# The Stock Market Valuation of Intellectual Capital in the IT Industry*

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**(This paper has been accepted by the *Review of Quantitative Finance and Accounting*)**

**January 03, 2014**

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*We would like to thank participants at AAA 2009 Annual Meeting (New York, US) and one anonymous reviewer for their valuable comments on an early version of this paper. All the errors are ours. Great help and assistance from Ling-Ching Chan and Ting-Kai Chou are highly acknowledged.

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# The stock market valuation of intellectual capital in the IT industry

**Abstract** This study adopts the *P/V* ratio developed from the residual income valuation model to examine whether Taiwan's IT companies with more intellectual capital are more likely to be mispriced by the stock market. We focus on four types of intellectual capital: human capital (measured by employees holding graduate degrees and ratio of labor costs to net sales), innovation capital (measured by R&D intensity and royalty ratio), process capital (measured by working capital turnover and fixed asset turnover), and relational capital (measured by marketing expense ratio and sales growth rate). Using 751 firm-observations in Taiwan's IT industry during 2003-2006, the empirical results show that Taiwan's stock market appears to overprice IT companies' innovation capital but underprice their human, process, and relational capital. Notably, the mispricing problem is more prominent on the human capital than on the other three types of intellectual capital. A further test indicates that the mispricing of intellectual capital is due to Taiwan's domestic investors rather than foreign institutional investors. Particularly, the mispricing problem is more prominent on the human and relational capital. The implications of these findings are discussed.

**Keywords** Intellectual capital · Human capital · Innovation capital · Process capital · Relational capital · Mispricing

**JEL Classification** M41 · G11 · G32 · G14

## 1 Introduction

The central purpose of accounting is to prepare financial statements that provide information to external users for optimal capital allocations. However, three problems impede the usefulness of accounting information to achieve such goal: the first one is the *measurement* problem, in which reported numbers could be irrelevant to the decision makers due to certain measurement rules (e.g., historical cost); the second one is the *recognition* problem, in which important unquantifiable economic events are not recorded (e.g., customer satisfaction) due to the monetary unit assumption; the last one is the *disclosure* problem, in which managers' are unwilling to voluntarily disclose private information (e.g., human resources) whose disclosure is not required by the Generally Accepted Accounting Principles (GAAP) but is useful in valuing firms' future prospects. Driven by these three problems, recent accounting studies explore the changing role accounting plays to the economy and find that the importance of accounting information has declined over time (e.g., Brown et al. 1999; Dontoh et al. 2004; Ely and Waymire 1999; Lev and Zarowin 1999). In light of this finding, a follow-up examination of what other important information should be disclosed and whether the stock market is able to correctly react to such information is warranted in determining new regulations and accounting standards.

Recent research has indicated that intellectual capital may explain the increasing disparity between firms' market values and book values (e.g., Barron et al. 2002; Chan et al. 2001; Edvinsson and Malone1997; García-Meca and Martínez 2007; Lev and Sougiannis 1996; Stewart 1997). The importance of intellectual capital raises the question of whether firms' market values reflect their intellectual capital.[1] In an efficient market, stock prices have already impounded the value of firms' intellectual capital, so there should be no association between intellectual capital and future stock returns. However, the creation of intellectual capital usually requires large expenditures over a long time horizon and the benefits of such intellectual capital are highly unpredictable and unobservable. More importantly, neither the U.S. GAAP nor the International Financial Reporting Standards provides clear rules for recognizing and disclosing major types of intellectual capital. Therefore, intellectual capital is subjected to the three accounting problems mentioned above. When firms have large amounts of intellectual capital, the omission or incomplete disclosure of such information generally complicates the task of equity valuation, giving rise to the possibility that stock prices do not fully incorporate the value of intellectual capital. On the one hand, underpricing may arise if investors have short time horizons (Hall 1993; Porter 1992) or mechanically interpret firms' financial statements without adjusting to the long-term benefits of intellectual capital (Chan et al. 2001). On the other hand, overpricing may also arise if investors are overly optimistic about firms' intellectual capital (Chan et al. 2001) or systematically overlook the possibility that intellectual capital may not bring real benefits to the firms in the long run (Jensen 1993). Thus, the mispricing of intellectual capital is an empirical question and deserves further examination.

This study investigates whether Taiwan's stock market appropriately incorporates the value of information technology (IT) companies' intellectual capital. We choose Taiwan's IT industry for two reasons. First, Taiwan's IT industry has gained world-wide recognition for many years (Einhorn et al. 2005; Liang and Yao 2005). Currently, Taiwan is the world's second-largest manufacturer of IT

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[1]Intellectual capital generally refers to *knowledge-based* assets such as the possession of certain domain knowledge, applied experience, organizational technology, customer relationships, and professional skills that can be put in use to create wealth and competitive edge in the market (Edvinsson and Malone 1997; Stewart 1997). Some researchers use "intangible assets" to describe intellectual capital and use these two terms interchangeably because they define intellectual capital as those intangible assets that have not been recorded and reported in the financial statements (e.g., Amir and Lev 1996; Lev 2001). We take Edvinsson and Malone's (1997) and Stewart's (1997) definition and assert that intellectual capital encompasses intangibles assets (which, following the GAAP, are defined as non-financial fixed assets that do not have physical substance but are identifiable and controlled by an entity through custody and legal rights).

products. In 2010, more than ten of Taiwan's IT products (e.g., motherboard, notebook PC, LCD monitor, netbook, tablet device, Cable CPE, DSL CPE, chip foundry, semiconductor packaging and testing, WLAN NIC, IP phone) have the largest market shares in the world. The outstanding performance and the prosperity of the IT industry have attracted institutional investors all over the world.[2] Second, unlike traditional industries, the IT industry exploits technologies through continuous R&D activities to gain unique competence for the delivery of new products, services, and solutions with enhanced values to customers. Since the design, process, and technological innovations are critical to IT companies' survival and success in the marketplace, intellectual capital should be more influential to their future performance than traditional industries. In fact, the focus on intellectual capital as the prime source of competitiveness in the knowledge-based economy has been emphasized by the accounting academics for many years (e.g., Goodwin and Ahmed 2006; Lev and Zarowin 1999). While a large body of research has examined how certain intangible assets affect firms' performance (e.g., Aboody and Lev 1998; Ittner and Larcker 1998a; Lev and Sougiannis 1996) and analysts' forecasts (e.g., Barron et al. 2002; García-Meca and Martínez 2007), studies on whether major types of intellectual capital (which is much broader than intangible assets) are mispriced are not common. Our study intends to address this issue.

We examine Taiwan's stock market with an aim to provide empirical evidence from a capital market that differs significantly from those of the U.S. and Europe. We believe that the ongoing development of international aspects of intellectual capital may benefit from evidence obtained from diverse economic environments. This study aims, therefore, at enlarging the understanding of the stock market's valuation of intellectual capital in an international context. In light of the increasing spread of globalization and the importance of Taiwan in the emerging markets, such an understanding is important to global investors and accounting academics all over the world.

Drawn on prior research, this study investigates four major types of intellectual capital, with each type captured by two proxies: human capital (measured by employees holding graduate degrees and ratio of labor costs to net sales), innovation capital (measured by R&D intensity and royalty ratio), process capital (measured by working capital turnover and fixed asset turnover), and relational capital (measured by marketing expense ratio and sales growth rate). Following current residual income valuation model such as Ohlson (1995), we use the price-to-intrinsic value (*P/V*) ratio as the dependent variable and find two major results. First, Taiwan's stock market appears to overprice IT companies' innovation capital but underprice their human capital, process capital, and relational capital. This mispricing problem is more prominent on the human capital than on the other three types of intellectual capital. Second, after considering the effect of foreign institutional investors' ownership, we find that the mispricing of intellectual capital is due to Taiwan's domestic investors rather than foreign institutional investors. Specifically, these domestic investors appear to misprice the human and relational capital more than the innovation and process capital.

The remainder of this paper is organized as follows. Section 2 discusses prior studies that are related to our study. Section 3 describes the research design and data. Section 4 presents and discusses the empirical results. A summary and conclusion are provided in section 5.

