

Intellectual capital and corporate value in an emerging economy: empirical study of Taiwanese manufacturers

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Competitive success now is based less on the strategic allocation of physical and financial resources, and more on the strategic management of intellectual capital. Although intellectual capital is intangible and cannot be accurately measured, companies must develop methods of increasing corporate value by proactively focusing on intellectual capital management. This study examines the relationship between intellectual capital and corporate value in an emerging economy.

This study employs an intellectual capital perspective, resource-based view and a financial perspective, and investigates how to apply the concept of intellectual capital to value creation. After reviewing the relevant literature, this study identifies human capital, organizational capital, innovation capital and relationship capital as four constructs of intellectual capital. Corporate value is measured using three selection methods: (1) Market/Book value, (2) Tobin's *Q* and (3) Value Added Intellectual Coefficient (VAIC™). Through a questionnaire survey and secondary data collection, this study applies the Structure Equation Model to analyze the relationships among four constructs of intellectual capital, as well as the relationship between intellectual capital and corporate value.

From the empirical findings, for Taiwanese manufacturers, a positive relationship exists between intellectual capital and corporate value. This study visualizes and mobilizes intellectual capital to articulate eight value creation paths.

1. Introduction

Knowledge and innovation are the dominating resources in the contemporary knowledge-based economy, and are far more important than land, capital or labor. Effective management of knowledge-based intellect and intangible assets thus has become a key to corporate success,

especially in the knowledge-based industries (Quinn et al., 1996). Data from Morgan Stanley's World Index revealed that the listed value of these companies, in the USA, ranges between twice and nine times their book value (Edvinsson and Malone, 1997). Since much of the value of knowledge-based companies is intangible, balance sheets cannot accurately represent the true value of these

companies. The difference between the market value and book value of a company is said to represent its intellectual capital (Edvinsson and Malone, 1997; Roos and Roos, 1997; Sveiby, 1997; Bukh et al., 2001). Competitive success depends less on the strategic allocation of physical and financial resources, and more on strategic management of intellectual capital. Since intangible assets often represent more than two-third of corporate value (Van Buren, 1999), furthermore, the other study also indicates that 80% of the value of a company is intangible (Osborne, 1998), traditional accounting measures are inadequate for determining real corporate value in the knowledge-based economy. Valuing intellectual capital is important to enabling companies to realize true value.

Some pioneering companies have publicly announced the adoption of a strategic approach to managing intellectual capital, and mostly have been successful in this area, for example Dow Chemicals estimates that it achieves tax savings of over US\$8 million annually by applying intellectual capital management to its patent holdings (Lynn, 1998). Additionally, measuring intellectual capital helped Skandia Assurance and Financial Services to reduce administrative expenses by 75% while increasing productivity by 400% over 6 years (Morgan, 1998). Moreover, introducing intellectual capital management at Toshiba is estimated to have generated a 20% annual increase in factory productivity (Fruin, 1997). Managers of leading-edge organizations have found intellectual capital to be a multifaceted phenomenon (Bontis, 1996). Once completely elusive, intellectual capital is increasingly well understood, and managers are shifting their strategic focus from managing tangible, visible, physical assets to exploiting intangible, often hidden, dynamic, intellectual assets.

If intellectual capital is so critical to competitiveness, this study must clarify how organizations can develop and manage intellectual capital. Furthermore, an improved understanding is required of how intellectual capital increased corporate value. However, as noted above, little is known about what occurs in the 'black box' between intellectual capital and corporate value. That is, the precise manner in which intellectual capital creates corporate value is unknown. Very little research has been done on the processes through which intellectual capital ultimately influences corporate value.

Additionally, this study reviews relevant literature and demonstrates that intellectual capital has

been extensively investigated in industrialized nations, including the UK (Roos et al., 1998), Sweden (Edvinsson and Malone, 1997), Australia (Sveiby, 1997), Canada (Bontis, 1998) and the USA (Stewart, 1997; Bassi and Van Buren, 1999), but that very few studies have targeted emerging economies. This study focuses mainly on investigating how intellectual capital and corporate value are related in an emerging economy.

2. Intellectual capital in Taiwan

Taiwan is good case study of an emerging knowledge economy for several major reasons. First, the Taiwanese business environment has undergone significant adjustments creating considerable uncertainty. Many Taiwanese companies thus are under growing pressure to develop appropriate practices for meeting the challenges of this uncertain business environment. Second, the Taiwanese government highly prioritizes that if the national infrastructure is to develop beyond its status as an emerging economy, then development must be based on intellectual capital more than physical assets. Finally, the McKinsey ranking of the 10 Asian companies creating the most value for shareholders from 1995 to 2001 (Hoschka and Livingston, 2002) included three Taiwanese companies (ranked second, sixth and ninth). These successful companies mostly focused on intangibles, such as fostering human capital and network effects, rather than on investment in physical assets. Given the above, Taiwanese business leaders can be expected to be familiar with the concept of intellectual capital, and moreover are likely to have taken action to enhance firm intellectual capital.

