Invested resource, competitive intellectual capital, and corporate performance

Meng-Yuh Cheng
Department of Accounting Information, Da Yeh University, Changhua, Taiwan
Jer-Yan Lin
Department of Statistics, Feng Chia University, Taichung, Taiwan
Tzy-Yih Hsiao
Department of Accounting, Feng Chia University, Taichung, Taiwan, and
Thomas W. Lin
Marshall School of Business, University of Southern California, Los Angeles, California, USA

Abstract

Purpose – On the health care industry, the paper aims to study the effects of intellectual capital, identify using an input-process-output concept of human, customer, innovative and process capitals, on company performances.

Design/methodology/approach – From a resource-based and intellectual capital perspective, the structural path model is applied to financial data to analyze the six-value creation relationships among the four components of intellectual capital, as well as the causal effects of intellectual capital on company performance.

Findings – Empirical findings suggest a significant relationship between intellectual capital and company performance. These results also suggest that innovative capacity and process reformation shall be considered first, and through the human value-added of human capital, firms can improve their company's performance.

Originality/value – There have been many arguments as to whether intellectual capital is quantitatively measurable. This paper provides a tangible means of quantifying intellectual capital.

Keywords Intellectual capital, Business performance

Paper type Research paper

1. Introduction

In today's market, a noticeable increase in the gap between a firm's market value and its book value exists. Lev (2001) pointed out that between 1977 and 2001 the market-to-book value ratios of Standard and Poors (S&P) 500 companies increased from slightly above one to over five, implying that company financial statements may not represent their true value. Several scholars have explored the discrepancies between financial statements and the relative market value of companies. Edvinsson and Malone (1997) suggest that the difference between a company's market price and its book value is related to its intangible assets. Intellectual capital (IC), considered a synonym for "intangible assets", are often not reported on financial statements; yet they are considered very important and may constitute 80 percent of an organization's market value (Fornell, 2000). IC includes human, structural, and customer capital, and

Journal of Intellectual Capital
Vol. 11 No. 4, 2010
pp. 433-450

1469-1930
DOI 10.1108/14691931011085623

has been shown to play an increasingly important role in a company's competitive advantage, which can increase profit of a company (Hazlina and Zubaidah, 2008).

In 1984, Wernerfelt used economic theories to demonstrate that modeling a company according to its resources, leads to coherent diversification decisions by defining common non-financial links (Chatterjee and Wernerfelt, 1991). According to the resource-based theory (RBT), in order to develop a competitive advantage a company must have resources and capabilities that are superior to those of its competitor(s). RBT focuses on resources and their deployment in organizations, leading to value creation, and strategic management disciplines (Peppard and Rylander, 2001). This shows that competitive advantage and superior performance are related to acquiring, holding and subsequently using strategic assets (both tangible and intangible) that are vital to developing a competitive advantage and achieving strong financial performance. Traditionally, the tangible physical assets which were examined in RBT, were land, machines, and or financial capital.

Recently, IC has been identified as a key resource and driver of organizational performance and value creation. IC has shown to be necessary to firms for both achieving and sustaining a competitive advantage (Wu *et al.*, 2006), attracting attention among both academics and managers (Edvinsson and Malone, 1997. This new understanding shows that the management and development of IC confers greater competitive advantage thus, improving company performance. Consequently, IC has replaced tangible physical assets and capital as the primary basis of creating value (Wu *et al.*, 2006). The combination of the well-balanced components of IC implies high value creation potential and anticipated future income. (Hermans and Kauranen, 2005). Thus IC, in an RBT framework, increases an organization's competitive advantage due to the superior value created by its unique resources and capabilities.

Although RBT and the competitive advantage theory can describe relationships between resources and value creation, they are unable to illustrate relationships between individual resources. However, using an IC perspective enables us to do so. Many empirical studies of IC, like Bontis (1998), Bontis *et al.* (2000), Tseng and Goo (2005), and Chu *et al.* (2008), use different methodologies to analyze the relationships between different kinds of IC. Our research seeks to incorporate IC into an RBT-based complete value creation process that includes factors ranging from resource or capital input to performance output. Section 2 will explore the reviewed literatures that aided us in formulating our research hypotheses, followed by section 3 which discusses the research design and methodology. Section 4 describes the empirical analysis, and section 5 contains discussion and conclusion of this study

2. Literature review and research hypotheses

This section briefly describes and then integrates two principal theories regarding the creation of value in organizations: the resource-based perspective and the IC framework.

2.1 The resource-based perspective

Ownership of firm-specific assets enables a company to develop a competitive advantage. This leads to idiosyncratic endowments of proprietary resources (Barney, 1991; Peppard and Rylander, 2001). According to RBT, sustainable competitive advantage results from resources that are inimitable, not substitutable, tacit in nature,

and synergistic (Barney, 1991). Therefore, managers need to be able to identify the key resources and drivers of performance and value in their organizations.

The RBT also states that a company's competitive advantage is derived from the company's ability to assemble and exploit an appropriate combination of resources. Such resources can be tangible or intangible, and represent the inputs into a firm's production process; such as capital, equipment, the skills of individual employees, patents, financing, and talented managers. As a company's effectiveness and capabilities increase, the set of available resources tends to become larger. Through continued use, these "capabilities", defined as the capacity for a set of resources to integratively perform a stretch task or an activity, become stronger and more difficult for competitors to understand and imitate.

2.2 IC framework

IC, though understood to be extremely valuable, is an intangible asset, and is thus difficult to directly observe or measure. In fact, there is currently no clear definition of what constitutes IC. Common intangible assets in today's marketplace are corporation intellectual property (such as patents, trademarks, copyrights, and so on), goodwill and brand recognition. Brennan and Connell (2000) consider a narrower definition of intangible assets that does not include human resources, customer loyalty or company reputation. In Bontis's (1998) managerial conceptual study, he suggests that IC does not include intellectual property. While Edvinsson and Sullivan (1996) assume a very broad definition, they define IC as knowledge that can be converted into value.

