan, 2009a, b; Ting and Lean, 2009; Zeghal and Maaloul, 2010; Maditinos *et al.*, 2011) (see Table II). Chen *et al.* (2005) study the relationship between VAIC and performance in Taiwanese listed companies between 1992 and 2002. Findings show that across four performance measures[4], there is a significant positive relationship with current and prior year VAIC, HCE, and CEE. Their findings however may be explained by the high number of “IC dependent” firms studied in the paper[5]. Shiu (2006b) also finds significant positive relationships between VAIC in current and prior periods and return on assets (ROA), and likewise Ting and Lean (2009) observe significant positive relationships between VAIC, HCE and CEE and ROA. Tan *et al.* (2007) find significant positive relationships between the current and prior year components of VAIC and ROE while Maditinos *et al.* (2011) also observe this relationship with HCE.

However, not all studies support these results. Firer and Williams (2003), Shiu (2006b), and Chan (2009b), all find that HCE has a significant negative relationship with asset turnover and market to book ratio, showing that the efficiency with which a firm can use its human resources impacts negatively on firm performance. Additionally, Appuhami (2007) does not find a significant relationship between HCE and the capital gains made by investors, although the relationship is a positive one. SCE is rarely found to have a significant relationship with performance. However when a relationship is found, it is often positive, and usually with ROA (Firer and Williams, 2003; Chen *et al.*, 2005; Chan, 2009b), although Ting and Lean (2009) observe a non-significant negative relationship. CEE is found to have a significant positive relationship with at least one measure of performance in most studies (e.g. Zeghal and Maaloul, 2010), with the exception of Appuhami (2007), who found that the relationship between capital gains and CEE was negative.

Overall, studies using VAIC have resulted in a mixture of results across different countries, industries, and years. For example, while Chen *et al.* (2005) conclude that IC is a driver of both firm value, and financial performance, Shiu (2006b) finds only weak relationships between VAIC and performance. In addition Firer and Williams (2003) and Chan (2009b) conclude that firms and investors place greater importance on physical capital over IC, but Appuhami (2007) concludes that IC is more important in the Thai financial sector. The inconsistent evidence does not lead to a compelling conclusion regarding the relationship between IC and firm performance. A further investigation with Australian data is therefore undertaken to provide evidence of any relationship between IC and firm performance, and if so, its direction.

Australia is an interesting site for such research for a number of reasons. First, it is a developed country that is shifting towards a knowledge-based economy. Based on data gathered in 2004, Australia ranks third out of 13 large OECD countries for

Table II. Prior studies investigating the relationship between VAIC (and its components) and performance

Study	Country and period	Dependent variables	Control variables	Significant relationships
Firer and Williams (2003)	South Africa 2001 (1 year)	ROA = Net Income less preference dividends/BV total assets ATO = Total Revenue/BV total assets MB = Market capitalisation/BV net assets	Size = Natural log of market capitalisation Leverage = Debt/BV total assets ROE = Net income less preference dividends/Total Shareholders equity, Industry type	HCE − ATO, MB SCE + ROA CEE + MB
Chen *et al.* (2005)	Taiwan 1992-2002 (11 Years) Tests 3 year lag	MB = MV common stock/BV common stock ROE = Pre-tax income/Average stockholders' equity ROA = Pre-tax income/Average total assets Revenue growth = ((Current revenue/ Prior year's revenue) − 1) x100% Productivity = Pre-tax income/ Number of employees	R&D and Advertising expenses BV Common Stock	VAIC + ROA, ROE, MB, GR, EP HCE + ROA, ROE, MB, GR, EP SCE + ROA, MB CEE + ROA, ROE, MB, GR, EP
Shiu (2006b)	Taiwan 2003 (1 year) Also tests 1 year lag	ROA = Net income/BV total assets ATO = Total revenue/BV total assets MB = Market capitalisation/BV net assets	Size = Natural log of market capitalisation Leverage = Debt/BV total assets ROE = Net income/Total shareholders equity	VAIC + ROA, MB HCE − ATO, MB CEE + ROA, ROE, MB, GR,EP
Appuhami (2007)	Thailand 2005 (1 Year)	Capital Gain on Shares (MR) = ((Market price per Share (PPS) − Prior year's market PPS)/Prior year's market PPS) x 100)	None	VAIC + MR CEE − MR
Tan *et al.* (2007)	Singapore 2000-2002 (3 years) Also tests 1 year lag	ROE = Profit to shareholders/total shareholders' funds EPS = Profit to shareholders/ weighted average number of shares Annual stock return (ASR) = ([share $price_{x+1}$ − share $price_{x}$] + dividends)/share $price_{x}$	None	HCE,SCE, HCE together + ROE, EPS, ASR Some support for lagged relationship

(*continued*)

Study	Country and period	Dependent variables	Control variables	Significant relationships
Chan (2009b)	Hong Kong 2001-2005 (5 Years)	MB ratio = Market capitalisation/BV common stock ROA = Operating income/BV total assets ATO = Total revenue/BV total assets ROE = Net income/Total shareholders equity	Size = Natural log of market capitalisation Leverage = Debt/BV total assets	VAIC + ROA, ROE HCE −ATO, MB SCE + ROA, ROE CEE + ROA, ATO, MB, ROE
Ting and Lean (2009)	Malaysia 1999-2007 (9 years)	ROA = Profit after tax/total assets	None	VAIC + ROA HCE + ROA CEE + ROA
Zeghal and Maaloul (2010)	United Kingdom 2005 (1 year)	Economic income (OI/S) = operating income/total sales ROA = EBIT/BV total assets MB = total market capitalization/BV net assets	Size = natural log of BV total assets Leverage = BV total assets/BV common equity	VAIC + OI/S, ROA CCE − OI/S CCE + ROA, MB
Maditinos *et al.* (2011)	Greece 2006-2008 (3 years)	ROE = Net income/Shareholders' equity ROA = Net income/Total assets Revenue growth = ((Current revenue/ Prior year's revenue) − 1) x 100% MB = Market capitalisation/BV common stock	None	HCE + ROE

Notes: MB = Market to book ratio; MV = Market value; BV = Book value; ROA = Return on assets; ROE = Return on equity; GR = Revenue growth; EP = Employee productivity; ATO = Asset turnover, MR = Capital gain on shares; VAIC = Value added intellectual coefficient; HCE = Human capital efficiency; SCE = Structural capital efficiency; CEE = Capital employed efficiency

Table II.

expenditure on fixed assets, and 12th in the world for national investment in IC (computer, telecommunications, internet, and social infrastructure) (Wood, 2003). The high-technology and knowledge-based sector is challenging the dominance of the traditional commodity and resource based sector in the economy (Guthrie and Petty, 2000), although some commentators believe Australia is underperforming in its economic use of IC (Wood, 2003).