According to the 'Global Competitiveness Report, 2001–2002' of the World Economic Forum, Taiwan rose from tenth to seventh place in the world on the Growth Competitiveness Index (GCI). Moreover, Taiwan ranked fourth in the world, and first in Asia, in terms of technology. Taiwan ranked third in the world, in terms of innovation. The above figures illustrate how years of promoting science and technological development has successfully fostered innovation and established a knowledge-oriented nation. Simultaneously, the industrial structure of Taiwan has turned towards the high-tech industry. Taiwan's information hardware industry ranks fourth globally in terms of output value. Looking at specific sectors, the Taiwanese semiconductor industry is second only to that of the US in terms of design

output, and third in the world in terms of manufacturing output. Moreover, the Taiwanese IC contract manufacturing industry has the highest output value in the world. The above figures demonstrate that the technological development efforts of government and the private sector are reaping significant rewards. Responding to the international trend towards knowledge innovation, the Taiwanese government passed the 'National Science and Technology Development Plan, 2001–2004' in May 2001. Under this plan Taiwan will continue to develop its high-tech industries, stimulating overall industrial restructuring and upgrading. Knowledge-intensive industries thus will account for at least 60% of GDP within 10 years, by which time Taiwan will have become an Asia-Pacific high-tech industrial research and development, manufacturing, and services center (Taiwan, 2002).

3. Theoretical framework-value creation

This study designs a value creation path to help fill in the 'black box' between intellectual capital and corporate value (Figure 1). A wide-ranging literature review reveals three main perspectives on value creation, as follows: the resource-based view (RBV), the financial perspective and the intellectual capital perspective.

3.1. RBV

The RBV notes that firms are not homogeneous, and have highly distinct individual characteristics and resources, such as equipment, people and ideas. The basic premise of RBV is that the value-creating capability of an organization comes not from the dynamics of the industry of that organization, but from organizational processes, leading to idiosyncratic endowments of proprietary resources (Barney, 1991; Collis and Montgomery, 1995; Peppard and Rylander, 2001a). These resources are typically valuable,

rare, imperfectly imitable and substitutable, and are the main source of sustainable competitive advantage. A key question in the RBV is how organizations develop strategic resources. That is, RBV examines the nature and quality of resources deployed in the value creation process, but does not provide a framework for understanding the deployment process and how the resulting value is created; the relationship between resource (input) and corporate value (output) is assumed, but not explained (Peppard and Rylander, 2001a).

3.2. Financial perspective

The financial perspective previously has focused on the question of company value (Stewart, 1994). That is, the financial perspective concentrates on measuring either the value created post implementation or the potential value creating ability of decision options. A number of investigations utilize a variety of approach in valuing a company, all loosely based on Net Present Value (NPV) calculations of future expected revenues and cash flow streams, which includes, Tobin's Q , Shareholder Value Analysis (SVA), Value-Based Management (VBM), Economic Value Added (EVA). These methods focus mainly on measuring rather than creating corporate value, and they share a common weakness in failing to clarify how an organization should mobilize resources to increase corporate value (Peppard and Rylander, 2001a). Nevertheless, Corporate value can be measured based on the financial perspective, especially represents the contribution of intangible resources to corporate value. For example, the Value Added Intellectual Coefficient (VAIC) method is based on the EVA method.

3.3. Intellectual capital perspective

The above two perspectives do not provide managers with a practical framework for understanding how resource inputs are turned into outputs during the value creation process: that is, understanding the dynamics of value creation. The intellectual capital perspective has since been adopted by academics as a useful framework for describing firm resources, and value creation. Accordingly, a common perspective and terminology now is emerging, based on case material and practitioner experience (Bontis, 1996, 1998; Sveiby, 1997; Roos et al., 1998; Bontis et al., 1999; Pike et al., 2002). Whereas some of the theoretical underpinnings of the intellectual capital literature

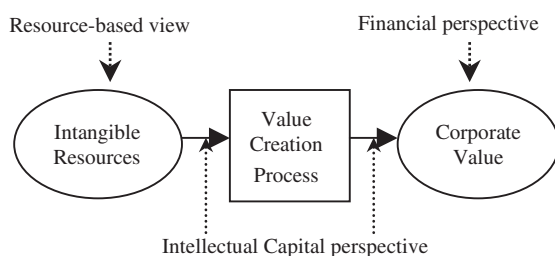


Figure 1. Theoretical framework – value creation.

lie in aspects of RBV from the strategic management literature (Barney, 1991; Collis and Montgomery, 1995; Peppard and Rylander, 2001), the practical applications and pragmatic approach of the intellectual capital practitioner provide a practical managerial tools and methodologies. Both intellectual capital perspective and RBV focus on resources and their deployment in a company. On the other hand, the IC perspective has emerged as a response to the frustration associated with applying conventional management schemes to leveraging intangible resources. Since intellectual capital perspective has practical roots, it places greater emphasis on the application of resources than RBV, which focuses on resource creation and deployment. To summarize, the intellectual capital perspective focuses on how to extract maximum value from the resources available and how they are deployed (Chatzkel, 2002), and this perspective thus provides a bridge between resources and corporate value.

To establish a theoretical framework this study uses the input-process-output diagram (Peppard and Rylander, 2001a) to illustrate the link between intangible resources and corporate value, that is, this study fills in the 'black box' by visualizing the value creation process. Figure 1 summarizes the central emphasis of these three different perspectives in value creation. Among the three perspectives, although the intellectual capital perspective was identified as most applicable perspective for the purposes of this study, the other two perspectives still are used in a supplementary role. Restated, this study seeks to understand the component of intangible resources based on RBV, and also attempts to measure corporate value based on the financial perspective.