Though it is unclear as to what IC "is", researchers have attempted to separate IC into three main components: human, structural, and customer capital (Roos *et al.*, 1998; Hermans and Kauranen, 2005). Wang and Chang (2005) and Tseng and Goo (2005) further extend the Edvinsson and Malone (1997) concept, and separated process capital and innovation capital from structural capital. This has lead to an emerging broad consensus on the definition of the following four interrelated categories of which most IC models are comprised: human, process, innovation, and customer capital (Table I).

2.3 Linkage of resource-based and IC perspective

The basic premise of RBT states that the value-creating capabilities of an organization are not related to the dynamics of the industry within which the organization competes, but rather to the processes of resource accumulation and deployment that are inherent to that organization. Peppard and Rylander (2001) present an input-process-output diagram to visually illustrate a relationship between resources and shareholder value. Because the RBT examines static measurement concepts, like the nature and quantity of deployed resources, it is unable to describe the value creation process, and thus does not provide managers with a precise framework for explaining how resource inputs are turned into outputs during the value creation process.

In response to the frustration associated with applying conventional management schemes to the leveraging of intangible resources, the IC perspective has emerged as a useful framework for describing firms' resources and value creation (Tseng and Goo, 2005), and has recently been adopted by academics over the resource-based perspective (Baxter and Matear, 2004; Martinez-Torres, 2006; Wu *et al.*, 2006).

Chatzkel (2002) notes that the IC perspective provides a bridge between resources and value by focusing attention on seeking out the best methods for extracting and

Table I.
Summary of recent research on IC

Authors	Research method	Source	Sample size	Object	Classification
Baxter and Matear (2004)	Path analysis	Questionnaire	314	New Zealand suppliers or distributors of manufactured goods	Human capital, Structural capital
Bollen *et al.* (2005)	Regression analysis	Questionnaire	41	German pharmaceutical industry	Human capital, Structural capital, Relationship capital
Chen *et al.* (2004)	Path analysis	Questionnaire	31	High-tech enterprizes	Human capital, Structural capital, Customer capital, Innovation capital
Chen *et al.* (2005)	Regression analysis	Secondary data	4,254	Firms listed on the Taiwan Stock Exchange	Human capital efficiency, Structural capital efficiency, Capital employed efficiency
Hermans and Kauranen (2005)	Regression analysis	Questionnaire	84	Biotechnology company	Human capital, Structural capital, Relationship capital
Martinez-Torres (2006)	Partial least squares	Questionnaire Secondary data	59	Knowledge-based organization	Human capital, Structural capital, Customer capital
Tseng and Goo (2005)	Structural equation model	Questionnaire	289	Top 500 Taiwanese manufacturers in terms of sales revenues	Human capital, Customer capital, Innovation capital, Organization capital
Wang and Chang (2005)	Partial least squares	Financial data	131	Firms in IT industry listed on the Taiwan Stock Exchange	Human capital, Customer capital, Innovation capital, Process capital

deploying maximum value from available resources. This study applies an IC framework in which the components of IC have been identified in an input-process-output concept, in order to illustrate the relationships between resources and value in the dynamic value creation process (Figure 1).

2.4 Constructing an empirical research framework

Due to the aforementioned lack of a clear definition of IC, various methods of measuring IC are currently used. For example, though brand equity is a form of IC, it lacks an easily defined physically measurable quantity. Aaker (1996), however, successfully combined perception and behavior measures to estimate the value of brand equity. This study extends Aaker's methodology by using financial measurements to estimate perception.

The previously mentioned four components of IC: innovation, process, human, and customer capital, are derived from managerial perception, and are not directly measured in financial reports. However, the authors believe that by considering these four components, respectively, "Innovative Capacity", "Efficient Operating Processes", "Human Value Added", and "Maintainable Customer Relationships", financial measures can be used to develop and explore a structural path model for the relationship between IC and performance.

2.4.1 Innovative capacity. Innovation capital refers to results of innovation that take the form of intellectual property rights, such as patents and licenses, and is a key factor for a company's ability to maintain long-term competitiveness. Previous researchers used perceived innovation capital, showing that intellectual property, innovation and technological ability contributed to corporate value. Though financial statements do not include data on such perceived innovation capital, some attempts to link financial data to innovation capital have been made. Wang and Chang (2005) use research and development (R&D) density to represent innovation ability.

Because R&D expenditures are fundamental to innovation, this study uses the financial measure of the input cost of innovation to describe the innovation process. Thus, innovative capacity is a measure of a company's ability to create new products

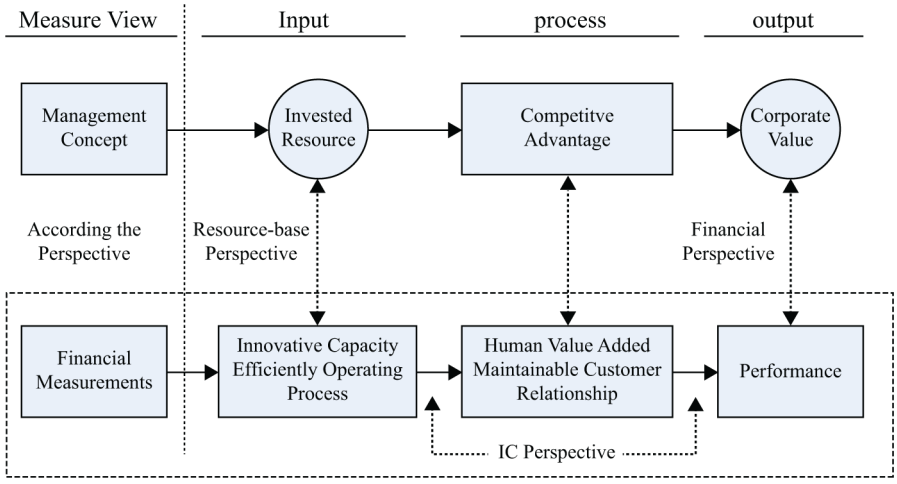

Figure 1.
Input-process-output concept and the conceptual model of this research

which meet customer's demands, and design more efficient operating processes. In regards to the relationships between innovative capacity and other forms of IC, this has lead to the following hypotheses:

H1a. Innovative capacity has a positive correlation with maintainable customer relationship costs.