Second, Australia's culture (e.g. low level of uncertainty avoidance and high level of individualism) (Salter and Niswander, 1995) and its high levels of education and political freedom mean that it is more likely than the developing countries investigated in prior VAIC studies (Table II) to display voluntary disclosure (Archambault and Archambault, 2003). Additionally Maditinos *et al.* (2011) suggest that the failure of the VAIC measure to consistently verify theoretically hypothesized relationships with firm performance is due to the emphasis on physical and financial capital and the imperfect functioning of capital markets in these developing countries. Therefore using the VAIC measure on Australian data, with its developed capital market may provide a more appropriate test of the relationship of VAIC with firm performance.

Third, Australia is well studied in terms of firm IC disclosure practices. Guthrie and Petty (2000), Sciulli *et al.* (2002), Guthrie *et al.* (2006), Abeysekera (2007), Dumay and Tull (2007), Sujan and Abeysekera (2007), White *et al.* (2007), Brüggen *et al.* (2009) and Whiting and Woodcock (2011) have all investigated Australian IC disclosure practices. In general the level of voluntary IC disclosure in annual reports is low. Larger firms, those with Big Four auditors and those in the more intangibles-intensive industries make more voluntary disclosures than other firms (Whiting and Woodcock, 2011).

However there are no Australian studies that investigate the link between IC and firm performance, and that constitutes the fourth reason for the use of Australian data in the current study. Finally the availability of published financial data for Australian companies in a number of databases provided the fifth impetus for this study.

In summary, measurement issues have limited quantitative research of the relationship between IC and firm performance. Studies generally find a significant and positive relationship between IC and performance, however the variety of methods and measures used make direct comparisons difficult. VAIC overcomes this by standardising a measure of IC efficiency, but studies using this tool find conflicting results. Therefore the main research question addressed in this Australian study is whether a firm's intellectual capital efficiency directly impacts on its performance in both the current or following year. As explained in the following section a further research question is also posed: does a firm's intellectual capital efficiency moderate the relationship between capital employed efficiency and performance in the current year?

3. Hypothesis development

Resource-based theory views IC as a strategic resource that is used by a firm to gain competitive advantage and create value that the firm can use to enhance its performance (Wernerfelt, 1984; Marr *et al.*, 2003). Although empirical tests of this theory provide mixed results, following the findings of Bollen *et al.* (2005), Chen *et al.* (2005) and Tan *et al.* (2007) and the tenets of resource-based theory, it is hypothesised that there is a direct positive relationship between IC efficiency and firm performance.

$H_1(a)$. VAIC is positively related to firm performance.

Prior studies have found that different aspects of IC have a greater impact on firm performance than others (Firer and Williams, 2003; Chen *et al.*, 2005; Shiu, 2006a, b; Appuhami, 2007; Chan, 2009a, b; Maditinos *et al.*, 2011). For instance, in the VAIC calculation, structural capital is dependent on human capital (as explained in Section 4.2.2) (Nazari and Herremans, 2007), and this may impact on the relative effect each has on firm performance. Therefore, it is hypothesised that the positive impact on performance varies between IC efficiency components:

H_1(b). HCE is positively related to firm performance.

H_1(c). SCE is positively related to firm performance.

Additionally, capital employed efficiency has been found to have a significant positive impact on performance (Chen *et al.*, 2005; Chan, 2009b; Zeghal and Maaloul, 2010). Therefore, this relationship is also hypothesised:

H_1(d) CEE is positively related to firm performance

IC or capital employed efficiency in one period may not affect performance until the following period. For example, new managers (HC) may not add value until after becoming more experienced. New systems (SC) and new plant and equipment (CE) may experience operational and/or acceptance problems on introduction which will be minimised as time progresses. Therefore, following Chen *et al.* (2005), Shiu (2006b) and Tan *et al.* (2007) it is hypothesised that VAIC and its components in one period, will positively impact on performance in the following period:

H_2(a). Last year's VAIC is positively related to this year's firm performance.

H_2(b). Last year's HCE is positively related to this year's firm performance.

H_2(c). Last year's SCE is positively related to this year's firm performance.

H_2(d). Last year's CEE is positively related to this year's firm performance.

While direct relationships between IC and performance have been examined in prior VAIC research, the evidence is not conclusive. Therefore this study explores another alternative relationship – a moderating effect. IC "cannot create value by itself" (Pulic, 1998, p. 8), and instead enhances the capabilities of the firm "only if [it] is combined with financial capital" (Pulic, 1998, p. 8). For example, a brand name adds little or no value without being attached to a product. When IC is used in conjunction with physical and financial assets however, the value added through the physical assets increases. Tying a popular brand (SC) to a product may boost sales for example. Therefore, a firm uses its physical and financial capital to improve its performance, but IC determines how well the physical and financial capital is used. It is hypothesised that IC efficiency (HCE and SCE) moderates the relationship between capital employed efficiency (CEE), and firm performance. The greater the HCE and SCE, the greater the effect CEE has on firm performance:

H_3(a). HCE moderates the relationship between CEE and firm performance.

H_3(b). SCE moderates the relationship between CEE and firm performance.

Bollen *et al.* (2005) studied the relationship between VAIC and firm performance through an intervening variable (intellectual property), and interaction effects between different categories of IC were found in Cohen and Kaimenakis (2007). However the interaction between IC and physical capital is a relatively untouched subject within the literature.