4. Intellectual capital

Intellectual capital is a broad-based term considered synonymous with firm intangible assets. Consensus is lacking on a clear definition of intellectual capital. However, one widely recognized definition describes intellectual capital as: 'material that has been formalized, captured, and leveraged to produce a higher-valued asset' (Stewart, 1997). This study concluded that intellectual capital has five characteristics.

- *Intangible*: Intellectual capital is invisible and intangible, and thus traditional measures do not capture it accurately. Although most intellectual capital is intangible, such capital is,

more or less directly, controlled by the company (Bontis et al., 1999).

- *Effect of time delays*: The effects of heavy investments in human and innovation capital take time to be fully implemented and felt, i.e. that is a kind of inertia exists that delays total and immediate deployment of the benefits derived from such investments (Joia, 2000). From an empirical study, the average duration of R&D benefits is approximately 5–9 years (Lev and Sougiannis, 1996).
- *Non-zero-sum effect*: Unlike traditional assets represented in accounting and cash flow, intellectual capital flows are not necessarily added to zero. Intellectual capital management is not necessarily a zero-sum game, for example, large financial investments in installing new IT systems may be wasted if IT systems are inappropriate or if company culture discourages their use (Roos and Roos, 1997).
- *Rule of multiplication*: Physical asset is measured using an addition rule in traditional financial statements, but intellectual capital measured as a multiplication rule in a knowledge-based economy. For example, O'Donnell and O'Regan (2000) suggested the following simple equation.

$$\begin{aligned} \text{Intellectual capital} &= \text{People} \\ &\quad \times \text{Internal capital} \\ &\quad \times \text{External capital} \end{aligned}$$

- *Law of increasing return*: While land, capital and labor all follow the law of decreasing return, knowledge and information conversely enjoy increasing return; this phenomenon is especially evident in the high-tech industries (Arthur, 1996). Restated, value created increases with the amount of intellectual capital applied and generated.

The theoretical roots of intellectual capital lie in two different streams of thought, namely the measurement and strategic streams (Roos et al., 1998). The measurement streams focused on developing a new reporting mechanism to enable non-financial, qualitative, items of intellectual capital to be measured alongside traditional, quantifiable, financial data (Johnson, 1999). Meanwhile, the strategic streams investigated creating and managing intellectual capital to enhance firm value (Petty and Guthrie, 2000). Recently, the focus of developments in intellectual capital has shifted from measuring intellectual capital to its management - that is from a stock concept to a flow concept (Roos et al., 1998).

Restated, intellectual capital perspective obviously aims at improving visualization company value-creation to enable comprehensive management of intellectual capital. Measurement is intended to clarify the effectiveness of these activities.

Additionally, this study identifies a tendency to focus on the components of intellectual capital. The reason for categorizing intellectual capital is that it can help companies better understand what is intellectual capital. This approach also clarifies the connections and flows among different intellectual capital stocks (Roos et al., 1998). That is, illustrates the main categories of intellectual capital as they exist in practice. A broad consensus is now emerging in which most intellectual capital models comprise three interrelated categories (Table 1): human Capital, structural (Internal) capital and relationship (external) capital (Saint-Onge, 1996; Stewart, 1997; Sveiby, 1997; Roos et al., 1998; O'Donnell and O'Regan, 2000), although substantial variation exists regarding how each category is conceptualized, theorized or measured, and there is also a dearth of good empirical studies.

Despite these difficulties, intellectual capital is viewed as existing in the complex interaction dynamics within and among these different categories (O'Donnell and O'Regan, 2000). For example, Knight (1999) identifies four factors that combine to establish the virtuous cycle leading to

increased market value, namely: human capital, structural capital, external capital and financial performance. Expressed simply, investments in human capital create more competent and capable personnel who then develop better structural capital, leading to the development of more productive external capital, and ultimately resulting in improved financial performance.

From above-mentioned analysis, this study concludes that human capital, organizational capital, innovation capital and relationship capital are four constructs of intellectual capital. Innovation capital must be separated from structural capital for two reasons. First, innovation and structural capital require different managerial actions, and should be assigned to two different categories. Second, review of numerous research papers and practitioner opinions reveals that innovation capital is considered a key success factor in Taiwan.

5. Corporate value

In the emergent intellectual capital discourse, company value (market value) is considered a combination of tangible value (book value) and intangible value (intellectual capital). The former comes from traditional capital – physical capital and monetary capital, while the latter comes from

Table 1. Classification schemas of intellectual capital

Developed by (Time)	Framework (Country)	Classification
Edvinsson and Malone (1997)	Skandia Value Scheme (Sweden)	Human capital Structural capital
Bontis (1998)	Canada	Human capital Structure capital Customer capital
Stewart (1997)	USA	Human capital Structural capital Customer capital
Saint-Onge (1996)	Canadian Imperial Bank of Commerce (Canada)	Human capital Structural capital Relationship capital
Sveiby (1997)	Intangible Assets Monitor (Australia)	Employee competence Internal structure External structure
Van Buren (1999)	American Society for Training and Development (USA)	Human capital Innovation capital Process capital Customer capital
Roos et al. (1998)	UK	Human capital Structural capital Relationship capital
O'Donnell and O'Regan (2000)	Ireland	People Internal structure External structure

intellectual capital – human capital, structural capital and relationship capital (Roos et al., 1998; O'Donnell et al., 2000). Regarding the present research objectives, this study is concerned with how much corporate value is created by intellectual capital.