## 2 Literature review

A majority of early studies have used R&D expenditures to proxy for innovation capital and documented a significantly positive association between such expenditures and firms' financial performance (e.g., ROA or ROE) and share prices (e.g., Bae and Kim 2003; Chan et al. 1990; Chauvin

[2]By the end of June, 2013, about 65.16 percent and 77.09 percent of the Taiwanese companies included in the iShares S&P Asia 50 Index and the MSCI Asia APEX 50 Index, respectively, belong to the IT industry.

and Hirschey 1993; Chen et al. 2005; Han and Manry 2004; Lu et al. 2012). Specifically, Sougiannis (1994) shows that a $1 increase in R&D expenditure leads to a $2 increase in profit and a $5 increase in market value over a 7-year period. Lev and Sougiannis (1996) further report that an average of $2.328 operating income will be brought in the future if a company increases $1 R&D expenditure in the current period. In a more recent study, Deeds (2001) also provides evidence showing that a high technology venture's R&D intensity, technical capabilities, and absorptive capacity are positively related to the amount of entrepreneurial wealth created by the venture.

Many researchers also adopt advertising expenditures to proxy for the relational (or customer) capital and examine whether this type of expenditures affects firms' stock prices or profitability. While some studies find a positive association (e.g., Chauvin and Hirschey 1993; Hirschey and Weygandt 1985), some others report no association (e.g., Ayanian 1983; Bloch 1974; Core et al. 2003) or even a negative association (e.g., Bublitz and Ettredge 1989; Chen et al. 2005). For example, Erickson and Jacobson (1992) show that neither R&D nor advertising expenditures increase firms' market values more than other types of investments or expenditures. Han and Manry (2004) find that R&D (advertising) expenditures are positively (negatively) associated with firms' stock prices. Wyatt (2008) argues that the mixed findings result from the fact that advertising expenditures are valuable only in the short term but prior research tests the association from a long-term perspective.

In a different strand, researchers use customer satisfaction to proxy for the relational capital. Again, some studies find a positive association between customer satisfaction and firms' financial performance (e.g., Banker et al. 2000; Ittner and Larcker 1998a) while some others do not. For example, Ittner and Larcker (1998b) do not discover any significant relationship between customer satisfaction and accounting earnings. In contrast, Anderson et al. (1994) report a negative association between customer satisfaction and ROI for the service industry but find a positive association for other industries. Foster and Gupta (1997) even show that customer satisfaction may have a positive, negative, or no effect on soft drink retailers' future profitability.

Ballester et al. (2002) find that a firm's human capital (measured by total expenditure on employees) is about 5% of its total market value and accounts for about 16% of the difference between firms' market and book values. Colombo and Grilli (2005) indicate that firms having employees with longer university education in economics and managerial fields are more likely to have higher growth. Also, employees' prior working experience in the same industry is positively associated with firms' growth. Huselid (1995) reports that companies' human resource management policies have a significant impact on employees' outcomes (turnover and productivity) and firms' financial performance. Using data from the 100 largest U.S. law firms, Hitt et al. (2001) show that human capital (measured by the quality of the law schools attended by the partners and total experience as partners in the focal firms) has a positive effect on law firms' performance.

Different from the above studies, several researchers turn their attention to information technology (IT) investment as a measure of process capital. However, only few of them use archival data to empirically examine the association between IT investment and firms' performance, and the empirical results are mixed. On the one hand, Raymond et al. (1995) and Bharadwaj et al. (1999) find that IT investment is positively associated with firms' financial performance and Tobin's q values, respectively. Brynjolfsson and Yang (1999) document that a $1 increase in IT investment gives rise to a $10 increase in market value. Lev et al. (2009) find that firms' process capital is associated with their 5-year future operating and stock return performance.[3] On the other hand, research in the IT

[3]According to Lev et al. (2009), organization capital refers to the unique structural and organizational designs and business processes generating sustainable competitive advantages. Since they compute organization capital by capitalizing and amortizing the annual sales, general, and administrative expense over a three-year period, we regard Lev et al.'s (2009) organization capital to be equivalent to the process capital.

productivity paradox provides the opposite results.[4] For example, Peslak (2003) shows that IT spending has no impact on financial-based or market-based productivity measures.

Recent studies begin to use composite indexes to capture multiple aspects of intellectual capital. One commonly-used index is the Value Added Intellectual Coefficient (VAIC), which measures a firm's overall value creation efficiency. This method uses data from financial statements to compute a firm's two efficiency measures: capital employed efficiency and intellectual capital efficiency (which can be further separated into human capital efficiency and structural capital efficiency). The VAIC equals the sum of these measures. Several studies have used this index but reported inconsistent results. For example, Chen et al. (2005) show that firms' VAICs are positively associated with their market values and financial performance. However, Zéghal and Maaloul (2010) report that the positive association between VAICs and stock prices is significant only for the high-tech industry. Conversely, Rahman (2012) finds no strong evidence supporting the association between VAICs and firms' market values. A major problem with the VAIC is that it only considers human capital and structural capital as two key types of intellectual capital. Moreover, the structural capital is computed by the difference between a firm's value added[5] and the human capital. Therefore, the effects of innovation capital, process capital, and relational capital cannot be estimated and tested separately.

Overall, a large portion of prior studies focus on individual intellectual capital items such as R&D expenditure, advertising spending, and IT investment for the purposes of assessing firms' performance and share prices. Only few studies empirically test whether customer satisfaction or human capital affects firms' performance (Gu and Lev 2001). Because intellectual capital contains multiple types and some types are complements of or substitutes for the others (Peteraf 1993), it will create firm value only when different types work in aggregate rather than in isolation (Edvinsson and Malone 1997; Mouritsen et al. 2001). Therefore, accounting research should incorporate a broader range of intellectual capital types in exploring the association between these capital types and firms' performance and share prices. Our study thus differs from prior studies in that we consider four major types of intellectual capital simultaneously.

Another problem in the intellectual capital literature is that many empirical results cannot provide consistent conclusions. Taking R&D expenditure as an example, Cañibano et al. (2000) point out that this lack of consistency results from a lack of considering other factors (e.g., firm size and earnings persistence) that may explain stock prices and returns with respect to which R&D intensity may have little incremental explanatory power. In fact, some studies have shown that the contribution of intellectual capital to firms' performance varies by industry (e.g., Abdel-khalik 1975; Green et al. 1996; Rahman 2012; Tan et al. 2007). Ballester et al. (2002) further report that the ratio of human capital to market value is positively related to firms' operating uncertainty, industry concentration, and industry-adjusted average compensation paid to employees. Therefore, controlling for other factors that may also affect firms' financial performance and share prices is deemed necessary for future research in intellectual capital. In light of this omitted variable problem, we base our empirical tests on the residual income valuation model so that we can better control for factors that may affect firms' *P/V* ratios. We focus on the association between intellectual capital and firms' *P/V* ratios because intellectual capital information is valuable only when it is associated with investors' valuation of the firms (Wyatt 2008).

Even though Han and Manry (2004) also adopt the residual income valuation model, our study

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[4] The IT Productivity Paradox is the concept that, despite massive investment and resourcing by companies and organizations worldwide in their IT systems, there still seems to be little pay-off (Willcocks and Lester 1999). Turban et al. (2005) point out that the discrepancy between measures of IT investment and measures of outputs at the national level is called the IT productivity paradox.

[5] According to Chen et al. (2005), value added = net sales revenues - bought-in materials and services – depreciation = wages + interests + dividends + taxes + changes in retained earnings = wages + interests + taxes + net income.

differs from theirs in three aspects. First, while Han and Manry (2004) use R&D and advertising expenditures to proxy for innovation and relational capital, respectively, we use eight variables to proxy for four major types of intellectual capital. Second, we control for the effect of industry on the association between intellectual capital and firm valuation by focusing on the IT industry. In contrast, Han and Manry (2004) include all industries in their sample but does not control for industry effect. Finally, because stock price per se does not represent firms' true value due to numerous corporate events (e.g., stock dividend, stock split, and exercise of employee stock options), Han and Manry's (2004) use of stock price as the dependent variable may not be a correct application of the residual income valuation model. We follow recent studies by adopting the *P/V* ratio as the measure of firm valuation.