4. Research design

4.1 Sample

The original sample, collected from the Compustat Global Vantage database, consists of 2,161 firms listed on the Australian Stock Exchange from the 2003 to the 2008 financial year. This yields a total sample of 12,966 observations across all years. Due to missing data on selected variables, the final sample for analysis consists of between 3,944 and 8,643 firm-year observations depending on the particular variable concerned. Table III shows the industry composition of the 1,676 firms (10,056 observations) for which there was industry data. The dominant industry is materials (35 percent of total observations) followed by financials (15.8 percent) and industrials (12.4 percent).

4.2 Measurement of the variables

4.2.1 Dependent variables. Prior studies measure performance in a number of ways: Return on assets (ROA), Return on equity (ROE), revenue growth, and employee productivity (e.g. Firer and Williams, 2003; Chen *et al.*, 2005; Shiu, 2006a, b; Chan, 2009a, b; Ting and Lean, 2009). This study uses all four of these performance measures. These four variables were defined as:

(1) Return on assets (ROA) = Profit before tax/Average total assets.

(2) Return on equity (ROE) = Profit before tax/Average common stock equity.

(3) Revenue growth (RG) = (Current year revenue/Prior year revenue) − 1.

(4) Employee productivity (EP) = Profit before tax/Number of employees.

4.2.2 Independent variables. Following Chen *et al.* (2005), VAIC and its three components, HCE, SCE and CEE represent the independent variables. As explained earlier, VAIC measures the level of IC of firms and provides information about the value creation efficiency of tangible and intangible assets within a firm (Tan *et al.* 2008).

Table III.
Sample distribution by industry

Industry	Firms	Percentage of sample
Materials	587	35.02
Consumer-discretionary	132	7.88
Consumer-staples	63	3.76
Healthcare	139	8.29
Energy	119	7.10
Financials	265	15.81
Industrials	207	12.35
Info Tech	111	6.62
Telecommunications	25	1.49
Utilities	28	1.67
Total	1,676	100.00

In order to calculate VAIC, a firm's ability to create value added (VA) to all stakeholders must first be calculated. In its simplest form VA is the difference between output and input. Output represents net sales revenues and input contains all the expenses incurred in earning the sales revenues except labour costs which are considered to be a value creating entity (Tan *et al.*, 2008). This VA is also defined as the net value created by firms during the year (Chen *et al.*, 2005), and can be expressed as follows:

$$VA = S - B = NI + T + DP + I + W$$

where: S is net sales revenues (Output); B is bought-in materials and services or cost of goods sold (Input); NI is net income after tax; T is taxes; DP is depreciation; I is interest expense; and W is employee wages and salaries. The VA equation above is known as the "Gross Value Added" approach (Riahi-Belkaoui, 2003) and is the method used in this study[6]:

- *Human capital efficiency (HCE)*. Human capital (HC) encompasses the skills, experiences, productivity, knowledge and fit of employees within the work place. Within the VAIC model, the level of HC is defined as salaries and wages at a point in time (Pulic, 1998). While controlling for size, higher wages proxy for a workforce with greater skills that should add more value to the firm than staff on lower wage rates. HCE shows how much VA is created by a dollar spent on human capital or employee and is calculated as:

$$HCE = VA/HC$$

If salaries are low and VA is high, the firm is using its HC efficiently. If VA is low in relation to salaries, the firm's HC is not being utilised efficiently and HCE will be low. Higher HCE results from effective utilisation of HC to add value through operating profit.

- *Structural capital efficiency (SCE)*. Structural capital (SC) includes IC items such as strategy, organisational networks, patents, and brand names. Pulic (1998) calculates SC as:

$$SC = VA - HC$$

Thus, VA is influenced by the efficiency of HC and SC. SC is dependent on HC, and greater HC translates into improved internal structures (Nazari and Herremans, 2007). HC and SC are inversely related (Tan *et al.*, 2008). This results in SC decreasing as HC increases, which is logically inconsistent with the theoretical definition of SC. To fix this, Pulic (1998) calculates SCE as:

$$SCE = SC/VA$$

SCE is therefore the dollar of SC within the firm, for every dollar of value added, and as HCE increases, SCE increases. If the efficiency measures for both HCE and SCE were calculated with VA as the numerator, the logical inconsistency would remain (Pulic, 1998).

- *Capital employed efficiency (CEE)*. CEE encompasses the efficiency that SCE and HCE fail to capture. Pulic (1998) argues that IC cannot create value on its own, and so it must be combined with capital (physical and financial) employed (CE).

Thus CE is calculated as total assets minus intangible assets and CEE is defined as:

$$CEE = VA/CE$$

CEE shows how much VA is created by a dollar spent on capital employed (CE).

- *Value added intellectual coefficient (VAIC)*. VAIC compiles the three efficiency measures into one index:

$$VAIC = HCE + SCE + CEE$$

As the firm uses its human, structural, physical and financial capital, value is added to the firm. The more efficiently these capitals are used, the more value is added to the firm, the greater the VAIC.

4.2.3 Control variables[7]. To minimise the impact of other variables that may explain observed relationships with firm performance, four control variables (leverage, research and development intensity, year, and industry) are included within the regression models:

(1) *Leverage*. A high proportion of debt may lead a firm to primarily focus on the needs of debt holders (Williams, 2000). This is not consistent with the stakeholder view assumed by VA and VAIC. Alternatively, firms that rely heavily on debt may lack the security required to attract investors, and will likely have higher interest payments, reflecting on the riskiness and returns of the firm[8]. Consistent with prior research (Firer and Williams, 2003; Shiu, 2006a, b; Chan, 2009a, b), leverage is calculated as:

$$\text{Leverage} = \text{Total debt}/\text{Total assets}$$

(2) *Research intensity*. Sougiannis (2004), Chen *et al.* (2005) and Ding *et al.* (2007) all found a positive relationship between firm performance and research and development (R&D). Consequently, firms that focus on R&D have a greater reliance on IC to drive performance. To control for this effect, firms that report a value (not $0) under R&D Expense are coded 1 under the "Research Intensive" dummy variable.