Most scholars have proposed directly measuring the stock of intellectual capital (Roos et al., 1998; Van Buren, 1999), which is a proxy for corporate value. Five methods exist for facilitating the valuation of intellectual capital.

- *Market-to-book ratio (M/B)*: The assumption is that the portion of the market value of a company in excess of its book value is the market value of its intellectual capital. That is, the difference between the book value and market value of a company is taken as equaling the level of intellectual capital of the business. The more knowledge-intensive a company is, the greater its M/B value will be (Stewart, 1997)
- *Tobin's Q*: This ratio is the ratio of market value to firm asset replacement cost (Tobin and Brainard, 1968) and can be used for making comparisons among firms. The replacement cost concept was designed to circumvent the differing depreciation policies used by accountants around the world (Joia, 2000). If Tobin's *Q* exceeds one, the company is likely to seek to acquire more intellectual capital.
- *Calculated Intangible Value (CIV)*: This value uses industry norms to establish rates of return for tangible assets, and calculates the level of intellectual capital by attributing to it any return exceeding the industry norm (IFAC, 1998).
- *Return of Management (ROM)*: This is a measure of management efficiency in using total capital, including both physical and intellectual capital (Strassmann, 1999). ROM is obtained by dividing management value by the sum of sales and administrative expenses. The weakness of this measure is that it assumes management to be the only value-adding layer and neglects the contribution of other employees to corporate success.
- *VAIC*: This measure is the total sum of the value creation efficiency of the physical capital of a company and two components of intellectual capital (namely human capital and structural capital). This measure is designed to indicate the intellectual capital efficiency of a company, and high VAIC value is associated with good management utilization of the po-

tential value creation from physical and intellectual capital (Williams, 2001). VAIC is an output oriented, process method that can be applied across different business forms and at various levels of operations (Pulic and Bornemann, 1999).

5.1. Research model and research hypothesis

Having defined the concept of intellectual capital, this study now needs to distinguish intellectual capital among the different categories to help enhance our understanding of intellectual capital, and also to enable the application of the concept to the strategic and even operational level (Roos et al., 1998). Restated, this study divided intellectual capital into four categories: human capital, innovation capital, organizational capital and relationship capital. This study develops and explores a conceptual model of the relationship between intellectual capital and corporate value (Figure 2), and corresponding hypotheses, based on the literature.

Empirical studies find the most common measures of firm's innovation capability are R&D expenditure, patent counts (Bosworth and Rogers, 2001), and statistics on new product introduction (Schoenecker and Swanson, 2002), all of which positively influence market value (H1a). Organizational capital embedded in routines, procedures, information systems etc. can help filter information and organizational sense-making (Galbraith, 1977), prevent organizations from repeating mistakes (Garvin, 1993) and thus enhance corporate value (H1b). Company value can be generated by all good relations with other participants in the environment external to the company, such as its customers, suppliers and other groups. For example, British Petroleum reported a saving of £50 million, or 30% of the budget for a particular off-shore project, because of closer cooperation with suppliers (Roos et al., 1998), thus this study suggests that relationship capital can enhance corporate value (H1c). Accordingly, the following hypotheses are advanced:

- H1a: *Innovation capital positive affects corporate value.*
- H1b: *Organizational capital positively affects corporate value.*
- H1c: *Relationship capital positively affects corporate value.*

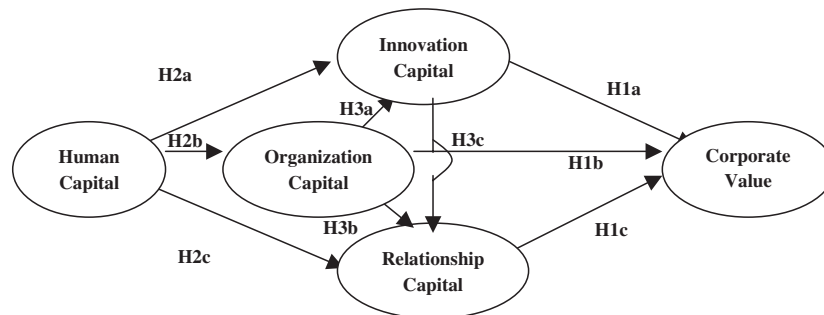


Figure 2. Hypothesized research model.

Early human capital theorists suggested that increased worker skills and knowledge might translate into increased organizational performance, but whether human capital directly or indirectly influences organization performance remains uncertain (Youndt, 1998). Recent scholars advocate that human capital generally is not controlled by the organization, and all employees participate in the company willingly. Consequently, the company does not directly control all of its parts (Roos et al., 1998). From prior empirical studies (Bontis, 1998; Bontis et al., 2000), human capital does not directly influence positive organization performance, but does indirectly affect organization performance through customer capital and structural capital. King and Anderson (1995) proposed that human capital is a major influence firm innovativeness (H2a). Specifically, employees who are trusting, with good attitude and high willingness to learn also should be more willing and able to share information and knowledge freely, therefore helping in establishing information systems and standard operating processes (H2b). People are the heart and soul behind product and service innovations that may increase customer value by better meeting their needs. That is, the more competent organization employees are, the better they will understand customer needs (H2c). Consequently, the following hypotheses are proposed:

H2a: *Human capital positively affects innovation capital.*

H2b: *Human capital positively affects organizational capital.*

H2c: *Human capital positively affects relationship capital.*

Tesluk et al. (1997) noted that influences on firm innovation ability include organization culture, internal organization structure and organizational climate. Because it is important for a

company to create a innovation culture, this study considers organizational capital help improve innovation ability (H3a). Specifically, to improve relationships with customers and suppliers, companies currently are devoted to developing Supply Chain Management (SCM) and Customer Relationship Management (CRM) through integrating information systems and operation processes. Davenport and Klahr (1998) proposed that a company must establish information systems to recognize customer demand, and establish a set of standard operation process to maintain good customer relationships (H3b). In the present customer-oriented age, to achieve good relationships with customers, suppliers generally seek to maximize customer benefits by helping to increase equality, reliability and flexibility through production and service delivery process innovation (Upton, 1995) (H3c). Additionally, having measured the stock and flow of intellectual capital components in the firm, Johnson (1999) suggested that human capital affect organizational capital and innovation capital, then both organizational capital and innovation capital help in establishing relationship capital. Accordingly, the following hypotheses are advanced:

H3a: *Organizational capital positively affects innovation capital.*

H3b: *Organizational capital positively affects relationship capital.*

H3c: *Innovation capital positively affects relationship capital.*

6. Methodology

6.1. Sampling and respondents

The subject of this study is listed Taiwanese manufacturers that ranked in the 500 largest in

terms of sales revenues in Taiwan. The rationale for sample selection was follows. First, most companies with have successful experience in managing intellectual capital have a large operating scale, such as Dow Chemicals, Skandia and Toshiba. Second, the study required comprehensive organizational level performance data to measure corporate value, thus necessitating the focus on publicly traded companies. Finally, at a general level, this study decided to select a broad group of organizations representing numerous industries to maximize variation of independent variables and enhance the generalizability of the findings. The 289 organizations sampled were selected to meet the above criteria. A total of 289 questionnaires were mailed to senior executives (usually CEOs) in October 2000. More details of these questionnaires will be provided in the next chapter. After 3 weeks telephone calls were made to remind non-respondents about the questionnaire. Executives from 81 of the organizations returned usable questionnaires, representing a response rate of 28.03%. Analyzing the returned questionnaires based on classification of levels of industrial technology (OECD, 1999) revealed that 35 companies (43.2%) were from high-technology industries while 46 companies (56.8%) were from industries other than high-technology industries. In a cautionary note regarding the external validity of our findings, an analysis of respondent—non-respondent organizational differences based on industry (High-tech versus non-high-tech) revealed no significant differences between the two groups.

6.2. Data collection and measures

To measure intellectual capital and corporate value, study data were separately obtained from the questionnaire as well as secondary data. To deal with measures of intellectual capital, four constructs of intellectual capital are defined, as follows:

- *Human capital* is the collective capability of the firm to extract the optimum solutions from employee knowledge, and is a direct consequence of the sum of workforce expertise, knowledge and attitude.
- *Innovation capital* is defined as the ability to build on previous knowledge and generate new knowledge. Innovation capital includes the ability of a company to develop new products, as well as any creative ideas.

- *Organizational capital* belongs to the company, and is the actual environment established by the firm to manage and generate its knowledge effectively. Organizational capital includes information system, operation process and organization culture.
- *Relationship capital* refers to the relationships or network of associates of an organization, as well as the satisfaction of these associates with and their loyalty to the company. Relationship capital generally is concerned with external groups.

This study reviewed theoretical discussions surrounding the RBV, intellectual capital perspective, human capital accounting, knowledge management, and so on, to develop multi-item scales of the four constructs of intellectual capital. The four items used to assess human capital are based on the discussions of human capital by Brooking (1996) and Roos et al. (1998), including discussions of 'leadership and management ability', 'training and development of human resources', 'workforce attitudes', and 'employee knowledge and skills'. The two items used to measure innovation capital included the tacit item 'Innovation and technological ability' (Edvinsson and Malone, 1997) and the explicit item 'Intellectual property' (Bassi and Van Buren, 1999). The four items assessing organizational capital draw on the work of Stewart (1997) and Youndt (1998), and emphasize an internal institutionalized knowledge and codified experience stored in organizational memory devices, including 'operational process', 'internal organization structure and administrative system', 'Information system', 'Organization culture'. Finally, the three items measuring relationship capital included 'customer relationships', 'supplier relationships' (Bontis, 1999) and 'relationships with other external group' (Johnson, 1999). Table 2 summarizes the above-mentioned 13 items in questionnaire. A questionnaire was used to gather systematic data from CEOs from each company. Respondents were asked to give their overall assessment of the degree to which each intangible resource contributed to corporate value, on a seven-point Likert scale ranging from 'extremely unimportant' to 'extremely important'.

To measures corporate value, this study directly measures stocks of intellectual capital as a proxy for corporate value. A screening criterion was designed to determine an appropriate measure of intellectual capital stock for use in this study from methods described in the literature.