## 3 Research design

### 3.1 Model specification

Based on recent studies in residual income valuation models (e.g., Ohlson 1990, 1995), Frankel and Lee (1998) measure a firm's fundamental equity value as the sum of book value and the present value of expected residual income, where residual income is the difference between reported income and the cost of equity capital multiplied by the beginning balance of reported book value. While Frankel and Lee's (1998) primary measure of firm value use a three-period model, we use a simplified two-period model specified in equation (3.1) of Frankel and Lee (1998) for two reasons. First, the three-period model requires two-year-ahead and three-year-ahead analysts' earnings forecasts, which are not available in Taiwan. Second, as shown in Table 2 of Frankel and Lee (1998), the two-period and three-period models provide equivalent estimates of the fundamental value metric *V*.[6] The two-period model and its components are as follows:

$$V_t = B_t + \frac{(FROE_t - r_e)}{(1+r_e)} B_t + \frac{(FROE_t - r_e)}{(1+r_e)r_e} B_t$$

$$FROE_t = FY1/[(B_{t-1} + B_{t-2})/2]$$

$$B_t = B_{t-1}[1 + FROE_t(1-k)]$$

where $FROE_t$ is the forecasted return on equity (*ROE*) in year *t*, $B_t$ is the estimated book value of common stockholders' equity at the end of year *t*, $r_e$ is the estimated cost of capital, and *k* is the dividend payout ratio. This formulation of the residual income model assumes that $FROE_t$ will be earned in perpetuity.

While Frankel and Lee (1998) estimate $FROE_t$ using one-year-ahead consensus earnings forecasts (*FY1*), we use the realized *EPS* for year *t* (denoted by $EPS_t$) to proxy for *FY1* because Barron et al. (2002) find that analysts' earnings forecast consensus is lower for high-tech companies due to their high uncertainty in future earnings associated with intangible assets. A literal use of consensus earnings forecasts may lead to imprecise estimation of $FROE_t$. Also, Frankel and Lee's (1998) Table 2 shows

[6]We do not adopt Chen et al.'s (2009) mispricing measure because they develop the measure mainly to capture investors' subjective growth rates, which are likely to revert to mean in the future. Such mean-reversion leads to the arbitrage return of the mispricing strategy. Since we are interested in testing whether Taiwan's stock market misprices IT companies' intellectual capital, mispricing strategy is not our major concern.

that the empirical results are similar no matter whether future *ROE* is proxied by current year *ROE* (which is determined by $EPS_t$) or forecasted *ROE* (which is determined by analyst consensus forecasts). Because negative *EPS* gives rise to negative *FROE* which, in turn, leads to negative fundamental value *V*, we eliminate firms with negative *EPS* from our sample.

Since there is little consensus on how the cost of capital $r_e$ should be determined (Frankel and Lee 1998) and existing models of computing $r_e$ (e.g., Ohlson and Juettner-Nauroth 2005) highly reduces our sample, we follow prior studies that adopt the residual income model (e.g., Barth et al. 1999; Dechow et al. 1999; Frankel and Lee 1998) by assuming a constant $r_e$ of 12%. This rate is approximately equal to Taiwan's long-term average rate of return.

The dividend payout ratio *k* is computed by dividing the cash dividends paid to common stockholders in the most recent year by net income before extraordinary items. Following Frankel and Lee (1998), we divide cash dividends by 6% of total assets to estimate *k* for firms with negative net income before extraordinary items (only one firm in our sample).

Once we obtain each firm's fundamental value *V*, we divide the firm's stock price (denoted by *P*) by this *V* to get the *P/V* ratio as our dependent variable.[7] Note that, since information that can be used to compute the intellectual capital proxies will not be publicly available until the firms release their annual reports (whose official deadline for all Taiwanese listed companies is April 30), we use each firm's *P* at the end of April in year *t*+1 to compute the *P/V* ratio.

We use the following model (1) to test whether Taiwan's IT companies with more intellectual capital are more likely to be mispriced by the stock market. To controls for unobserved firm-level heterogeneity, we also include industry and year fixed effects (Bowen et al. 2010; Linck et al. 2009).

$$
\begin{aligned}
P/V = {} & \alpha_0 + \alpha_1 \cdot Beta + \alpha_2 \cdot Ivolatility + \alpha_3 \cdot D/M + \alpha_4 \cdot Ln\,(ME) + \alpha_5 \cdot Altman's\ Z + \alpha_6 \cdot B/P + \alpha_7 \cdot CT \\
& + \alpha_8 \cdot EDU + \alpha_9 \cdot LABOR + \alpha_{10} \cdot RD + \alpha_{11} \cdot ROYALTY + \alpha_{12} \cdot WORKING + \alpha_{13} \cdot FIXED \\
& + \alpha_{14} \cdot PROMOTION + \alpha_{15} \cdot GROWTH + \varepsilon \qquad (1)
\end{aligned}
$$

where all the variables are defined in Table 1.

[Insert Table 1 here]

### 3.2 Discussions of variables

#### 3.2.1 Firm-specific risk control variables

We follow Ali et al. (2003), Gebhardt et al. (2001), and Gode and Mohanram (2003) by including several major control variables that may proxy for firm-specific risks. For example, *Beta* measures the systematic component of stock price variability. *Ivolatility* measures the non-systematic component of stock price variability because market tends to price idiosyncratic risk (Merton 1987). We also consider *D/M* to control for risk resulting from a firm's financing activities (Fama and French 1992). We control for firm size *Ln(ME)* because size might capture firm-specific risk (Fama and French 1992) and larger firms are more likely to be subjected to closer scrutiny by regulators and investors (Balsam et al. 2003; Romanus et al. 2008). Also, controlling for size can potentially mitigate the problem of correlated omitted variables (Myers et al., 2005; Ahmed and Goodwin 2007). We consider *Altman's Z* because

[7]Tsay et al. (2008) also adopt the Ohlson (1995) model but use stock price as the dependent variable. Note that stock price per se does not represent firm value because many corporate events distort prices. For example, stock dividend, stock split, exercise of employee stock options and some other events decrease the stock price. Thus, we use stock return (more precisely, the stock abnormal return) as the measure of firm valuation.

this score is a good indicator of financial distress (Abbott et al. 2004) or even bankruptcy (Palmrose and Scholz 2004). Finally, we consider *B/P* because prior studies show that *B/P* is associated with future return and, therefore, may proxy for omitted risks (Fama and French 1992).

### *3.2.2 Taiwan's specific control variable – Shareholders' imputed credits (CT)*

The full imputation credit prototype forms the core of Taiwan's integrated tax system adopted in 1998. Under this new system, individual shareholders are allowed a tax credit against their individual income tax for any dividend income tax paid at the corporate level. Dividends paid to corporate shareholders are exempt from corporate income tax, and the imputation credit will be passed on, in its entirety, to individual shareholders. It is this full imputation feature that changes the nature of corporate income tax from a pure operating expense to an asset (Yu et al. 2003). To accommodate this tax reform, Taiwan's GAAP mandate listed companies to disclose shareholders' taxable dividend balance (STDB) in the footnotes of the financial statements. Due to this Taiwan-specific feature, we consider *CT* in model (1). Note that *CT* is measured by adding accrued tax payables to the STDB because STDB denotes the actual amount of cash a firm has paid in year $t$ but does not include the tax that the firm will pay in year $t$+1.

### *3.2.3 Intellectual capital variables*

Because mispricing results from information asymmetry, Taiwan's stock market may overprice or underprice IT companies' intellectual capital. Therefore, we do not predict the signs of the coefficients of our eight intellectual capital variables. If a specific type of intellectual capital is underpriced, the relation between the *P/V* ratio and the proxies for this intellectual capital should be negative. In contrast, if there is a positive relation between the *P/V* ratio and a specific intellectual capital proxy, this intellectual capital is overpriced. We adopt this approach with an aim to examine whether Taiwan's stock market reacts to different intellectual capital differently.