(3) *Year*. Between 2004 and 2008, markets internationally underwent radical economic shifts, and Australia adopted international accounting standards. These factors may have affected the reported performance of the Australian firms. Four dummy variables are included to control for the difference between these five years[9]. These variables are coded 1 if an observation related to the year that the dummy variable represents.

(4) *Industry*. Kujansivu and Lönnqvist (2007) found that IC efficiency differed between industries. Chen *et al.* (2005) and Tan *et al.* (2007) split VAIC and performance regression models into industry samples, and found significant differences in explanatory power between industries. Consistent with Firer and Williams (2003), industry is controlled for in this study through a dummy control variable. Similar to the year dummy variable, nine dummy variables represent the effects of ten different industries defined by the Global Vantage

Economic Sector Code. These industries range from high IC telecommunications firms, through to physical resource based firms such as those in the utilities and materials industries. Each variable is coded 1 if an observation relates to the industry represented by that variable.

4.3 Empirical models

The three hypotheses to be empirically tested are reflected in the following three equations relating VAIC (Model 1) and components of VAIC (Model 2) to firm performance. Model 3 tests whether IC efficiency (HCE and SCE) moderates the relationship between CEE and firm performance in the current year.

$$\mathrm{Perf}_{it} = \beta_0 + \beta_1 \mathrm{VAIC}_{it} + \beta_2 \mathrm{VAIC}_{it-1} + \beta_3 \mathrm{Control\ variables}_{it} + \varepsilon_{it} \qquad \text{(Model 1)}$$

$$\begin{aligned}\mathrm{Perf}_{it} =& \beta_0 + \beta_1 \mathrm{HCE}_{it} + \beta_2 \mathrm{SCE}_{it} + \beta_3 \mathrm{CEE}_{it} + \beta_4 \mathrm{HCE}_{it-1} \\ & + \beta_5 \mathrm{SCE}_{it-1} + \beta_6 \mathrm{CEE}_{it-1} + \beta_7 \mathrm{Control\ variables}_{it} + \varepsilon_{it}\end{aligned} \qquad \text{(Model 2)}$$

$$\begin{aligned}\mathrm{PerfResids}_{it} =& \beta_0 + \beta_1 \mathrm{HCE}_{it} + \beta_2 \mathrm{SCE}_{it} + \beta_3 \mathrm{CEE}_{it} + \beta_4 \mathrm{HCE}_{it-1} \\ & + \beta_5 \mathrm{SCE}_{it-1} + \beta_6 \mathrm{CEE}_{it-1} + \beta_7 \mathrm{HCE}_{it} \mathrm{xCEE}_{it} \\ & + \beta_8 \mathrm{SCE}_{it} \mathrm{xCEE}_{it} + \varepsilon_{it}\end{aligned} \qquad \text{(Model 3)}$$

where:

- Perf is Return on assets (ROA), Return on equity (ROE), Revenue growth (RG), or Employee productivity (EP);
- PerfResids is the residuals from a regression model[10] where the independent variables include only the control variables;
- VAIC is Value added intellectual coefficient; HCE is Human capital efficiency; SCE is Structural capital efficiency; CEE is Capital employed efficiency.
- β_0 = Constant; i = firm; t = year (between 2004 and 2008).

Control variables

- LEV = Leverage;
- R&DI = Research intensive;
- YR = Year.
- INDUSTRY includes MAT = Materials, CD = Consumer discretionary, CS = Consumer staples, HELC = Health care, EN = Energy, FIN = Financials, IND = Industrials, IT = Information technology, TELE = Telecommunications; and UTL = Utilities

Models are run four times, each iteration replacing the dependent variable with each performance measure.

Moderating effects can be tested by incorporating multiplicative terms into a regression model (Jaccard *et al.*, 1990). However, problems with multicollinearity occur when adding the multiplicative terms in this study which then prevents the use of an OLS regression analysis. While "centering" the predictor and moderating variables is suggested as a solution to multicollinearity in moderating models (Jaccard *et al.*, 1990; Meyers *et al.*, 2006), negative values cause additional issues. Transforming variables into ranks is also considered, however this did not solve the multicollinearity problem. Instead, a univariate two-way between-subjects analysis of variance (ANOVA) is conducted[11]. Not only is ANOVA similar to OLS regression analysis (Meyers *et al.*, 2006), it is suggested as an alternative to regression modelling when testing for interaction effects (Jaccard *et al.* 1990). Each performance measure is cut into five pentiles based on levels of HCE, SCE, and CEE. Each pentile is coded between 1 (lowest) and 5 (highest). Each performance measure undergoes three independent splits, one for each VAIC component. This allows for example, the residuals from the regression of the control variables[12] only of firms with low HCE, to be compared to the residuals of firms with high CEE. This between-groups comparison is used to test for interactions between CEE, and HCE or SCE that impact on performance.

The effect of adding interaction terms to Model 3 is addressed by comparing Model 3 to a separate ANOVA model with the interaction terms removed (see Appendix (Table AI). This gives a more direct comparison than with the OLS regression models.

5. Results

5.1 Descriptive statistics

Similar to Shiu (2006a) data was not normally distributed and displayed extreme values. To improve the distribution for statistical testing, extreme values were trimmed from the sample (Meyers *et al.*, 2006). Table IV presents descriptive statistics for the dependent and independent variables. Due to a number of loss-making firms HCE, ROA, and employee productivity all have negative means [13]. However revenue growth shows that on average, firm's revenue grew by approximately 20 percent annually over the five years under investigation. SCE has a significantly greater mean than HCE and CEE.