H1b. Innovative capacity has a positive correlation with human value added resources.

2.4.2 Efficient operating processes. Process capital focuses on the internal procedures that define the system and structure of a company. These processes highlight the business activities that are especially favored by a company, investments in R&D, lead time, and the economy and productivity of administrative processes. Processes are also an expression of quality, error rate and waiting time, according to the Danish Trade and Industry Development Council (DTIDC, 1997). In this sense, companies with strong and efficient process capital will create favorable conditions for customers (Chen *et al.*, 2004).

To achieve improved customer relationships, a business may need to shorten the cycle time of its operating processes and develop high-quality internal processes. For example, Seggie *et al.* (2006) show that the positive effect of partner dependence on the focal firm is a causal factor of firm performance, and thus an excellent supply chain can improve customer relationships.

According to balanced score card perspective, a company that displays efficient operating processes with reduced cycle time and improved quality, creates customer loyalty (Kaplan and Norton, 1996). The proxy variables which represent the efficiency of internal control of a company's operating process include inventory turnover, receivables, fixed assets, and total assets turnover. This study extends the work of Wang and Chang (2005), by using turnover to measure process capital. Assuming higher turnover rates represent more efficient operation processes, the authors infer that higher turnover rates allow for a reduction in the input costs of maintaining customer relationships, such as selling, advertising, and general administrative expenses. This leads us to the following hypothesis:

H2. Efficient operating processes reduce the costs of maintaining customer relationships.

2.4.3 Human value added. Hayton (2005) indicated that human capital refers to knowledge, skills, and the abilities of employees (Martinez-Torres, 2006), and that the depth and breadth of expertise and other human capital characteristics of top management teams are a major organizational resource. Jardón and Martos (2008) study a sequential model where the human capital is in the base of the other dimensions of intellectual capital. Human capital is developed in internal relations within the company generating capital structural.

According to the results of Kamath (2007), Yalama and Coskun (2007) and Ting and Lean (2009), human capital is important factor for company and has a positive relationship with the firm's performance. Furthermore, excellent human capital increases customer trust. To measure such indices of human capital, the authors exclude background information concepts of human capital (Jardón and Martos, 2008,

2009) and consider output concepts as proxies for knowledge-based resources in accounting statements and financial reports.

Then the efficiency by output concept of human resources is adopted, to represent human capital. By replacing the background information of human resources, the output concept is employees' value added output ability. In financial reports, the authors find that the output view of human resources provides a suitable measure that can represent human capital. Using the output view, the quantitatively efficiency of employees and managers indicates human capital as productivity and value added.

Hayton (2005) uses the formal educational and industry experience of managers to describe human capital. Wang and Chang (2005) adopt the scale of a company, and its employees' ages, education, and experience in order to analyze human capital's relationship with other types of capital. As mentioned above, the value added output of employees and managers is the created value by their using abilities of any innovative process. Hence, this study argues that value added human resources is an appropriate intermediary variable between innovation capital and performance. These abilities also improve a company's relationship with its customers, and can help companies retain major customers. Consequently, the following hypothesis is proposed:

H3. Human value added is positively correlated with maintainable customer relationships.

2.4.4 Maintainable customer relationships. Customer capital is the knowledge embedded in the relationships with any stakeholder that influences an organization. Bontis (1998) states that knowledge of marketing channels and customer relationships play a major role in customer capital, and that they are primarily derived from knowledge embedded in relationships that are external to the company. Prahalad and Ramaswamy (2000) suggest that customers become a new source of competence for the organization because they renew the overall competency of the organization. In addition, other aspects relating to suppliers and competitors contribute to customer capital. Fornell (1992) finds that customer satisfaction enhances business relationships, decreases the elasticity of product price and improves company prestige.

In this study, customer capital is classified by market intensity and marketing capabilities, which are used to describe relationships with stakeholders. An interesting point relates to the relationship between customer capital and corporation performance. The quality perceived by customers is the key factor of customer satisfaction. Customer expectations and perceived value are not controllable, but input cost of maintaining customer relationships is measurable.

This study uses maintaining customer relationships, instead of customer behavior, to measure performance. A company's primary task in enhancing customer satisfaction is to increase perceived quality. Thus, companies often have large budgets for maintaining customer relationships in order to maintain or create a positive customer image. Maintaining customer relationships positively affects performance.

Morgan and Hunt (1999) noted that financial performance is an outcome of resource value. Recently, other researchers have also discovered that human capital, positively affects a company's value. Bontis *et al.* (2000) find consistent results with Bontis (1998), namely that human capital significantly affects company performance. Chen *et al.* (2005) showed that companies with human capital efficiencies tend to have higher financial performance. Wang and Chang (2005) argue that human capital directly and

positively affects innovation capital and process capital, which then affects performance. Hayton (2005) also showed that the human capital of a company's top management team is significant. In a good working environment, the employees are more willing and able to create organizational performance.

Based on these previous findings, the following hypotheses are proposed:

H4a. The higher the maintainable customer relationship cost, the higher the positive effect on the corporation's performance.

H4b. The higher the human value added resources are, the higher the positive effect is on corporate performance.

The influential factors between structural capital and company performance are innovative capacity and efficient operating process capital, as shown in Figure 2.