Table 2. Summary of 13 items in questionnaire

To what extent do you think the following intangible resources contribute to the corporate value of your organization?	
extremely unimportant	extremely important
	1 2 3 4 5 6 7
1. Leadership and management ability	□□□□□□
2. Intellectual property	□□□□□□
3. Operational process	□□□□□□
4. Training and development of human resource	□□□□□□
5. Internal organization structure and administrative system	□□□□□□
6. Innovation and technological ability	□□□□□□
7. Workforce attitudes	□□□□□□
8. Information system	□□□□□□
9. Employee knowledge and skills	□□□□□□
10. Organization culture	□□□□□□
11. Customer relationships	□□□□□□
12. Supplier Relationships	□□□□□□
13. Relationships with other external groups	□□□□□□

The literature supports the respective features of the screening criterion (for example, Schneider, 1999; Petty and Guthrie, 2000; Williams, 2001; Pike et al., 2002). The screening criteria are defined as follows:

- The measure utilized publicly financial information, thus increasing data availability and measure reliability.
- The method can be consistently easily applied to various firm structures, ensuring comparability of measured performance.
- The method enables evidence of intellectual capital leverage to corporate value to be gathered.
- The measure can be calculated and used by both internal and external stakeholders, for example managers, investors and pressure groups.
- The method is relatively straightforward, facilitating cognitive understanding.
- The measure helps companies to plan future strategy and promptly identify specific actions.

From the above screening criteria, after reviewing various measures of intellectual capital proposed in the literature, three methods, namely

M/B, Tobin'Q and VAIC, were identified as the most applicable proxies for the purposes of this study. These data were collected by the Taiwan Economic Journal (TEJ), a private agency conducting financial data collection of all publicly-traded companies, and this data set was equivalent to the COMPUSTAT data set in the USA.

6.3. Analytical procedures

This study used the Structural Equation Model (SEM) to assess the direct and indirect relationships among intellectual capital and corporate value. The main purpose of SEM is to simultaneously explain the pattern of a series of inter-related dependence relationships between a set of latent (unobserved) constructs, each of which are measured using multiple manifest (observed) variables. SEM is particularly well suited for analyzing causal links between latent constructs (Wong and Schal, 2002). The LISREL program is not appropriate for use with the relatively small sample of 81 in this study. The SEM was therefore analyzed using AMOS program. (Byrne, 2001a). SEM involves two stages of modeling based on AMOS (Byrne, 2001b):

- *Stage 1: The Measurement Model* assesses the extent to which latent or hypothetical constructs depended upon or were indicated by the observed variables. Confirmatory Factor Analysis (CFA) can be used to establish the validity and reliability of a hypothesized measurement model, and is considered one of the more rigorous scale development procedures.
- *Stage 2: The Structural Model* specifies the causal relationships amongst latent constructs, describes the causal effects and assigns the explained and unexplained variance. Figure 2 illustrates the model of hypothesized relationships tested using Path Analysis, and then examines the significance of the individual paths.

7. Results

7.1. Descriptive statistics

Table 3 summarizes the respondent ratings for the degree of importance of each intangible resource to corporate value. Except for 'relationship with other external groups', which is less important, all other items were important to contributing to corporate value. Notably, 'innovation and tech-

nological ability' is most important, followed by 'workforce attitude' and 'employee knowledge and skills'. Eleven out of 13 intangible resources are important to improving corporate value in High-tech industry more than in Non-High-tech industries. Measurement results using the three selective methods indicate that corporate value in the High-tech industry is significantly higher than in the Non-high-tech industry. This finding demonstrates that effect of intellectual capital on enhancing corporate value in High-tech companies more than in Non-high-tech companies.

Additionally, almost two-thirds of companies have been managing intellectual capital. Moreover, 93.83% of companies think intellectual capital management is important to corporate value. Finally, 76.54% of companies suggest that it is necessary to measure intellectual capital. These figures demonstrate that Taiwanese companies have taken action to manage intellectual capital, and therefore achieve good outcomes.

7.2. Assessing measurement model validity, reliability and fit

Validity was addressed in three ways. First, operationalization of constructs drew upon an exten-

sive literature review and questionnaires were discussed with superiors in actual organizations, both of which processes were intended to enhance *content validity*. Second, the results of CFA also illustrated that four constructs displayed *convergent validity*, since the analysis yielded four factors with factor loading displaying expected patterns. Third, the distinctiveness of measures of different constructs can be assessed using the χ^2 statistic (Garbarino and Johnson, 1999). Based on the significant differences (P -value < 0.001) in χ^2 value between the based and alternative models, the measurement model has *discriminant validity*. Cronbach α coefficients of four constructs of intellectual capital all exceed the 0.70 threshold recommended by Hair et al. (1998), constructs are confirmed to request of *reliability*, and display internal consistency.