5.2 Correlation analysis

To analyse the association between the dependent and independent variables, a correlation analysis (Spearman) is undertaken and the results are presented in Table V. Current and lagged VAIC, HCE, and CEE are positively and significantly correlated with all measures of performance, while current and lagged SCE are negatively and significantly correlated with the same performance measures, similar to the results

Table IV.
Descriptive statistics for selected variables

Variable	*n*	Mean	Median	Std. dev	Minimum	Maximum	Skewness	Kurtosis
VAIC	3367	0.42	1.41	5.73	−22.84	24.08	−0.46	2.87
HCE	3501	−0.65	−0.24	4.55	−18.83	16.97	−0.55	2.92
SCE	3832	1.03	1.01	0.80	−2.53	4.06	0.37	2.44
CEE	3812	0.06	0.00	0.45	−1.76	1.95	0.03	1.93
ROA	7396	−0.11	−0.02	0.33	−1.40	1.16	−1.03	1.90
ROE	7194	0.02	−0.03	0.32	−1.22	1.30	0.60	2.02
Revenue growth	6165	21.70	11.41	77.12	−254.23	367.27	1.07	223
Employee productivity	1936	−0.08	0.00	0.29	−1.38	1.05	−0.98	2.75
Leverage	8616	0.15	0.04	0.20	0.00	1.10	1.62	2.54

Table V. Spearman correlations – independent and dependent variables

Variable	HCE_t	HCE_{t-1}	CEE_t	CEE_{t-1}	SCE_t	SCE_{t-1}	$VAIC_t$	$VAIC_{t-1}$	ROA	ROE	RG	EP
HCE_t	1.000											
HCE_{t-1}	0.714*	1.000										
CEE_t	0.830*	0.640*	1.000									
CEE_{t-1}	0.626*	0.818*	0.772*	1.000								
SCE_t	−0.475*	−0.464*	−0.641*	−0.560*	1.000							
SCE_{t-1}	−0.478*	−0.495*	−0.617*	−0.720*	0.604*	1.000						
$VAIC_t$	0.763*	0.510*	0.571*	0.427*	−0.312*	−0.301*	1.000					
$VAIC_{t-1}$	0.591*	0.893*	0.524*	0.673*	−0.340*	−0.336*	0.473*	1.000				
ROA	0.779*	0.598*	0.881*	0.678*	−0.499*	−0.498*	0.533*	0.515*	1.000			
ROE	0.725*	0.542*	0.791*	0.597*	−0.466*	−0.474*	0.480*	0.456*	0.896*	1.000		
RG	0.160*	0.060*	0.116*	0.027*	−0.079*	0.006	0.127*	0.070*	0.220*	0.176*	1.000	
EP	0.835*	0.712*	0.773*	0.629*	−0.506*	−0.524*	0.537*	0.601*	0.836*	0.826*	0.147*	1.000

Notes: * indicates significant at the 1 percent level in the two-tailed test. Spearman correlation is used due to non-normal distribution of variables' data reported in Ting and Lean (2009). Revenue growth tends to have the weakest correlations with the VAIC terms. Additionally, all performance measures are significantly positively correlated with each other, and ROA and ROE have the strongest relationships.

5.3 Multiple regression results: direct relationship with current year performance

Table VI (Panels A and B) shows the results of regression coefficients for all independent variables VAIC and its components, using each performance measure (ROA, ROE, revenue growth, and employee productivity) as the dependent variable[14]. Model 1 at Panel A presents the results for VAIC while Model 2 at Panel B presents the results for VAIC components.

In Model 1 of Table VI, VAIC coefficient is positive and significant at the 1 percent level across all performance measures. Adjusted R^2 is 0.270 for ROA, 0.232 for ROE, and 0.393 for employee productivity; i.e. the model for employee productivity is able to explain 39 percent of the variance in the dependent variable. The revenue growth model has the least explanatory power (adjusted R^2 is 0.013). This result is a strong indicator that there is a relationship between overall IC, and firm performance, thus supporting $H_1(a)$. That is, if a firm is able to use its IC more efficiently in one year, this can lead to a performance increase in the same year.

In Model 2 of Table VI, the coefficients of both HCE and CEE are significant at the 1 percent level and positively related to all performance measures, except revenue growth for CEE. $H_1(b)$ and *H1(d)* are supported. In addition CEE has greater explanatory power than HCE in two performance models, shown by its larger standardised coefficients, and is therefore generally the more dominant component in VAIC when predicting performance. This result is consistent with prior studies by Chen *et al.* (2005) and Ting and Lean (2009). Accordingly, this suggests that it is important that firms use physical, financial and human capital efficiently to generate higher profitability. However, these results are inconsistent with firms in South Africa (Firer and Williams, 2003), Taiwan (Shiu, 2006b) and Hong Kong (Chan, 2009b), where significant negative relationships between HCE and two of three performance measures are found. SCE is not found to be significant in any of the performance measures and this result is generally consistent with prior VAIC studies. Chen *et al.* (2005), for example, finds that the effect of SCE is small, negative, and not significant for ROE and employee productivity. Ting and Lean (2009) and Shiu (2006b) also find negative but insignificant association between SCE and profitability. $H_1(c)$ is not supported.

Noticeably, across all models, adjusted R^2 increases substantially when VAIC is split into its components (see Table VII). Particularly strong is the ROA model, for example, where the adjusted R^2 increases from 0.234 in Model 1a to 0.709 in Model 2a and from 0.199 to 0.475 for the ROE model. These results are consistent with Chen *et al.* (2005), where the explanatory power in the ROA and ROE models increased from 0.468 and 0.439 to 0.842 and 0.729 respectively when VAIC was split, but is less for the other two performance measures.

Overall, these results show that the VAIC components have significantly greater explanatory power than when they are combined into the single VAIC index. As SCE is the only VAIC component with inconsistent evidence, it suggests that the most

Table VI. Regression results of firm performance using both current and lagged independent variables