3. Research design and methodology

Previous studies of IC, have been based on questionnaire data that analyze subjective managerial measures of behavior perceptions (Bollen *et al.*, 2005; Tseng and Goo, 2005; Chen *et al.*, 2005; Martinez-Torres, 2006). These questionnaires collected data from behavioral attitudes, which is an indirect method, and investigated the relationships between IC perceptions and company value (Baxter and Matear, 2004; Bollen *et al.*, 2005; Tseng and Goo, 2005; Martinez-Torres, 2006). In this study, the authors draw behavioral perceptions from financial measurements. Using the results from prior questionnaire based research as a framework; the authors attempt to find financial data that can represent questionnaire items. The advantages of using financial data lie in their directness, transparency and accuracy, as confirmed through audits carried out by Certified Public Accountants (CPA). Adopting real financial data also allows us to attempt to compensate for the subjectivity and quantitative insufficiencies of the managerial behavior perceptions found in prior research.

3.1 Conceptual model

Quantitative studies of the relationship between IC and corporate value can be classified into those that attempt to measure management concepts and those that use financial figures (Figure 1, left side). Previous studies have focused on management concepts and

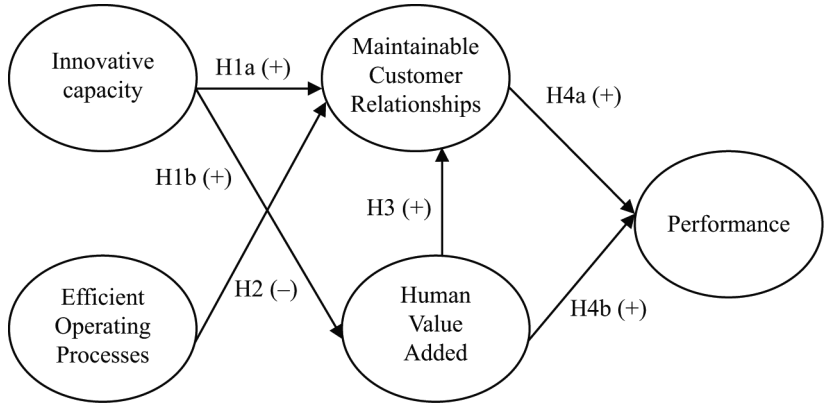

Figure 2.
Structural and measurement model

behavior perceptions in order to describe IC (Martinez-Torres, 2006). Figure 1 shows the conceptual model of this research. This study applied the input-process-output concept to investigate the interrelationships between individual components of IC and corporate value. Regardless of managerial concepts or financial measurements, they also use resource-based perspectives to describe input resource and apply financial perspectives to illustrate output results (as shown middle in Figure 1).

From a financial measurement view, first, the innovative capacity and efficient operating processes are used as proxy variables of invested resources. Second, the human value added resources and maintained customer relationships represent competitive advantages; and finally, performance was used to explain corporate value. Additionally, this paper uses the IC perspective to describe the value-creating process. The line in Figure 1 reflects the research framework of this paper. The following conceptual model was developed for use in this study.

3.2 Construct measurement

Based on the value distinction tree introduced by Roos *et al.* (1998), the components of IC include human, innovation, processes and customer capital. Financial indicators that represent quantitative measurements of each IC component were adopted from previous studies of IC or other determinants of business performance (Table II).

For measurement of innovative capacity based on the theories of Chen *et al.* (2004), they use new technology and product to represent innovative output. Our innovative output replaces sale revenue. The authors adopted variables on R&D density from Hermans and Kauranen (2005), and Wu *et al.* (2006). In addition, in accordance with Chu *et al.* (2008), data representing the tangible assets possessed by employees as a proxy for measuring equipment capacity was also collected. Administrative expense ratios were taken from Danish Trade and Industry Development Council (DTIDC, 1997), and the largest customer sales were used to assess the amount of maintainable customer relationships.

To measure the efficiency of human value added resources, this study extend DTIDC (1997), and Wang and Chang (2005) methodology, the authors adopted the productivity and value added output of employees and managers variables. Operating process capital, based on Chen *et al.* (2004) and Chu *et al.* (2008), was assessed using inventory and asset turnover variables found on financial statements that measured process efficiency. For performance, return on assets and equity, Tobin's Q, and price to book ratio were taken, calculated, as in Bontis *et al.* (2000), Gleason *et al.* (2000), Chen *et al.* (2005), and Chu *et al.* (2008).

3.3 Data collection and sample

A study by Read *et al.* (2001) that looked at the market to book value ratio of 15 different industries, was discovered that the pharmaceutical industry not IT tops that list with a ratio of almost 30:1. The research uses the US healthcare industry, including health care equipment and pharmaceuticals firms listed on GICS1 35[1] in the S&P500 from a database of publicly traded firms in the COMPUSTAT databank, as the research model. The health care industry shows all the characteristics of knowledge-based companies, and relies on innovation through the utilization of emerging technologies for the development of new products and services. This implies that the way companies within the health care industry develop and handle knowledge