#### Human capital

Human capital refers to the knowledge, skills, and competencies of people in an organization. Numerous studies have emphasized the importance of human as a key component of intellectual capital (e.g., Davis and Noland 2003; Lee and Witteloostuijn 1998; Ulrich 1998). We adopt *employees' educational background* (denoted by *EDU*) to proxy for human capital because educational background reflects employees' professional knowledge and learning potential to enhance problem-solving capability (Bröcheler et al. 2004; Lim and Dallimore 2004; Skaggs and Youndt 2004). We measure *EDU* by the percentage of total professional employees holding a graduate degree.

We also use the *labor costs paid to the employees* (denoted by *LABOR*) as our second proxy because knowledge-focused firms generally view employees as key profit producers and emphasize firms' internal investments on them (Sveiby 1997). In addition, salaries and bonus are regarded as two most important types of compensation in motivating capable employees to create firm value (Mavrinac and Siesfeld 1998; Wilson and Peel 1991). In fact, well-designed salary and bonus-sharing contracts lower the probability of strike (Brown et al. 1999), employee turnover (Wilson and Peel 1991), and improve productivity (Bhargava 1994). Due to these reasons, some researchers have suggested the use of employee salaries and bonuses to capture human capital (e.g., Van Buren 1999). We measure *LABOR* by the total labor costs (including salary, bonus, health insurance, pension, meal, welfare, and others) paid to the employees divided by a firm's net sales.

### Innovation capital

Innovation capital is an organization's capability to use emerging technologies to innovate and develop new products, services, and solutions. Therefore, innovation is an vital intellectual capital to IT companies' survival and success. We choose two proxies to capture innovation capital: *R&D* intensity (denoted by *RD*) and *royalty ratio* (denoted by *ROYALTY*). These two proxies are selected mainly because most of Taiwan's IT companies obtain new technology either by their own R&D activities or by acquiring patents through royalty payments.[8] We measure *RD* by the ratio of R&D expenses to net sales because previous research has found that R&D expenditures play a pivotal role to firms' innovation activities, giving rise to future growth opportunities (e.g., Bae and Kim 2003; Bhagat and Welch 1995). Also, spending on R&D is viewed as a form of investment in intangible assets with predictably positive effects on future cash flows (Chauvin and Hirschey 1993), leading to favorable market reactions (Sougiannis 1994). Similar to *RD*, we measure *ROYALTY* by the ratio of total royalty payments to net sales.

### Process capital

Process capital is the procedures, systems, and techniques an organization adopts to facilitate its operations. Since investors regard the quality of internal processes as an important business valuation factor (Mavrinac and Siesfeld 1998), firms should maintain smooth and flexible operation processes to achieve process quality. Prior studies have indicated that working capital turnover serves as a good measure of firms' *operating efficiency* because higher working capital turnover implies less overstocking of capital, higher inventory turnover, shorter operating cycle (e.g., Knight 1999; Stewart 1997), and better firm performance (e.g., Wang and Chang 2005). The higher the working capital turnover, the less the money a company has tied up to get its sales (Stewart 1997). On the other hand, since the IT industry requires large investments in high-technology fixed assets with greater asset specificity, production efficiency influences its global competiveness and future growth (OECD 1996, 1999). Several recent studies have used fixed assets turnover to proxy for *production efficiency* and shown that IT companies with higher fixed asset turnover have better earnings performance (e.g., Mouritsen et al. 2001; Wang and Chang 2005). Because both operating and production efficiencies are vital to Taiwan's IT companies, we adopt these two turnovers as our two proxies for process capital. *WORKING* is measured by the ratio of net sales to average working capital (according to Stewart (1997), working capital is defined as receivables plus inventory and then minus payables) and *FIXED* is measured by the ratio of net sales to average fixed assets.

### Relational (customer) capital

Relational capital is the value of an organization's relationships with its suppliers, customers, and other stakeholders (Johanson et al. 2001). The first proxy we choose is the *marketing (promotion) expense ratio* (denoted by *PROMOTION*), which is measured by the ratio of total marketing expenses to net sales. We use marketing expenses instead of advertising expense because the former is broader than the latter. Specifically, marketing expenses usually include expenditures related to advertising, sales, distribution of products, and services. Furthermore, since many of the buyers of Taiwan's IT products (especially semiconductor and electronic components) are manufacturers rather than individual customers, the use of advertising expense may not appropriately capture these companies' relational capital. While some prior studies emphasize that marketing expenditures affect consumers' product or brand image (e.g., Edvinsson and Malone 1997; Lim and Dallimore 2004; Stewart 1997) and

[8]Since most of Taiwan's IT companies only provide verbal descriptions of their technologies and products successfully developed, we cannot find appropriate measurable metrics to proxy for their innovation capital. Therefore, we use R&D and royalty payments to measure these IT companies' innovation capital.

document a positive effect on future earnings (e.g., Bublitz and Ettredge 1989; Cañibano et al. 2000; Chauvin and Hirschey 1993), some other studies do not find such evidence (e.g., Ayanian 1983; Bloch 1974; Bublitz and Ettredge 1989; Chen, Cheng, and Hwang 2005; Core et al. 2003). Therefore, whether marketing expense increases relational capital is an empirical question.

The second proxy is *revenue growth* (denoted by *GROWTH*). Previous research has indicated that customer capital can be measured by revenue or market growth (e.g., Lim and Dallimore 2004; Mavrinac and Siesfeld 1998; Sveiby 1997; Van Buren 1999). Sveiby (1997) emphasizes that revenue growth occurs when a firm's business concept (e.g., Apple's product innovation and user experience) is so strong and its knowledge level is so high (e.g., the retina touch screen and fingerprint sensor in iPhone 5S) that this firm's knowledge is sought by more customers. Therefore, a company that grows in sales implies that its business concept is appreciated by the market. Following Sveiby (1997), we measure *GROWTH* by the net sales in year *t* divided by the net sales in year *t*-1

## 4 Empirical results

### 4.1 Data and sample selection

We collect the data from the *Taiwan Economic Journal* database for the years 2003-2006. Our preliminary sample consists of 1,228 firm-year observations. After subtracting observations with negative earnings, missing data, and outliers,[9] we obtain 751 observations for estimating model (1). We analyze variance inflation factors (VIFs) among independent variables and find that all of the VIFs are between 1.198~2.865. Because these VIFs are far below the 10.0 threshold suggested by Neter et al. (1996) and Kleinbaum et al. (1997), multicollinearity is not a problem in our analyses.

### 4.2 Descriptive Statistics

Panel A of Table 2 indicates that the numbers of firm-year observations are roughly the same across the period 2003~2006. However, there are considerable variations among sub-categories within the IT industry. For example, the last column of Table 2 shows that 20.24% of the companies are manufacturers of electronic parts / components, followed by computer peripheral equipment (19.31%), semiconductor (16.51%), and optoelectronic (15.31%). Only 9.59%, 5.59%, and 2.66% of the companies belong to Internet communication, electronic product distribution, and information service, respectively. Finally, some of the largest companies are classified as "Others" because of their high diversification feature (e.g., Foxconn Technology Group, the world largest provider of CEM, EMS, ODM and CMMS).[10]

[Insert Table 2 here]

[9]To control for outliers, we trim observations that fall outside the upper and lower 1% of the empirical distributions for both the dependent and independent variables.

[10]Contract electronic manufacturers (CEM) are companies that offer contracts for electronic assembly for other original equipment manufacturers (OEM). Generally, a CEM does not post its brand name on any product, and both the design and the brand name belongs to the OEM. In contrast, electronics manufacturing service (EMS) providers are companies that design, test, manufacture, distribute, and provide repair services for electronic components and assemblies for OEM. Original design manufacturers (ODM) are companies that manufacture products which ultimately will be branded by another company for sale. ODM companies allow the brand firm to produce without having to engage in the organization or running of a factory. Finally, component module move service (CMMS) providers are companies offering joint development manufacturing (JDVM) and joint design manufacturing (JDSM). Since a CMMS takes the advantages of CEM and ODM, it can effectively reduce its production costs and speed up the production process. The CMMS model was initially developed and adopted by Foxconn since 1998.