Independent variables	ROA Coefficients	ROA t-statistic	ROE Coefficients	ROE t-statistic	RG Coefficients	RG t-statistic	EP Coefficients	EP t-statistic
Panel A: Model 1								
Constant	0.368	6.108**	0.299	5.066**	15.833	0.984	0.525	6.984**
VAIC $_t$	0.302	13.031**	0.229	9.604**	0.103	3.812**	0.238	7.110**
VAIC $_{t-1}$	0.214	9.038**	0.203	8.360**	−0.027	−0.989	0.317	9.260**
Adjusted R^2	0.270		0.232		0.013		0.393	
F-value	36.285**		29.693**		2.205**		25.649**	
Panel B: Model 2								
Constant	0.230	5.931**	0.287	5.767**	14.656	0.899	0.593	8.862**
HCE_t	0.210	11.910**	0.234	9.936**	0.137	4.268**	0.303	8.659**
CEE_t	0.751	35.378**	0.502	17.688**	0.024	0.631	0.302	7.147**
SCE_t	0.007	0.439	0.002	0.082	−0.028	−0.995	−0.038	−1.256
HCE_{t-1}	0.008	0.452	0.074	3.095**	−0.063	−1.929	0.213	6.038**
CEE_{t-1}	−0.007	−0.324	−0.040	−1.386	−0.019	−0.478	−0.053	−1.242
SCE_{t-1}	0.016	1.031	−0.031	−1.480	0.134	4.640**	−0.064	−2.023*
Adjusted R^2	0.708		0.478		0.028		0.552	
F-value	199.692**		75.785**		3.347**		40.057**	

Notes: * indicates significant at the 5 percent level; ** indicates significant at the 1 percent level; Model 1: $Perf_{it} = \beta_0 + \beta_1 VAIC_{it} + \beta_2 VAIC_{it-1} + \beta_3 Control\ Variables_{it} + \varepsilon_{it}$; Model 2: $Perf_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 HCE_{it-1} + \beta_5 SCE_{it-1} + \beta_6 CEE_{it-1} + \beta_7\ Control\ Variables_{it} + \varepsilon_{it}$; Where: Perf is Return on Assets, Return on Equity, Revenue Growth, or Employee Productivity; VAIC is Value Added Intellectual Coefficient; HCE is Human Capital Efficiency; SCE is Structural Capital Efficiency; CEE is Capital Employed Efficiency; β_0=Constant; i=firm; t=year (between 2004 and 2008); *Control variable:* Leverage; Research Intensive; Year; and Industry which includes Materials, Consumer Discretionary, Consumer Staples, Health Care, Energy, Financials, Industrials, Information Technology, Telecommunications and Utilities

	Variable	Model	Adjusted R^2	Change statistics F change	Sig. F change
Model 1	ROA	1a	0.234	231.539	0.000
		1b	0.270	81.690	0.000
	ROE	1a	0.199	135.885	0.000
		1b	0.232	69.895	0.000
	RG	1a	0.013	13.563	0.000
		1b	0.013	0.978	0.323
	EP	1a	0.311	80.537	0.000
		1b	0.393	85.739	0.000
Model 2	ROA	2a	0.709	1139.988	0.000
		2b	0.708	0.477	0.698
	ROE	2a	0.475	372.236	0.000
		2b	0.478	3.836	0.009
	RG	2a	0.012	5.120	0.002
		2b	0.028	9.985	0.000
	EP	2a	0.524	137.533	0.000
		2b	0.552	14.178	0.000

Notes: Model 1 and Model 2 are presented below in two forms. The "a" models exclude lagged terms while the "b" models include these terms: *Model 1a:* $\text{Perf}_{it} = \beta_0 + \beta_1\text{VAIC}_{it} + \beta_2\text{Control Variables}_{it} + \varepsilon_{it}$; *Model 1b:* $\text{Perf}_{it} = \beta_0 + \beta_1\text{VAIC}_{it} + \beta_2\text{VAIC}_{it-1} + \beta_3\text{Control Variables}_{it} + \varepsilon_{it}$; *Model 2a:* $\text{Perf}_{it} = \beta_0 + \beta_1\text{HCE}_{it} + \beta_2\text{SCE}_{it} + \beta_3\text{CEE}_{it} + \beta_4\text{Control Variables}_{it} + \varepsilon_{it}$; *Model 2b:* $\text{Perf}_{it} = \beta_0 + \beta_1\text{HCE}_{it} + \beta_2\text{SCE}_{it} + \beta_3\text{CEE}_{it} + \beta_4\text{HCE}_{it-1} + \beta_5\text{SCE}_{it-1} + \beta_6\text{CEE}_{it-1} + \beta_7\text{Control Variables}_{it} + \varepsilon_{it}$. In Model 1, the F change between Model 1a and 1b tests is significant at the 1 percent level in all performance measures, except for revenue growth. Similarly, in Model 2 the F change is significant at the 1 percent level in all performance measures, except for ROA. This suggests that on average the lagged components of VAIC do add significant explanatory power

Table VII.
Regression statistics: comparing "current year only" model against "current and last year combined" model

important efficiencies for improving firm performance are HCE and CEE. SCE appears to detract from the predictive power of the other two components in the VAIC index.

5.4 Multiple regression results: direct relationship with following year performance

The last year's VAIC variable (VAIC_{t-1}) is significant at the 1 percent level across all current year performance measures except revenue growth (Table VI). Coefficients are positive and very close to the current year's VAIC coefficient. In the revenue growth model, VAIC_{t-1} is not significant and weakly negatively related. $H_2(a)$ is supported. These results are again consistent with Chen *et al.* (2005), who finds significant relationships between VAIC_{t-1}, and all measures of performance. Shiu (2006b) also finds similar results with ROA.

Last year's HCE (HCE_{t-1}) is positively and significantly related to employee productivity and ROE at the 1 percent level. It is positively related to ROA, and negatively related to revenue growth but insignificant in both. Overall, this provides support for $H_2(b)$. Chen *et al.* (2005) finds this lagged variable significant and positive in three of four performance measures, and negative but not significant for revenue growth model.

Last year's SCE (SCE_{t-1}) is significantly positively related to revenue growth at the 1 percent level, but significantly negatively related to employee productivity at the 5 percent level. SCE_{t-1} is negatively related to ROE, and positively in ROA, but not significant in either model. (ANOVA results discussed under the moderating relationships also show significant results for SCE_{t-1}). Chen *et al.* (2005) shows SCE_{t-1} to be positively significant at the 5 percent level in ROA but insignificant in the other three performance measures. Overall there is cautious support for $H_2(c)$.

Last year's CEE (CEE_{t-1}) is insignificantly negatively related to all performance measures and thus $H_2(d)$ is rejected. This finding is inconsistent with that of Chen *et al.* (2005), who finds positive significant relationships in all performance models. In summary, it is suggested that HCE_{t-1} and possibly SCE_{t-1} drive $VAIC_{t-1}$.