Variables	Sources
Innovative capacity	
Current year R&D density (INN1)	Chen *et al.* (2004), Wang and Chang (2005)
Last year R&D density (INN2)	Chen *et al.* (2004), Wang and Chang (2005)
R&D intensity (INN3)	Wang and Chang (2005)
Per employee equipment (INN4)	Chu *et al.* (2008)
Maintainable customer relationships	
Largest single customer (CUS1)	Sales of the largest customer by net sale
Concentration (CUS2)	Wang and Chang (2005)
Selling, general and administrative expense ratio adjusted by sale (CUS3)	DTIDC (1997), Wang and Chang (2005)
Selling, general and administrative expense ratio adjusted by all cost (CUS4)	DTIDC (1997)
Human value added	
Productivity per employee (HUM1)	Wang and Chang (2005)
Productivity per manager's average salary (HUM2)	(Sale by employees)/(average salary of top five senior executives)
Operating income per employee (HUM3)	Operating income by employees
Operating income per manager's average salary (HUM4)	(Operating income by employees)/(average salary of top five senior executives)
Value added per employee (HUM5)	DTIDC (1997), Wang and Chang (2005)
Value added per manager's average salary (HUM6)	(Net income by employees)/(average salary of top five senior executives)
Efficient operating processes	
Inventory turnover (PRO1)	Chen *et al.* (2004), Wang and Chang (2005)
Receivables turnover (PRO2)	Net sales divided by the average of total receivables
Fixed asset turnover (PRO3)	Chen *et al.* (2004), Chu *et al.* (2008)
Total assets turnover (PRO4)	Chu *et al.* (2008)
Performance	
Return on assets (PER1)	Bontis *et al.* (2000), Chen *et al.* (2005), Gleason *et al.* (2000), Chu *et al.* (2008)
Return on equity (PER2)	Chen *et al.* (2005), Chu *et al.* (2008)
Tobin's *Q* (PER3)	Bontis *et al.* (2000), Chen *et al.* (2005), Wang and Chang (2005), Tseng and Goo (2005)
Price to book ratio (PER4)	Bontis *et al.* (2000)

Table II.
Research variables

has a large impact on their economic success. Business performance within the health care industry is driven by specific internal and external resources, which are composed of intangible assets and the technological infrastructure that enhances a company's unique core competencies.

The authors collected supplementary data from publicly available financial reports such as the 10 K, and proxy statements. Data was selected according to the following criteria:

- the company has no missing values during the sample period; and
- the company had 10 K and proxy statements available.

From the selection criteria, 224 samples from 56 companies spanning the period 2002-2005 were considered.

4. Analysis and results

4.1 Descriptive analysis

Table III displays descriptive statistics. In 2005, the total assets ranged from $117.57 billion to $1.43 billion. The mean of market value, sales, and R&D expenses were $26.21, $14.79 and $1 billion, respectively. Zero minimum value of R&D expenses indicates no R&D investment. This indicates that the health care equipment sector includes service companies that may not invest in R&D.

Table IV summarizes the descriptive statistics of each intangible resource and company performance indicator. Because value added output of employees and managers (HUM5 and HUM6), and items of performance are measured through net income, the minimum values of these variables are negative, most likely due to net loss experienced by some companies.

Data reliability depends on how the data is used, and first needs to be assessed (Churchill, 1979). Cronbach's alpha tests the reliability of data measurement by gauging the correlation of an item with the sum of other items, as suggested by Nunnally (1978). For our data, the Cronbach alphas results for innovative capacity, maintainable customer relationships, human value added, efficient operating processes, and performance are 0.921, 0.709, 0.602, 0.547, and 0.611, respectively (Table V). All five values are above 0.5, which indicates reliability within acceptable ranges (Dey, 2008).

Traditionally, researchers using Cronbach's α and internal consistency measure convergent validities. In Table V, all measures sufficient Cronbach's α and internal consistency to exceed Nunnally's "modest" standard of 0.70 (Nunnally, 1978). The traditional methodological complement to convergent validity is discriminant validity, which represents the extent to which measures of a given construct differ from measures of their constructs in the same model. To assess discriminate validity, Fornell and Larcker (1981) suggest the use of Average Variance Extracted (AVE). An AVE value of at least 0.5 indicates sufficient convergent validity, meaning that a latent

	Min.[a]	Max.[a]	Mean[a]	SD[a]
Total assets – 2002	786	88,950	10,955	15,969
Total assets – 2003	951	116,775	13,260	21,019
Total assets – 2004	1,014	123,684	14,815	21,649
Total assets – 2005	1,429	117,565	15,308	20,405
Sales – 2002	404	57,121	10,708	14,431
Sales – 2003	679	69,506.1	11,505	15,461
Sales – 2004	883	80,515	13,064	17,545
Sales – 2005	991	88,050	14,787	19,613
R&D expense – 2002	0	5,176	747	1,267
R&D expense – 2003	0	12,183	944	20,694
R&D expense – 2004	0	8,755	926	1,703
R&D expense – 2005	0	9,094	1,003	1,831
Market value – 2002	1,034	188,377	21,607	38,168
Market value – 2003	2,100	269,622	24,995	44,552
Market value – 2004	2,477	202,508	25,030	38,913
Market value – 2005	3,070	178,798	26,209	36,210

Note: [a]All entries are in millions of US dollars

Table III.
Descriptive statistics of health care firms – GICS35 ($n = 224$)[a]

Variables[a]	Min.	Max.	Mean	SD
INN1	0.0	75.3	5.7	9.37
INN2	0.0	75.3	5.8	9.94
INN3	0.0	46.0	3.8	6.18
INN4	0.0	2.8	0.5	0.52
CUS1	0.0	92.9	5.0	10.93
CUS2	0.0	92.1	8.9	19.89
CUS3	0.8	72.0	30.9	16.84
CUS4	0.9	90.0	43.1	25.38
HUM1	0.0	4.1	0.6	0.69
HUM2	0.0	4.2	0.5	0.69
HUM3	0.0	0.6	0.1	0.08
HUM4	0.0	0.5	0.1	0.09
HUM5	−0.7	0.4	0.0	0.08
HUM6	−0.7	0.4	0.0	0.08
PRO1	0.7	102.6	10.2	17.13
PRO2	0.9	45.1	9.2	7.37
PRO3	0.9	162.7	18.5	32.46
PRO4	0.1	4.9	1.2	1.05
PER1	−50.2	42.8	8.2	7.70
PER2	−103.8	317.8	18.6	28.19
PER3	0.8	31.4	4.9	3.70
PER4	−7.5	44.0	5.2	5.06

Note: [a]Variable definitions are shown in Table II

Table IV.
Descriptive statistics of research variables

variable is able to explain more than half of the variance of its indicator on average. Table V, Cronbach's α, internal consistency and AVE exceeded the threshold levels commonly suggested in the literatures (Nunnally, 1978; Fornell and Larcker, 1981). The fit statistics propose a superior degree of reliability and convergent validity of all components.