Panel B of Table 2 presents the descriptive statistics of our variables. All monetary amounts are measured by New Taiwan (NT) dollars (with an exchange rate around US$1 = NT$30). As reported in this Table, the *P/V* ratio has a mean value of 2.348, ranging from 0.161 to 128.233. Notably, unreported statistics indicate that firms in the Computer Peripheral Equipment and Semiconductors categories tend to have larger *P/V* ratios (account for 47 out of the 100 largest *P/V* ratios), while firms in the Electronic Parts / Components, Internet Communication, and Others categories have smaller *P/V* ratio (account for 48 out of the 100 smallest *P/V* ratios). Table 3 also shows substantial variations between and within four types of intellectual capital. For example, the mean values of *EDU* and *LABOR* are 0.685 (ranging from 0.04 to 1) and 0.058 (ranging from 0.002 to 0.278), respectively, indicating that Taiwan IT companies' human capital is more likely to be driven by hiring more employees with graduate degrees. In contrast, the mean values of *RD* and *ROYALTY* are 0.037 (ranging from 0 to 0.235) and 0.003 (ranging from 0 to 0.326), respectively, implying that sample firms tend to develop innovation capital mainly through their own R&D activities rather than acquiring patents from outside parties. The mean values of *WORKING* and *FIXED* are 7.879 (ranging from -60.283 to 85.987) and 15.67 (ranging from 0.499 to 306.221), respectively, suggesting that Taiwan's IT companies appear to focus more on production efficiency rather than operating efficiency in developing their process capital. Finally, the mean values of *PROMOTION* and *GROWTH* are 0.042 (ranging from zero to 0.43) and 0.205 (ranging from -0.82 to 2.105), respectively, indicating that most of the IT companies have fairly good sales growth based on which they build up their relational capital.

We report in Table 3 the Pearson (the upper right part) and Spearman (the lower left part) correlations among all variables in model (1). Positive and significant correlations (both Pearson and Spearman) of *P/V* ratio and *Beta*, *Ivolatility*, *D/M*, and *B/P* suggest that high *P/V* stocks are riskier. However, negative and significant correlations (both Pearson and Spearman) of *P/V* ratio with *Altman's Z* suggest that high *P/V* stocks are less risky. Overall, these univariate correlation results are inconclusive on whether omitted risks are associated with high *P/V* firms exhibiting high future returns. This result is consistent with Ali et al. (2003).

[Insert Table 3 here]

### 4.3 Mispricing of intellectual capital

In Table 4, we report the regression results based on model (1). Because the measurement units of our control variables and intellectual capital proxies are different, we report standardized coefficients to make the coefficients more comparable to each other. Since the intercept is identically equal to zero, there is no standardized intercept.

[Insert Table 4 here]

The model in Column (1) includes only firm-specific risk variables. The coefficients on *Ivolatility* and *B/P* are positive and significant (two-tailed $p < 0.000$), suggesting that firms with high *P/V* ratios are riskier and should therefore be associated with higher future returns. However, the insignificant and mixed coefficients on *Beta* (i.e., 0.041), *D/M* (i.e., 0.024), and *Altman's Z* (i.e., -0.050) suggest that risk factors appear not to be the drivers of the association between *P/V* ratio and future returns. As with the correlation results in Table 4, the regression results do not conclusively suggest whether high *P/V* ratio firms are riskier. Therefore, consistent with the conclusion of Ali et al. (2003) and Frankel and Lee (1998), it appears that market mispricing better explains the *P/V* effect than omitted risk factors in Taiwan's stock market. We thus adopt the mispricing notion to examine whether Taiwan's stock market appropriately incorporates the value of IT companies' intellectual capital.

The model in Column (2) includes all 8 intellectual capital variables. The coefficients on *EDU* and *LABOR* are negative and significant (one-tailed $p < 0.10$ and two-tailed $p < 0.05$, respectively), suggesting that Taiwan's stock market underprices IT companies' human capital. In contrast, the coefficients on *RD* and *ROYALTY* are positive but only the coefficient on *RD* is significant (two-tailed $p < 0.05$). These results indicate that Taiwan's stock market overprices innovation capital with a focus on IT companies' R&D intensity. The significance of the coefficient on *RD* may reflect the fact that the stock market views high R&D intensity as a signal of IT companies' ability to develop their own patents and copyrights.

Different from the human capital, the coefficients on the process capital proxies (i.e., *WORKING* and *FIXED*) and relational capital proxies (i.e., *PROMOTION* and *GROWTH*) are all negative with marginally significant coefficients on *WORKING* and *GROWTH* only. Therefore, Taiwan's stock market appears to underprice IT companies' process and relational capital with a focus on working capital turnover and net sales growth. Overall, the mispricing problem appears to be more prominent on the human capital than on the other three types of intellectual capital.

## 4.4 Additional tests

### 4.4.1 Foreign institutional investors' ownership

As reported in Table 4, there is only a 1.6% (i.e., 9.9% – 8.3%) increase in adjusted $R^2$ when we include all intellectual capital variables into the model. This trivial increase may lead one to question whether Taiwan's stock market is unable to incorporate IT companies' intellectual capital into the determination of their equity values. To address concern, we further consider the impacts of foreign institutional investors' ownership on our empirical results.

Due to its high competitiveness and good financial performance, Taiwan's IT industry has long been the target to foreign institutional investors since early 1990s (Dean 2004). Taiwan Securities Exchange reports that foreign institutional investors hold 23.15% and 33.24% ownerships of Taiwan's electronics and semiconductor companies in 2003, respectively. These percentages jump to 30.72% and 42.78% in 2005, 32.90% and 46.66% in 2006, and drop slightly to 31.94% and 44.18% in 2007, respectively. Because foreign institutional investors have better professional knowledge and are more capable of gathering and analyzing accounting information than domestic investors (Kim and Singal 1994), they usually take a leadership position in Taiwan's stock market, especially in the IT industry (You and Lai 1999). Therefore, foreign institutional investors and domestic investors may value intellectual capital differently.

We first separate our full sample into two sub-groups based on the median of institutional investors' ownership percentages. Table 5 reports the means and medians of our 8 intellectual capital variables between the high-ownership and low-ownership groups. Notably, the differences in means and medians are significant in 7 of our intellectual capital variables. These results imply that foreign institutional investors and domestic investors may react to intellectual capital in different ways.

[Insert Table 5 here]

We then run model (1) for the high-ownership and low-ownership groups separately. As shown in the Low-ownership column of Table 6, the significance of the coefficients on *EDU*, *LABOR*, *RD*, *WORKING*, and *GROWTH* improves a lot. In addition, the coefficient on *PROMOTION* becomes marginally significant, suggesting that the mispricing problem is more prominent on the human and relational capital than on the innovation and process capital. The adjusted $R^2$ jumps from 9.9% to 24.6%. In contract, the High-ownership column shows that all intellectual capital variables are insignificant except *RD*, which is only marginally significant at one-tailed 10% significance level. Also, the adjusted $R^2$ drops by 2.2% (i.e., 9.9% − 7.7%).

[Insert Table 6 here]

The results reported in Table 6 bear three important implications. First, as compared to foreign institutional investors, Taiwan's domestic investors are more likely to under- or overprice IT companies' intellectual capital. Because foreign institutional investors are sophisticated due to their professional expertise and knowledge in the IT industry, they are less likely to misprice intellectual capital. This finding is not consistent with prior studies that report that the U.S. stock market tends to misprice intangible assets such as R&D expenditures (e.g., Chan et al. 2001; Lev et al. 2005). Since institutional investors dominate the U.S. stock market and most of Taiwan's foreign institutional investors are from the U.S., our empirical results suggest that the U.S. institutional investors' mispricing problem appears to diminish when they invest in other countries.

Second, for IT companies whose shares are largely owned by foreign institutional investors, Taiwan's domestic investors are less likely to suffer the mispricing problem. In other words, domestic investors may benefit from foreign institutional investors in determining firms' equity values. This is consistent with prior studies' finding that Taiwan's domestic investors often rely on foreign investors' strategy to guide their own investment decisions (Liu 2004).