7.3. Model test

The path relationships shown in Figure 2 were further analyzed by the SEM using AMOS program (Byrne, 2001b). This study used Maximum Likelihood estimates for each parameter, Table 4 lists analytical results for the hypothesized

Table 3. Mean scores and t test of each of measure items

Items	Mean			t scores for difference
	Total ($n=81$)	N-H-t ($n=46$)	H-t ($n=35$)	
Human Capital				
Leadership and management ability	6.10	6.02	6.20	-0.81
Training and development of human resource	6.00	5.76	6.31	-2.24*
Workforce attitudes	6.16	6.22	6.09	0.51
Employee knowledge and skills	6.16	6.13	6.20	-0.29
Innovation capital				
Intellectual property	5.57	5.37	5.83	-1.77
Innovation and technological ability	6.16	5.96	6.49	-2.50*
Organizational Capital				
Operational process	5.75	5.52	6.06	-2.41*
Internal organization structure and administrative system	5.70	5.61	5.83	-0.99
Information system	5.65	5.54	5.80	-1.16
Organization culture	5.69	5.50	5.94	-1.80
Relationship capital				
Customer relationships	6.15	6.00	6.34	-1.58
Supplier relationships	5.52	5.41	5.66	-1.04
Relationships with other external group	4.60	4.85	4.29	1.62
Corporate value				
M/B	1.31	0.80	1.97	-4.58**
Tobin'Q	0.79	0.49	1.19	-3.86**
VAIC	3.26	2.08	4.81	-2.86**

N-H-t, Non-High-Tech companies; H-t: High-Tech companies, Classification of levels of industrial technologies (high-tech, medium-high-tech, medium-low-tech, low-tech) is mainly based on the OECD 1997 revised edition. We modify two classification of levels of industrial technologies, the one is High-tech, the other is Non-High-tech that include medium-high-tech, medium-low-tech, low-tech. M/B, market-to-book ratio; VAIC, Value Added Intellectual Coefficient. ** P -value < 0.01 ; * P -value < 0.05 .

research model. The research model displays acceptable relevant fit indices, for example, the χ^2 value is 6.606, Goodness of Fit Index (GFI) is 0.969, Normed Fit Index (NFI) is 0.971 and Comparative Fit Index (CFI) is 0.974. From the parameter estimates in Table 4, it is predicted that all but one of the coefficients of estimated parameters will be positive and significant. The one exception is the effect of organizational capital on corporate value. In this case, while the coefficient is not significant (t -value = -0.46), the sign takes the opposite direction to the expected one. In summary, eight of the nine hypotheses are accepted, and only H1b is rejected; that is, organizational capital does not directly and positively affect corporate value.

Besides demonstrating whether hypothesized relationships are supported, the standardized Maximum Likelihood coefficients can provide information about the influence of a standard deviation change of each model variable. For example, Table 4 indicates that a single standard deviation change in innovation capital can be expected to directly enhance corporate value by 0.28 standard deviations. This study now discusses these results and considers their implications in the next section.

Finally, eight value-creating paths are useful to pilots in their efforts to enhance corporate value through intellectual capital management.

- Effectively managing the effect of innovation capital on enhancing corporate value (H1a).
- Effectively managing the effect of relationship capital on enhancing corporate value (H1c).
- Effectively managing the effect of human capital on innovation capital (H2a).
- Effectively managing the effect of human capital on organizational capital (H2b).

- Effectively managing the effect of human capital on relationship capital (H2c).
- Effectively managing the effect of organizational capital on innovation capital (H3a).
- Effectively managing the effect of organizational capital on relationship capital (H3b).
- Effectively managing the effect of innovation capital on relationship capital (H3c).

8. Discussion

The results generally support the hypothesis regarding the relationship between intellectual capital and corporate value, except for H1b. Consequently, organizational capital does not directly and positively impact corporate value, contradicting the above result, and also prior research suggesting a significant and positive relation between organizational capital and performance (Bontis, 1998; Bontis et al., 2000). Because this study separated innovation and organizational capital, it obtained different results from prior research. Restated, organization capital also indirectly and positively influences company value through its positive impact on innovation capital (H3a) and relationship capital (H3b). This phenomenon implies that company organizational culture, information system and operation process affect innovation ability. Additionally, effectively managing organizational capital helps a company to establish good relationships with other participants in the external environment. Progressing as described above H1b, the difference between the results of this study and previous investigation does not represent an irreconcilable conflict.

Like organizational capital, human capital indirectly and positively influences corporate value

Table 4. Parameter estimates for hypothesized paths in structure equation model

Research hypothesis		Result (β)
Item	Path description	Coefficient
H1a	Innovation capital \rightarrow Corporate value	0.275*
H1b	Organization capital \rightarrow Corporate value	-0.078
H1c	Relationship capital \rightarrow Corporate value	0.268*
H2a	Human capital \rightarrow Innovation capital	0.578**
H2b	Human capital \rightarrow Organization capital	0.550**
H2c	Human capital \rightarrow relationship capital	0.315**
H3a	Organization capital \rightarrow Innovation capital	0.402**
H3b	Organization capital \rightarrow Relationship capital	0.345**
H3c	Innovation capita \rightarrow Relationship capital	0.174*

** P -value < 0.01; * P -value < 0.05.

through innovation capital (H2a), organizational capital (H2b) and relationship capital (H2c). In this study, human capital interacts significantly with other three types of intellectual capital ($\beta_{2a} = 0.578$, $\beta_{2b} = 0.550$, $\beta_{2c} = 0.315$). That is, if human capital cannot be effectively managed, it reduces other intellectual capital ability to increase corporate value (Edvinsson and Malone, 1997). On the other hand, firms usually cannot own human capital, which manifests itself in individual expertise and skills (Brooking, 1996; Stewart, 1997; Knight, 1999). Firms can increase their level of human capital by hiring, developing and retaining and best personnel. Employee intellectual capital gives a company the leverage and flexibility to rapidly deploy new knowledge and create an ever-changing array of products and services (Housel and Bell, 2001).