4.2 Analytical procedures

This study uses the Structural Equation Model (SEM) to assess the direct and indirect relationships between IC and corporate performance. Two-step approaches are applied, beginning with a confirmatory factor analysis (CFA) and then the cause-effect among latent constructs by using the LISREL package (Babin *et al.*, 2008). In assessing the fit of the model with the dataset, Hu and Bentler (1999) suggest a comparative fit index (CFI) and nonnormed fit index (NNFI) close to 0.95, and a root mean square error of approximation (RMSEA) close to 0.06 for a good fit. Our CFA results show a good fit for the model with $\chi^2 = 155.07$ on 80 df, CFI = 0.975, NNFI = 0.962 RMSEA = 0.065, and GFI = 0.92, AGFI = 0.863. In addition, all loadings for each component of IC are significantly positive.

The second step in the two-step approach specifies the causal relationships among latent constructs. From the good overall fit of our data, the study has confident in the reliability of hypothesis testing. The six path relationships shown in Figure 2 are further analyzed using Path Analysis in order to show the significance of the individual paths. Table VI lists analytical results for the structural path model. The model results in a good validation with $\chi^2 = 1.70$ on 2 df, CFI = 1.00, NNFI = 0.99,

	Factor loadings	Measurement error	Internal consistency[a]	Cronbach α	AVE[b]
Innovative capacity			0.919	0.921	0.834
INN1	0.983	0.034			
INN2	0.980	0.040			
INN3	0.894	0.201			
INN4	0.781	0.390			
Maintainable customer relationships			0.985	0.709	0.885
CUS1	0.915	0.163			
CUS2	0.875	0.234			
CUS3	0.988	0.024			
CUS4	0.980	0.040			
Human value added			0.952	0.602	0.915
HUM1	0.981	0.038			
HUM2	0.982	0.036			
HUM3	0.944	0.109			
HUM4	0.934	0.128			
HUM5	0.946	0.105			
HUM6	0.952	0.094			
Efficient operating process			0.968	0.547	0.758
PRO1	0.633	0.599			
PRO2	0.905	0.181			
PRO3	0.938	0.120			
PRO4	0.965	0.069			
Performance			0.934	0.611	0.741
PER1	0.745	0.445			
PER2	0.860	0.260			
PER3	0.919	0.155			
PER4	0.908	0.176			

Notes: [a] Internal consistency $= (\sum\lambda_{yt})^2/[(\sum\lambda_{yt})^2 + \sum \mathrm{var}(\varepsilon_i)]$
[b]Average variance extracted $= \sum\lambda_{yt}^2/[\sum\lambda_{yt}^2 + \sum \mathrm{var}(\varepsilon_i)]$

Table V.
Validity test for the five components

	Path description	Coefficient	SD	*t*-value
H1a	Innovative capacity → Maintainable customer relationship	0.30^{***}	0.05	6.06
H1b	Innovative capacity → Human value added	0.09^{*}	0.07	1.39
H2	Efficient operating processes → Maintainable customer relationships	-0.52^{***}	0.05	−10.37
H3	Human value added → Maintainable customer relationships	0.19^{***}	0.05	4.04
H4a	Maintainable customer relationships → Corporation performance	0.12^{*}	0.09	1.25
H4b	Human value added → Corporation performance	0.28^{***}	0.07	−1.60

Notes: Significant at $^{*} < 0.1$; $^{**} < 0.05$; $^{***} < 0.01$

Table VI.
Results of parameter estimates for the structural path model

RMSEA = 0 and GFI = 0.997, AGFI = 0.977. From the parameter estimates in Table VI, it is shown that all coefficients of the estimated parameters fit expectations and are significant.

In terms of the first hypothesis, effective management of innovation input is shown to enhance customer relationships (*H1a*). Innovative capacity has a strong positive impact on maintainable customer relationships ($\beta_{1a} = 0.30$, $p < 0.01$). This study found similar findings to Tseng and Goo (2005). On the other hand (*H1b*) Innovative capacity showed to only have a slightly positive effect on human value added resources ($\beta_{1b} = 0.09$, $p < 0.1$).

H2 is highly supported, with the finding of an inverse and significant relationship between the effective management of operating processes and the input cost of maintainable customer relationships ($\beta_2 = -0.52, p < 0.01$). This may be the first time that a measurement of the efficiency of operating processes has been related to maintainable customer relationships. Our findings suggest that efficient operating processes will likely reduce sales and administrative expenses.

H3 was also supported, as human value added has a positive relationship with maintaining customer relationships ($\beta_3 = 0.19$, $p < 0.01$). This result suggests that strong human value added resources can lead to a significantly positive enhancement of customer relationships, similar to the findings of Bollen *et al.* (2005), Chen *et al.* (2004), Seggie *et al.* (2006), Tseng and Goo (2005) and Wang and Chang (2005).

In terms of *H4*, our analysis shows that maintainable customer relationships have little effect on company performance. From the financial perspective, human value added efficiency has significant effects on company performance. This is similar to the findings of Bollen *et al.* (2005), Chen *et al.* (2005), and Hayton (2005) that effective management of human value added resources enhances company performance, as indicated by increased returns on its assets and equity.

5. Discussion and conclusion

The relevant literature surrounding IC, used perception-based questionnaires (Baxter and Matear, 2004; Bollen *et al.*, 2005; Bontis, 1998), but few studies have used financial data. For investors, financial measurements of IC are more useful when making decisions. This study also adopted financial data to find value drivers. Using different components of IC data to investigate the same subject can yield different results. Evidence from this study indicates that from the resource input concept, innovation and operating processes play antecedent roles.