Finally, the drop in adjusted $R^2$ implies that foreign institutional investors may adopt different valuation models with a focus on different variables in valuing Taiwan's IT companies. The significance of the coefficient on *RD* suggests that foreign institutional investors appear to over-emphasize on R&D activities because patents and copyrights developed by the IT companies themselves are deemed crucial to maintain leadership in the highly competitive global IT market. This result may partially explain HTC's (Asia's second-largest Android smartphone maker) sharp stock price drops in August 2011 when Apple sued HTC for patent infringement.

### 4.4.2 Alternative measure of shareholders' imputed credits

Because Taiwan's GAAP requires companies to disclose shareholders' taxable dividend balances in the footnotes, market participants may interpret these numbers mechanically without taking into account the accrued tax payables to be paid in the next year. To test whether the results reported in Table 5 are subjected to market participants' "functional fixation," we exclude accrued tax payables from *CT* and re-estimate model (1). Our conclusions remain the same.

### 4.4.3 Eliminate Year 2004

As compared to 2003, 2005, and 2006, Taiwan's stock market suffered substantial fluctuation in 2004 because of the presidential election on March 20. Due to many provoking political actions and scandals in his Administration, former President Shui-bian Chen's opinion polls were far behind his competitor, Chan Lien. With the expectation that Chan Lien would win the election, the stock market soared in terms of trading amount and volume in early 2004. However, Shui-bian Chen was shot one day before the poll. Using this as an allegation of assassination planned by China, Chen narrowly won the election. Chan Lien refused to concede and sued for a nullification of the election result while supporters held a week-long riot in front of the Presidential House due to alleged election irregularities throughout the island. The stock market reacted to this unexpected event by a drop of more than 400 points in the week following the election. Because Taiwan's 2004 Presidential Election is a political event that has never occurred before in Taiwan's history, the above analyses may be subjected to the uniqueness of this non-economic event, leading to weak generalization of our empirical results. We eliminate observations in 2004 and re-estimate model (1). The results obtained in Table 5 remain unchanged.

## 5 Discussions and conclusions

### 5.1 Discussions of the overpricing of R&D intensity

Our finding that R&D intensity is overpriced is inconsistent with recent studies that use different measures of R&D expenditures to proxy for innovation and document underpricing on such measures. For example, Chen et al. (2014) adopt R&D spillover (which is defined as a firm's ability to take advantage of innovations created by other firms) to capture innovation and report that R&D spillover effect is underpriced because investors cannot concretely measure and recognize spillover effect on firms' future profitability. In addition, Cohen et al. (2013) utilize R&D ability (which is defined as a firm's ability to turn its R&D expenditures into future sales) to measure innovation and find that R&D ability is underpriced because investors could not take into account firms' past track records at R&D in an ex ante and predictable way. Hirshleifer et al. (2013) employ innovative efficiency (which is defined as the numbers of patents and citations scaled by R&D expenditures) to evaluate firms' innovation activities and show that innovative efficiency is underpriced because it is difficult for investors to determine the economic implications of patents and citations resulting from R&D expenditures. Several reasons may explain the inconsistency between our finding and these recent studies' conclusions. First, different R&D measures may capture different dimensions of R&D expenditures that may or may not be observable and understandable to the investors. While R&D spillover, R&D ability, and innovative efficiency are not publicly available and require much complicated tracing and calculation efforts over a long time period, R&D intensity is more comprehensible and easier to compute using firms' financial statements.

Second, these recent studies examine firms in all industries (excluding financial institutions) across a much longer period (i.e., from late 1970s to the middle of 2000s). In contrast, we focus on the IT industry over a shorter period 2003~2006. Focusing on the IT industry by itself accentuates the importance of R&D expenditures because, as compared to other industries, R&D activities are viewed as the most vital decision to IT companies' future success. Also, choosing a shorter time period allows us to rule out certain macroeconomic and regulatory factors that may affect IT companies' R&D decisions, leading to cleaner empirical results.

Third, IT industry is the most important industry in Taiwan that has received the greatest attention by domestic and foreign institutional investors. Furthermore, the professional media in Taiwan usually reports the R&D investments made by major IT companies such as TSMC (the world's largest manufacturer of wafer foundry), HTC, and ASUS (the world's largest motherboard manufacturer who introduced the *EeePad Transformer* tablet PC in 2011). R&D intensity is the most commonly-used measure adopted by the media. Note that Taiwan's IT industry also leads Taiwan Securities Exchange's daily weighted index. Therefore, domestic and foreign institutional investors shall have strong incentives to emphasize more on IT firms' R&D activities in determining their stock prices.

Finally, since the 1970s, Taiwan's government has passed the *Act of Encouragement of Investment* specifically for the IT industry. Most of the IT companies thus enjoyed large tax subsidies for their capital and R&D expenditures in the past several decades. This favorable regulatory environment does not exist in other Asia countries, the Europe, and the North America.

### 5.2 Summary and conclusions

This study employs the residual income valuation model to examine whether Taiwan's stock market appropriately incorporates the value of IT companies' intellectual capital. The empirical results show that Taiwan's stock market overprices IT companies' innovation capital but underprices their human, process, and relational capital. Notably, the mispricing problem is more prominent on the human capital than on the other three types of intellectual capital. Therefore, Taiwan's stock market reacts to different types of intellectual capital differently. When we separate our sample by the median of foreign institutional investors' ownership, we find that the mispricing of intellectual capital is due to Taiwan's domestic investors rather than foreign institutional investors. Specifically, the mispricing problem is more prominent on the human and relational capital.

Recent regulations of compulsorily disclosing certain information have received much attention by the accounting academics (e.g., Bushee et al. 2004; Linsmeier et al. 2002). We base our study on Taiwan's IT companies and find that the stock market appears to underprice some types of intellectual capital but overprice the others. Because mispricing results mainly from information asymmetry, our finding accentuates the necessity of requiring the disclosure of information related to intellectual capital by regulators and policy-makers in other countries. From regulators' perspective, such disclosure can increase the transparency of firms. From the investors' perspective, disclosure of intellectual capital could help them make more precise and appropriate assessment of firms' true market values. Although the empirical results are based on data from Taiwan, we believe that the results should be applicable to more mature and larger size stock markets such as the North America and Europe. Since intellectual capital has received much attention by the academics and practice as a vital means of competing with others in the global markets, institutional and individual investors who plan to trade securities from foreign firms in these countries should take the disclosure of intellectual capital into consideration appropriately in formulating their business valuation models.

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**Table 1** Definitions of variables

| Variables | Definitions |
|---|---|
| *P/V* | *P/V* ratio, where *P* is the stock price at the end of April in year *t*+1 and *V* is the firm's fundamental value computed using Frankel and Lee's (1998) two-period model |
| *Beta* | Systematic risk estimated using monthly returns over a maximum of 36 months ending in April of year *t*+1 |
| *Ivolatility* | Standard deviation of residuals from a market model regression estimated using daily returns, over a one-year period ending in April of year *t*+1 |
| *D / M* | Book value of long-term debt in year *t* divided by the market value of equity at the end of April of year *t*+1 |
| *Ln(ME)* | Natural log of the market value of equity (in millions) at the end of April of year *t*+1 |
| *Altman's Z* | A bankruptcy score from Altman's (1968) discriminant model: 0.012×(working capital / total assets) + 0.014×(retained earnings / total assets) + 0.033×(earnings before interest and taxes / total assets) + 0.006×(market value of equity / book value of total liabilities) + 0.999×(sales / total assets), with all the variables from year *t* |
| *B / P* | Book value in year *t* divided by the market value of equity at the end of April in year *t*+1 |
| *CT* | Stockholders' tax deductible balance plus accrued tax payable per share in year *t* |
| *EDU* | Percentage of employees holding graduate degrees at the end of year *t* |
| *LABOR* | Ratio of labor costs to net sales in year *t* |
| *RD* | R&D intensity (i.e., R&D expenses divided by net sales) in year *t* |
| *ROYALTY* | Ratio of royalty payments to net sales in year *t* |
| *WORKING* | Working capital turnover in year *t* |
| *FIXED* | Fixed assets turnover in year *t* |
| *PROMOTION* | Ratio of marketing expenses to net sales in year *t* |
| *GROWTH* | Ratio of net sales in year *t* to net sales in year *t-1* |