Similar to Model 1a and Model 2a at Table VII, by adding last year VAIC components' variables to Model 2b at Table VII, adjusted R^2 increases substantially from Model 1b to Model 2b. For example, in the ROA and ROE models adjusted R^2 s increase from 0.270 and 0.232 to 0.708 and 0.478, respectively.

5.5 Multiple regression results: Alternative Moderating relationship for current year performance

The exploratory moderating relationships are examined by comparing two ANOVA models, one with the interaction terms removed (see Section 4.3 and Appendix, Table AI). Table VIII presents the results of this moderating relationship between CEE and firm performance in the current year.

Partial Eta squared (η^2) measures the percentage of variance explained by an individual effect (Meyers *et al.*, 2006), and where appropriate is used as a comparison of effect strength. No comparisons are made with previous studies, as none have investigated an interaction effect using VAIC. Due to the exploratory nature of the investigation into this relationship, a wider significance level of up to 10 percent is considered a significant result.

The interaction between HCE and CEE is significant at the 1 percent level under the ROA and at the 10 percent level under the employee productivity models. Half of the performance measures therefore have a significant relationship with the HCE X CEE interaction term. The partial η^2 for the interaction term in the ROA model is above the direct HCE term[15], but approximately one-third of the direct CEE term. Under the employee productivity model, the partial η^2 of the interaction term is double that of direct HCE, and just above half of direct CEE. The highest partial η^2 shows the HCE X CEE interaction effect explains 4.0 percent of the variance in employee productivity.

The interaction between SCE and CEE is significant at the 10 percent level in both the revenue growth and employee productivity models. Again, half of the performance measures have a significant relationship with the SCE X CEE interaction term. The partial η^2 across these two performance measures is at least seven times that of direct SCE, is close to direct CEE in the employee productivity model, and is also seven times that of direct CEE in the revenue growth model.

Overall, all adjusted R^2 and partial η^2 increase slightly in the interaction ANOVA model (see Table VIII), suggesting that the interaction terms did add explanatory power to the models. This finding supports the existence of a possible moderating effect.

Table VIII.
ANOVA results of firm performance for moderating variables

	ROA		ROE		RG		EP	
	Partial Eta Squared	*F*-statistic	Partial Eta Squared	*F*-statistic	Partial Eta Squared	*F*-statistic	Partial Eta Squared	*F*-statistic
ANOVA of Model 3								
Constant	0.000	0.183	0.000	0.006	0.004	3.774	0.008	2.775
HCEt	0.019	5.945***	0.018	5.367***	0.010	2.556**	0.020	1.872
CEEt	0.066	22.099***	0.026	7.952***	0.003	0.868	0.067	6.487***
SCEt	0.004	1.379	0.003	0.764	0.003	0.815	0.007	0.594
HCE t−1	0.003	1.037	0.004	1.140	0.004	1.057	0.006	0.537
CEE t−1	0.022	6.930***	0.003	0.820	0.006	1.516	0.011	1.007
SCE t−1	0.012	3.895***	0.009	2.601**	0.019	4.996***	0.001	0.064
CEEt * HCEt	0.021	2.920***	0.008	1.012	0.013	1.583	0.040	1.901*
CEEt * SCEt	0.013	1.053	0.016	1.238	0.022	1.576*	0.065	1.669*
Overall	0.608	39.407***	0.428	18.139***	0.089	2.143***	0.443	6.145***
Adjusted R^2	0.593		0.405		0.048		0.371	
ANOVA of Model 3 with interaction terms removed								
Constant	0.001	1.538	0.003	4.033	0.003	3.582	0.024	9.483***
HCEt	0.031	10.047***	0.031	9.68***	0.014	3.722***	0.066	6.769***
CEEt	0.305	139.349***	0.09	30.035***	0.003	0.825	0.059	6.084***
SCEt	0.006	1.943	0.005	1.504	0.004	1.086	0.003	0.296
HCE t−1	0.002	0.567	0.004	1.159	0.004	1.13	0.003	0.315
CEE t−1	0.019	6.162***	0.002	0.608	0.005	1.349	0.012	1.201
SCE t−1	0.014	4.459***	0.01	3.016**	0.018	4.813***	0.002	0.167
Overall	0.588	75.635***	0.41	35.129***	0.057	2.717***	0.366	9.291***
Adjusted R^2	0.581		0.399		0.036		0.327	

Notes: * indicates significant at the 10 percent level; ** indicates significant at the 5 percent level; *** indicates significant at the 1 percent level; Model 3: $PerfResids_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 HCE_{it-1} + \beta_5 SCE_{it-1} + \beta_6 CEE_{it-1} + \beta_7 HCEx_{it}CEE_{it} + \beta_8 SCE_{it}xCEE_{it} + \varepsilon_{it}$. Where: PerfResids is the residuals from a regression model where the independent variables include only the control variable

6. Conclusions

Firm value is based on more than physical capital. Intangible assets such as IC have always existed, however it is only recently that the accounting profession has seriously attempted to define, disclose, and measure them. As such, the nature of the relationship between IC and firm performance is a relatively virgin territory. Studies have investigated this relationship in various countries using various measurement tools. VAIC is one of these tools, providing easy access to information on a firm's IC efficiency. IC disclosure studies have been dominant in Australian IC research, however the IC and performance relationship has not been investigated. This study examines the practical implications of IC in Australian firms, asking whether IC has a positive relationship with firm performance. Using VAIC, the study investigates three main hypotheses regarding the relationship between IC and performance.

The first hypothesis investigates a direct relationship between IC and firm performance. Unfortunately the data does not meet all the assumptions of OLS regression and so some caution must be exercised in interpreting the findings. Nevertheless the results support this relationship, and suggest that human capital efficiency is a particularly important element of IC. Therefore, Australian firms do benefit from investing in their employees' skills and knowledge. However, physical and financial capital provides the strongest influence over firm performance, showing that intangible values are not yet the sole driver of firm success. On the other hand, structural capital is less important, and appears to detract from the explanatory power of VAIC over performance. Additionally, although VAIC significantly influences firm performance, it is not until VAIC is disaggregated that performance is explained substantially. The components of VAIC models explain ROA the most, ROE the second most, employee productivity the third most, and revenue growth the least.