Finally, the findings of this study suggest that both innovation capital and relationship capital directly influence corporate value. Notably, innovation capital positively impacts relationship capital ($\beta_{3c} = 0.174$), and also has a stronger effect on corporate value than does relationship capital ($\beta_{1a} = 0.275$, $\beta_{1c} = 0.268$). This finding reflects the fact that Taiwanese manufacturers stress the importance of innovation capital, consistent with the generalizations about Taiwanese firms made in the introduction of this study.

This study found that the four constructs of intellectual capital are positively related and also intertwined. Rather than separately and independent enhancing corporate value, these four constructs complement one another other to increase corporate value. This finding is similar to the findings of previous research, including O'Donnell and O'regan (2000), Ulrich (1998).

9. Conclusions and suggestions

This study, based on intellectual capital, resource-based and financial perspectives, examines how to apply the concept of intellectual capital to value creation. This study tries to connect intellectual capital deployment with changes in corporate value, and specifically tries to establish a link between the two. After reviewing the relevant literature, this study concludes that human capital, organization capital, innovation capital and relationship capital are four constructs of intellectual capital. Corporate value is measured using three selective methods: (1) Market/Book value; (2) Tobin' Q ; (3) VAICTM. From the empirical findings reported in this study, not only must the

relationships be found among the four constructs of intellectual capital, but eight value creation paths also must be articulated. That is, this study finds that both human capital and organizational capital indirectly and positively influence corporate value, and oppositely both innovation capital and relationship capital directly and positively impact corporate value. Human capital has a high degree of interaction with other three types of intellectual capital. Organizational capital also positively influences on innovation capital and relationship capital. Innovation capital positively affects relationship capital. Additionally, this finding demonstrates that effect of intellectual capital on enhancing corporate value in High-tech companies more than in Non-high-tech companies.

Companies presently face the difficulty of measuring and managing the key ingredient in the new economy, namely intellectual capital. Intellectual capital is elusive, but once identified and exploited, it can provide a value-creating path. However, traditional measurement tools are of limited use when applied to intellectual capital, and current accounting standards do not represent intellectual capital accurately. The popularity of intellectual capital has even led major accounting firms such as Ernst and Young to admit that they need to develop new measurement tools and revise current accounting standards (Bontis, 1996). When companies view themselves as comprising particular items of intellectual capital, they can identify and invest in human capital, innovation capital, organizational capital, and relationship capital to enhance corporate value. This view facilitates a portfolio approach to the management of corporate intellectual capital, and the development of suitable valuation tools for companies.

This study made various contributions to both researchers and practitioners. First, this study integrated two different theoretical streams, namely the measurement streams and strategic streams. The SEM was applied to examine the interrelationships among intellectual capital and obtain a comprehensive insight into the cause and effect relations involved in intellectual capital value creation capacity. Additionally, this study selected three methods of measuring objective corporate value, a substitute for subjective performance. VAIC measurement method differs from prior research (Bontis, 1998; Bontis et al., 2000). Second, this study conducted one of the first empirical tests of the association between intellectual capital and corporate value in an

emerging economy. This empirical test expands understanding of the impact of intellectual capital on corporate value under different environmental conditions. Third, eight value creation paths, within the context of the intellectual capital process, are helpful in understanding how a company creates value, namely what resources the company uses, how these resources are deployed (transformed into other resources), the relative importance of these resources and transformations, and how these resources and transformations are interrelated in the value creation process (Peppard and Rylander, 2001a). Finally, the present findings should interest a wide range of internal and external stakeholders, including CEO, managers, shareholders, government and academic researchers.

This study has many practical implications for R&D managers. The ability to innovate is very important for increasing corporate value. Effectively managing human capital positively affects innovativeness of a firm. A company's hiring the brightest employees it can find does not suffice. A company must establish a human resource management system to increase its stock of human capital; foster leadership and management ability, improve the attitude of workforce, and increase knowledge and skills. Another important implication is that good structural capital will translate the human capital of innovation into company property, and create wealth from such innovation. A company must support and nurture bright individuals into sharing their innovation knowledge and ability through organization learning (Bontis et al., 2000). Good structural capital is built by operational processes, information systems, organization culture, internal organization structure and administrative systems, for example. Finally, relationship capital is another main determinant of corporate value. The ability of manufactures to innovate affects the decisions of consumers to adopt. A company can advance its ability to innovate to improve its relationships with its customers, suppliers, and other external groups. In a conclusion, a company must invest many resources in the accumulation of innovation capital to increase corporate value. Additionally, R&D managers must also understand the link between innovation and other intellectual capital.

The limitations of this study constrain the generalization of its results and point to three areas of future research. First, the limitations of a cross-sectional study constrain attributions of causality. A longitudinal study of the effect of these invisible constructs could help to overcome this shortcoming. Second, four constructs of in-

tellectual capital were evaluated using of 13 perceptual measures. The measurement system should provide broad insights into the value-creating capacity of intellectual capital. Future research would benefit from the development of more objective measures, including quantitative information – both financial and non-financial. Third, work must be done on how numbers of a company can be informed of how intellectual capital increases the capacity to create value. Therefore in-depth research is required to offer a better understanding of the idiosyncrasies of managing intellectual capital in specific industries and organizations.

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