**Table 2** Descriptive statistics (N = 751)

Panel A: Sample distribution by IT sub-categories and year

| IT Sub-categories | 2003 | 2004 | 2005 | 2006 | Total by Sub-categories |
|---|---|---|---|---|---|
| Semiconductor | 29 (15.03%) | 32 (17.20%) | 28 (15.82%) | 35 (17.95%) | 124 (16.51%) |
| Computer and peripheral equipment | 42 (21.76%) | 34 (18.28%) | 35 (19.77%) | 34 (17.44%) | 145 (19.31%) |
| Optoelectronic | 33 (17.10%) | 31 (16.67%) | 23 (12.99%) | 28 (14.36%) | 115 (15.31%) |
| Communications and Internet | 15 (7.77%) | 16 (8.60%) | 18 (10.17%) | 23 (11.80%) | 72 (9.59%) |
| Electronic parts / components | 39 (20.21%) | 37 (19.89%) | 40 (22.60%) | 36 (18.46%) | 152 (20.24%) |
| Electronic products distribution | 10 (5.18%) | 10 (5.38%) | 10 (5.65%) | 12 (6.15%) | 42 (5.59%) |
| Information service | 5 (2.59%) | 6 (3.23%) | 4 (2.26%) | 5 (2.56%) | 20 (2.66%) |
| Other electronic | 20 (10.36%) | 20 (10.75%) | 19 (10.74%) | 22 (11.28%) | 81 (10.79%) |
| Total | 193 (25.70%) | 186 (24.77%) | 177 (23.57%) | 195 (25.96%) | 751 (100.00%) |

Panel B: Statistical properties

| Variables* | Mean | Std. Dev. | Min. | Q1 | Median | Q3 | Max. |
|---|---|---|---|---|---|---|---|
| *P/V* | 2.348 | 6.667 | 0.161 | 0.622 | 0.940 | 1.615 | 128.233 |
| *Beta* | 0.987 | 0.255 | 0.138 | 0.819 | 1.001 | 1.170 | 1.832 |
| *Ivolatility* | 2.173 | 0.594 | 1.055 | 1.786 | 2.132 | 2.495 | 7.366 |
| *D/M* | 0.089 | 0.133 | 0.000 | 0.000 | 0.030 | 0.127 | 0.870 |
| *Ln (ME)* | 9.032 | 1.429 | 6.157 | 7.995 | 8.745 | 9.771 | 14.389 |
| *Altman's Z* | 1.019 | 0.575 | 0.213 | 0.633 | 0.897 | 1.271 | 4.629 |
| *B/P* | 0.606 | 0.347 | 0.059 | 0.365 | 0.536 | 0.775 | 2.783 |
| *CT* | 0.563 | 0.715 | 0.000 | 0.123 | 0.337 | 0.748 | 6.319 |

**Table 2** continued

| Variables* | Mean | Std. Dev. | Min. | Q1 | Median | Q3 | Max. |
|---|---|---|---|---|---|---|---|
| *EDU* | 0.685 | 0.212 | 0.040 | 0.514 | 0.696 | 0.878 | 1.000 |
| *LABOR* | 0.058 | 0.048 | 0.002 | 0.022 | 0.041 | 0.083 | 0.278 |
| *RD* | 0.037 | 0.038 | 0.000 | 0.012 | 0.025 | 0.046 | 0.235 |
| *ROYALTY* | 0.003 | 0.022 | 0.000 | 0.000 | 0.000 | 0.000 | 0.326 |
| *WORKING* | 7.879 | 9.281 | -60.283 | 3.686 | 5.683 | 10.048 | 85.987 |
| *FIXED* | 15.670 | 29.756 | 0.499 | 2.442 | 5.941 | 16.685 | 306.221 |
| *PROMOTION* | 0.042 | 0.043 | 0.000 | 0.019 | 0.032 | 0.050 | 0.430 |
| *GROWTH* | 0.205 | 0.308 | -0.820 | 0.020 | 0.161 | 0.340 | 2.105 |

*See Table 1 for the definitions of the variables.

**Table 3** Correlation coefficients (N = 751)*

| Variables | *P/V* | *Beta* | *Ivolatility* | *D/M* | *Ln (ME)* | *Altman's Z* | *B/P* | *CT* | *EDU* | *LABOR* | *RD* | *ROYALTY* | *WORKING* | *FIXED* | *PROMOT* | *GROWTH* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *P/V* | | 0.087 | 0.129 | 0.086 | -0.039 | -0.070 | 0.177 | -0.133 | -0.003 | -0.014 | 0.070 | 0.038 | -0.062 | -0.053 | 0.017 | -0.111 |
| | | (0.017) | (0.000) | (0.018) | (0.289) | (0.054) | (0.000) | (0.000) | (0.940) | (0.710) | (0.054) | (0.294) | (0.090) | (0.147) | (0.635) | (0.002) |
| *Beta* | 0.195 | | 0.156 | 0.064 | 0.346 | -0.079 | 0.075 | -0.146 | -0.126 | 0.035 | -0.004 | 0.078 | -0.009 | -0.045 | -0.200 | 0.114 |
| | (0.000) | | (0.000) | (0.080) | (0.000) | (0.030) | (0.039) | (0.000) | (0.001) | (0.333) | (0.912) | (0.032) | (0.807) | (0.220) | (0.000) | (0.002) |
| *Ivolatility* | 0.279 | 0.152 | | -0.072 | -0.119 | -0.012 | -0.129 | -0.062 | -0.069 | 0.079 | 0.082 | 0.049 | -0.054 | -0.007 | -0.011 | 0.172 |
| | (0.000) | (0.000) | | (0.048) | (0.001) | (0.741) | (0.000) | (0.088) | (0.060) | (0.029) | (0.024) | (0.183) | (0.136) | (0.844) | (0.757) | (0.000) |
| *D/M* | 0.020 | 0.145 | -0.078 | | -0.176 | -0.134 | 0.434 | -0.135 | -0.173 | 0.192 | -0.169 | -0.027 | -0.102 | -0.051 | -0.006 | 0.017 |
| | (0.086) | (0.000) | (0.032) | | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.465) | (0.005) | (0.161) | (0.864) | (0.639) |
| *Ln (ME)* | 0.006 | 0.393 | -0.076 | -0.125 | | 0.073 | -0.436 | 0.139 | 0.103 | -0.273 | 0.019 | 0.054 | 0.169 | 0.069 | -0.144 | 0.209 |
| | (0.879) | (0.000) | (0.038) | (0.001) | | (0.046) | (0.000) | (0.000) | (0.005) | (0.000) | (0.595) | (0.140) | (0.000) | (0.060) | (0.000) | (0.000) |
| *Altman's Z* | -0.267 | -0.129 | -0.050 | -0.230 | 0.098 | | -0.138 | 0.255 | 0.325 | -0.526 | -0.238 | -0.079 | 0.252 | 0.594 | -0.199 | 0.191 |
| | (0.000) | (0.000) | (0.169) | (0.000) | (0.007) | | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.030) | (0.000) | (0.000) | (0.000) | (0.000) |
| *B/P* | 0.203 | 0.108 | -0.147 | 0.371 | -0.497 | -0.203 | | -0.258 | -0.046 | 0.172 | -0.135 | -0.014 | -0.026 | -0.097 | 0.087 | -0.252 |
| | (0.000) | (0.003) | (0.000) | (0.000) | (0.000) | (0.000) | | (0.000) | (0.206) | (0.000) | (0.000) | (0.703) | (0.481) | (0.008) | (0.017) | (0.000) |
| *CT* | -0.378 | -0.235 | -0.160 | -0.181 | 0.115 | 0.357 | -0.330 | | 0.069 | -0.171 | -0.188 | -0.004 | 0.025 | 0.221 | -0.065 | 0.098 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) | (0.000) | (0.000) | | (0.057) | (0.000) | (0.000) | (0.914) | (0.502) | (0.000) | (0.077) | (0.007) |
| *EDU* | -0.004 | -0.111 | -0.120 | -0.221 | 0.097 | 0.360 | -0.061 | 0.074 | | -0.538 | 0.297 | 0.106 | 0.191 | 0.315 | 0.127 | -0.104 |
| | (0.904) | (0.002) | (0.001) | (0.000) | (0.008) | (0.000) | (0.095) | (0.042) | | (0.000) | (0.000) | (0.004) | (0.000) | (0.000) | (0.000) | (0.004) |
| *LABOR* | 0.041 | -0.021 | 0.086 | 0.234 | -0.328 | -0.664 | 0.180 | -0.195 | -0.567 | | -0.044 | -0.047 | -0.260 | -0.347 | 0.249 | -0.100 |
| | (0.266) | (0.557) | (0.019) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | | (0.224) | (0.195) | (0.000) | (0.000) | (0.000) | (0.006) |
| *RD* | 0.162 | -0.008 | 0.103 | -0.220 | -0.030 | -0.256 | -0.147 | -0.261 | 0.150 | 0.147 | | 0.230 | -0.092 | -0.179 | 0.237 | -0.110 |
| | (0.000) | (0.831) | (0.005) | (0.000) | (0.405) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | | (0.000) | (0.012) | (0.000) | (0.000) | (0.003) |
| *ROYALTY* | 0.159 | 0.180 | 0.017 | -0.010 | 0.264 | 0.014 | -0.031 | -0.059 | 0.118 | -0.172 | 0.143 | | -0.017 | -0.029 | 0.583 | -0.020 |
| | (0.000) | (0.000) | (0.650) | (0.778) | (0.000) | (0.709) | (0.398) | (0.105) | (0.001) | (0.000) | (0.000) | | (0.636) | (0.435) | (0.000) | (0.582) |
| *WORKING* | -0.151 | 0.033 | -0.080 | -0.172 | 0.371 | 0.450 | -0.165 | 0.120 | 0.270 | -0.553 | -0.167 | 0.132 | | 0.161 | -0.100 | 0.037 |
| | (0.000) | (0.364) | (0.028) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | | (0.000) | (0.006) | (0.311) |
| *FIXED* | -0.186 | -0.149 | -0.084 | -0.297 | 0.089 | 0.816 | -0.147 | 0.356 | 0.483 | -0.723 | -0.245 | 0.015 | 0.445 | | -0.157 | 0.110 |
| | (0.000) | (0.000) | (0.022) | (0.000) | (0.014) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.682) | (0.000) | | (0.000) | (0.003) |
| *PROMOT* | 0.027 | -0.239 | -0.102 | -0.046 | -0.318 | -0.177 | 0.196 | -0.029 | 0.023 | 0.347 | 0.240 | 0.048 | -0.259 | -0.194 | | -0.178 |
| | (0.455) | (0.000) | (0.005) | (0.204) | (0.000) | (0.000) | (0.000) | (0.429) | (0.537) | (0.000) | (0.000) | (0.190) | (0.000) | (0.000) | | (0.000) |
| *GROWTH* | -0.248 | 0.136 | 0.149 | 0.113 | 0.213 | 0.195 | -0.279 | 0.109 | -0.140 | -0.083 | -0.071 | 0.056 | 0.099 | 0.049 | -0.250 | |
| | (0.000) | (0.000) | (0.000) | (0.002) | (0.000) | (0.000) | (0.000) | (0.003) | (0.000) | (0.022) | (0.052) | (0.128) | (0.006) | (0.178) | (0.000) | |