The second hypothesis investigates a direct relationship between IC in the prior year and performance. This relationship is found with overall IC efficiency ($VAIC_{t-1}$), human capital efficiency (HCE_{t-1}) and structural capital efficiency (SCE_{t-1}). This suggests that human capital is important in the current year, and also has a significant lag effect that flows on to effect performance in the future. SCE appears to take longer to have an effect on firm performance.

The third hypothesis investigates an alternative interaction effect, specifically IC moderating the relationship between capital employed efficiency and performance. Results are not conclusive, but the findings suggest that this interaction could exist for both the structural and human capital efficiencies. Interaction effects provide a promising avenue for future IC research.

This study adds to the IC body of knowledge, and is the first to study the IC relationship with firm performance in Australia. Results are generally consistent with Chen *et al.* (2005), which examines Taiwanese firms and finds a small, but positive effect between IC and performance. Both Firer and Williams (2003), and Chan (2009b) conclude that firms and investors place greater importance on physical and financial capital than IC (human and structural capital) in South Africa and Hong Kong respectively. Even though Australia is a developed country whose firms might display a higher regard for IC than those in developing countries (Maditinos *et al.*, 2011), the same conclusion is supported in this study.

However there is also evidence of a smaller but consistent influence of IC on performance which should not be ignored. In particular the significant direct effect of human capital on the firm's performance both in the current and following periods, and the combined effect with physical and financial capital is of practical importance. These relationships indicate to firms that employees are extremely valuable assets that should not be neglected, in order to enhance firm performance and remain competitive in the market place.

Since physical and financial capital is an important determinant of firm performance, solely and in conjunction with human capital, further work could be done to examine the moderating relationship to identify which of either physical or financial capital plays the leading role in the interaction with human capital. In addition, further developments of this study could employ more sophisticated statistical techniques (e.g. non-linear and quantile regression) and could investigate performance lags of more than one year.

Notes

1. Hard IC is IC which the firm can determine a value (e.g. patents).
2. Functional IC incorporates organisational processes (e.g. monitoring processes).
3. Soft IC is IC which no value can be determined.
4. Return on assets, Return on equity, Revenue growth, and Employee productivity.
5. Just over 28 percent of Chen *et al.* (2005) sample are electronics firms.
6. The "Net value added approach" is VA as calculated above, less depreciation.
7. Prior literature has used size as a control variable (Firer and Williams, 2003; Shiu, 2006a, b; Chan, 2009a,b). However, all variables in this study are relative (ratio) measures. Therefore size is not included as a separate control variable.
8. Interest costs and debt covenants also hinder the ability of the firm to invest within IC (Williams, 2000).
9. The first year (2004) is represented by observations with all other year dummy variables equal to zero. Therefore, a fifth year dummy is not required, as it results in redundancy within the model. This argument also applies to the industry control variable.
10. $\text{Perf}_{it} = \beta_0 + \beta_1 \text{ Control variables}_{it} + \varepsilon_{it}$
11. A similar process was carried out in Tan *et al.* (2007).
12. The effect the control variables has on each performance measure is first excluded entirely before *H3* was tested. To do this, each performance measure is regressed with only the control variables in a separate OLS linear regression model (see Appendix, Table IX change to AI). The residuals from these regressions are saved as a separate variable, resulting in one set of control model residuals for each performance measure. These residuals are interpreted as the variance that the control variables cannot explain. The primary objective of this study is to examine the effect VAIC components have on firm performance, not what the control variables can explain. Therefore, rather than modelling performance itself (which incorporated the effect of the control variables), the control model residuals are analysed using ANOVA. By doing this, the explanatory power of the VAIC components and the interaction terms on performance can be examined in isolation.
13. Some studies delete companies with negative book values of equity or negative VAIC, HC or SC from their samples (e.g. Shiu (2006b) and Zeghal and Maaloul (2010)).
14. Some of the assumptions of OLS regression are not met so caution must be exercised in the interpretation of the results. There is some deviation from normality in the distribution of the

independent and dependent variables, from linearity in the relationship and in addition some homoscedasticity is present. However all VIF scores were below 3 and Durbin-Watson statistics were 2 or below, which indicates no problems with multicollinearity between independent variables or autocorrelation between residuals.

15. "Direct" refers to a term by itself. For example, "direct HCE" is the lone direct relationship HCE term, not the moderating CEE x HCE term.

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Corresponding author
Rosalind H. Whiting can be contacted at: ros.whiting@otago.ac.nz

Appendix

Table AI.
Regression statistics from the control variables only

	ROA		ROE		RG		EP	
	Significance	Direction	Significance	Direction	Significance	Direction	Significance	Direction
Constant		+		+		+	**	+
Yr05		−		−		+		+
Yr06		+		+		+		−
Yr07		+		−	**	+		−
Yr08		−	**	−		−	**	−
Materials	**	−	*	−		+	**	−
Consumer discretionary		−		+		+	**	−
Consumer staples		−		+		+	**	−
HealthCare	**	−	*	−		+	**	−
Energy	**	−	*	−		+	**	−
Financials		−		+		+	**	−
Industrials		−	*	+		+	**	−
InfoTech	*	−		−		+	**	−
Telecommunications	**	−		−		+	**	−
R&D intensive	*	−		−		−	*	+
Leverage		+		+		+	**	+
Adjusted R^2	0.124		0.132		0.005		0.225	
F-value	74.677**		79.211***		5.536**		36.842**	

Notes: * Indicates significant at the 5 percent level; ** indicates significant at the 1 percent level; $\text{Perf}_{it} = \beta_0 + \beta_1 \text{Control Variables}_{it} + \varepsilon_{it}$; The above model was used to remove the effect of the control variables from performance. The 2004 year control variable, and Utilities industry control variable were excluded from the regression equation to avoid the "dummy trap" of including redundant dummy variables