Both types of capital affect performance via the intermediary components of maintainable customer relationships. These results are different from previous research, because the authors adopted a distinctive input-process-output concept. The results presents that efficient operating processes and maintainable customer relationships have a significantly inverse relationship. This phenomenon implies that by reducing spending, managers can increase the maintainability of customer relationships. Yet at the same time, by maintaining customer relationships, managers can strengthen the efficiency of execution in addition to rising promotional and advertisement budgets.

According to our results, IC significantly influences company performance. An input-process-output concept shows that innovative capacity and efficient operating processes are antecedent factors which represent input invested resources. Two other

IC components, human value added and maintainable customer relationships are also factors in the competitive advantage of a company. Innovative capacity and efficient operating processes indirectly affect company performance via maintainable customer relationships and human value added resources.

This study used short-term turnover as an indicator of a company's efficiency. Therefore, efficient operating processes can be used as a proxy indicator of maintainable customer relationships. Short-term turnover will deepen the positive image of a company held by customers and improve a company's customer relationships. This is an important message to business managers: if companies want to use IC to improve their performance, innovative capacity and increased efficiency of operating processes must be considered. This implies that managers that wish to quickly improve corporate value should begin with innovative capacity and efficient operating processes.

In summary, the six hypotheses were accepted, indicating that the six value-creating paths are useful for guiding efforts to enhance corporate performance through IC management. This study cannot describe the relation between markets and financial performance, because the authors simultaneously considered market and financial performance. Future research can divide performance measures into two segments, market and financial performance, and investigate their relationship.

Note

1. The GICS is used as basis for certain Morgan Stanley financial market indexes. It was developed by Morgan Stanley Capital International (MSCI). The GICS structure consists of ten sectors, 24 industry groups, 67 industries and 147 sub-industries.

References

Aaker, D.A. (1996), "Measuring brand equity across products and markets", *Calfornia Management Review*, Vol. 38 No. 3, pp. 102-20.

Babin, B.J., Hair, J.F. and Boles, J.S. (2008), "Publishing research in marketing journals using structural equation modeling", *Journal of Marketing Theory and Practice*, Vol. 16 No. 4, pp. 279-85.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17, pp. 99-120.

Baxter, R. and Matear, S. (2004), "Measuring intangible value in business-to-business buyer-seller relationships: an intellectual capital perspective", *Industrial Marketing Management*, Vol. 33, pp. 491-500.

Bollen, L., Vergauwen, P. and Schnieders, S. (2005), "Linking intellectual capital and intellectual property to company performance", *Management Decision*, Vol. 43 No. 9, pp. 1161-85.

Bontis, N. (1998), "Intellectual capital: an exploratory study develops measures and model", *Management Decision*, Vol. 36 No. 2, pp. 63-76.

Bontis, N., Keow, W.C. and Richardson, S. (2000), "Intellectual capital and business performance in Malaysian industries", *Journal of Intellectual Capital*, Vol. 1 No. 1, pp. 85-100.

Brennan, N. and Connell, B. (2000), "Intellectual capital: current issues and policy implications", *Journal of Intellectual Capital*, Vol. 1 No. 3, pp. 206-40.

Chatterjee, S. and Wernerfelt, B. (1991), "The link between resources and types of diversification: theory and evidence", *Strategic Management Journal*, Vol. 12, pp. 33-48.

Chatzkel, J. (2002), "A conversation with Goran Roos", *Journal of Intellectual Capital*, Vol. 3 No. 2, pp. 96-117.

Chen, J., Zhu, Z. and Xie, H.Y. (2004), "Measuring intellectual capital: a new model and empirical study", *Journal of Intellectual Capital*, Vol. 5 No. 1, pp. 192-212.

Chen, M.C., Cheng, S.J. and Hwang, Y.C. (2005), "An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance", *Journal of Intellectual Capital*, Vol. 6 No. 2, pp. 159-76.

Chu, P.Y., Hsiung, H.H., Huang, C.H. and Yang, C.Y. (2008), "Determinants of the valuation of intangible assets- a contrast between Taiwanese and American IC design houses", *International Journal of Technology Management*, Vol. 41 Nos 3/4, pp. 336-58.

Churchill, G.A. (1979), "A paradigm for developing better measures of marketing constructs", *Journal of Marketing Research*, Vol. 16, pp. 64-73.

Danish Trade and Industry Development Council (DTIDC) (1997), *Intellectual Capital Accounts Reporting and Managing Intellectual Capital*, The Danish Trade and Industry Development Council (DTIDC).

Dey, A. (2008), "Corporate governance and agency conflicts", *Journal of Accounting Research*, Vol. 46 No. 5, pp. 1143-81.

Edvinsson, L. and Malone, M.S. (1997), *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Brainpower*, HarperCollins, New York, NY.

Edvinsson, L. and Sullivan, P. (1996), "Developing a model for managing intellectual capital", *European Management Journal*, Vol. 14 No. 4, pp. 356-64.

Fornell, C. (1992), "A national customer satisfaction barometer: the Swedish experience", *Journal of Marketing*, Vol. 55, pp. 1-22.

Fornell, C. (2000), "Customer asset management, capital efficiency, and shareholder value", paper presented at Performance Measurement, Past, Present and Future Conference, July.

Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18, pp. 39-50.

Gleason, K.C., Mathur, L.K. and Mathur, I. (2000), "The interrelationship between culture, capital structure, and performance: evidence from European retailers", *Journal of Business Research*, Vol. 50, pp. 185-91.

Hayton, J.C. (2005), "Competing in the new economy: the effect of intellectual capital on corporate entrepreneurship in high-technology new ventures", *R&D Management*, Vol. 35 No. 2, pp. 137-55.

Hazlina, H. and Zubaidah, Z.A. (2008), "Relationship between intellectual capital and firms' performance: evidence from public listed companies in Malaysia", *Proceedings of International Accounting Business Conference, Johor Bahru, Malaysia*.

Hermans, R. and Kauranen, I. (2005), "Value creation potential of intellectual capital in biotechnology – empirical evidence form Finland", *R&D Management*, Vol. 35 No. 2, pp. 171-85.

Hu, L.T. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modeling*, Vol. 6 No. 1, pp. 1-55.

Jardón, C. and Martos, M. (2008), "Capital intellectual y resultados empresariales en la cadena de la madera de Oberá (Argentina)", *Estudios De Economia Aplicada*, Vol. 26 No. 3, pp. 141-64.

Jardón, C. and Martos, M. (2009), "Intellectual capital and performance in wood industries of Argentina", *Journal of Intellectual Capital*, Vol. 10 No. 4, pp. 600-16.

Kamath, G.B. (2007), "The intellectual capital performance of Indian banking sector", *Journal of Intellectual Capital*, Vol. 8 No. 1, pp. 99-123.

Kaplan, R.S. and Norton, D.P. (1996), "Linking the Balanced Scorecard to strategy", *California Management Review*, Vol. 39 No. 1, pp. 53-79.

Lev, B. (2001), *Intangibles: Management, Measurement, and Reporting*, The Brookings Institution, Washington, DC.

Martinez-Torres, M.R. (2006), "A procedure to design a structural and measurement model of intellectual capital: an exploratory study", *Information & Management*, Vol. 43, pp. 617-26.

Morgan, R.M. and Hunt, S. (1999), "Relationship-based competitive advantage: the role of relationship marketing in marketing strategy", *Journal of Business Research*, Vol. 46, pp. 281-90.

Nunnally, J.C. (1978), *Psychometric Theory*, 2nd ed., McGraw-Hill, New York, NY.

Peppard, J. and Rylander, A. (2001), "Using an intellectual capital perspective to design and implement a growth strategy: the case of APion", *European Management Journal*, Vol. 19 No. 5, pp. 510-25.

Prahalad, C.K. and Ramaswamy, V. (2000), "Co-opting customer competence", *Harvard Business Review*, Vol. 78 No. 1, pp. 79-87.

Read, C., Ross, J., Dunleavy, J., Schulman, D.S. and Bramante, J. (2001), *eCFO: Sustaining Value in the New Corporation*, Price Waterhouse Coopers.

Roos, J., Roos, G., Dragonetti, N. and Edvinsson, L. (1998), *Intellectual Capital: Navigating in the New Business Landscape*, Macmillan Business, London.

Seggie, S.H., Kim, D. and Cavusgil, S.T. (2006), "Do supply chain IT alignment and supply chain interfirm system integration impact upon brand equity and firm performance?", *Journal of Business Research*, Vol. 59, pp. 887-95.

Ting, I. and Lean, H.H. (2009), "Intellectual capital performance of financial institutions in Malaysia", *Journal of Intellectual Capital*, Vol. 10 No. 4, pp. 588-99.

Tseng, C.Y. and Goo, Y.J. (2005), "Intellectual capital and corporate value in an emerging economy: empirical study of Taiwanese manufacturers", *R&D Management*, Vol. 38 No. 2, pp. 187-201.

Wang, W.Y. and Chang, C.F. (2005), "Intellectual capital and performance in causal models-evidence form the information technology industry in Taiwan", *Journal of Intellectual Capital*, Vol. 6 No. 2, pp. 222-36.

Wu, W.Y., Tsai, J.J., Cheng, K.Y. and Lai, M. (2006), "Assessment of intellectual capital management in Taiwanese IC design companies: using DEA and the Malmquist productivity index", *R&D Management*, Vol. 35 No. 2, pp. 531-45.

Yalama, A. and Coskun, M. (2007), "Intellectual capital performance of quoted banks on the Istanbul stock exchange market", *Journal of Intellectual Capital*, Vol. 8 No. 2, pp. 256-7.

About the authors

Meng-Yuh Cheng is Assistant Professor in the Department of Accounting Information, Da Yeh University, Taiwan R.O.C. She received her doctorate in Business from Feng Chia University. Her current research interests include intellectual capital and family business. She has published in *Journal of Intellectual Capital, International Journal of Services and Standards (IJSS),* and others. Meng-Yuh Cheng is the corresponding author and can be contacted at: bh7349@mail.dyu.edu.tw

Jer-Yan Lin is Professor in the Department of Statistics, Feng Chia University, Taiwan. He received his doctorate in Statistics from University of California at Santa Barbara. His current

research interests include selection and ranking, applied statistical disciplines at intangible assets, employee management, and materials engineering. He has published in *Physica-A, Textile Research Journal, Materials Letters, Japanese Journal of Applied Physics, International Journal of Business and Economics* and others.

Tzy-Yih Hsiao is Professor in the Department of Accounting, Feng Chia University, Taiwan. He received his doctorate in Management Science from National Chiao Tung University. His current research interests include fuzzy, intangible assets, employee bonus and earning management. He has published in *European Journal of Operational Research*, *International Journal of Management*, Advances *in Quantitative Analysis of Finance and Accounting*, *Journal of Interdisciplinary Mathematic*, and others.

Thomas W. Lin is Professor at Marshall School of Business, University of Southern California. Thomas Lin specializes in management accounting and control systems, strategic cost management, and Chinese accounting and management. He has published over 50 articles in refereed journals and several books, including Cost Management and Advanced Auditing. He serves on the editorial board of the *Journal of Economics and Management* and the *Journal of Accounting and Corporate Governance*. He received best paper awards from the *Journal of Management Accounting Research* and the 9th World Congress of Accounting Educators; is the founding president of the Chinese Accounting Professors Association of North America; and former president of the Chinese-American Faculty Association of Southern California.