*The Pearson (Spearman) correlation coefficients are reported in the upper right (lower left) part of the Table. See Table 1 for the definitions of the variables. Two-tailed *p* values are reported in parentheses.

**Table 4** Regression results of the valuation of intellectual capital

$$P/V = \alpha_0 + \alpha_1 \cdot Beta + \alpha_2 \cdot Ivolatility + \alpha_3 \cdot D/M + \alpha_4 \cdot Ln\,(ME) + \alpha_5 \cdot Altman's\ Z + \alpha_6 \cdot B/P + \alpha_7 \cdot CT + \alpha_8 \cdot EDU + \alpha_9 \cdot LABOR + \alpha_{10} \cdot RD + \alpha_{11} \cdot ROYALTY + \alpha_{12} \cdot WORKING + \alpha_{13} \cdot FIXED + \alpha_{14} \cdot PROMOTION + \alpha_{15} \cdot GROWTH + \varepsilon \quad (1)$$

| Variables[a] | Column (1) | | Column (2) | |
|---|---|---|---|---|
| | Standardized Coefficients | *t* statistics[b] | Standardized Coefficients | *t* statistics[b] |
| *Beta* | 0.041 | 0.963 | 0.032 | 0.735 |
| *Ivolatility* | 0.158 | 4.102*** | 0.175 | 4.491*** |
| *D/M* | 0.024 | 0.600 | 0.049 | 1.173 |
| *Ln (ME)* | 0.059 | 1.239 | 0.080 | 1.608# |
| *Altman's Z* | -0.050 | -1.206 | -0.036 | -0.650 |
| *B/P* | 0.230 | 4.764*** | 0.238 | 4.770*** |
| *CT* | -0.077 | -1.992** | -0.073 | -1.871* |
| *EDU* | | | -0.082 | -1.527# |
| *LABOR* | | | -0.120 | -2.174** |
| *RD* | | | 0.108 | 2.305** |
| *ROYALTY* | | | 0.053 | 1.096 |
| *WORKING* | | | -0.062 | -1.638# |
| *FIXED* | | | -0.002 | -0.053 |
| *PROMOTION* | | | -0.054 | -0.958 |
| *GROWTH* | | | -0.077 | -1.888* |
| Fixed Effects | Included | | Included | |
| N | 751 | | 751 | |
| *F* value | 4.972*** | | 4.307*** | |
| Adj. $R^2$ | 0.083 | | 0.099 | |

[a] See Table 1 for the definitions of the variables.

[b] Arterisks ***, **, * indicate two-tailed significance at the 0.01, 0.05, 0.10 levels, respectively; pound key # indicates one-tailed significance at the 0.10 levels.

**TABLE 5** Descriptive statistics of high vs. low foreign institutional investor ownership groups

| Intellectual capital proxies[a] | Tests of Means | | | Tests of Medians | | |
|---|---|---|---|---|---|---|
| | Low-ownership (n=375) | High-ownership (n=376) | *t* statistics | Low-ownership (n=375) | High-ownership (n=376) | Wilcoxon z statistics |
| *EDU* | 0.654 | 0.717 | -4.128*** | 0.658 | 0.729 | -4.311*** |
| *LABOR* | 0.067 | 0.048 | 5.607*** | 0.056 | 0.033 | 6.910*** |
| *RD* | 0.033 | 0.040 | -2.362** | 0.026 | 0.024 | 0.003 |
| *ROYALTY* | 0.002 | 0.005 | -1.871* | 0.000 | 0.000 | -4.940*** |
| *WORKING* | 6.176 | 9.576 | -5.103*** | 4.599 | 7.224 | -8.902*** |
| *FIXED* | 13.477 | 17.857 | -2.021** | 4.855 | 8.748 | -3.610*** |
| *PROMOTION* | 0.042 | 0.041 | 0.248 | 0.035 | 0.028 | 3.136*** |
| *GROWTH* | 0.202 | 0.208 | -0.285 | 0.157 | 0.166 | -0.378 |

[a] See Table 1 for the definitions of the variables.

[b] Arterisks ***, **, * indicate two-tailed significance at the 0.01, 0.05, 0.10 levels, respectively.

**TABLE 6** Regression results of the valuation of intellectual capital – Separated by foreign institutional investors' ownership –

$$P/V = \alpha_0 + \alpha_1 \cdot Beta + \alpha_2 \cdot Ivolatility + \alpha_3 \cdot D/M + \alpha_4 \cdot Ln\ (ME) + \alpha_5 \cdot Altman's\ Z + \alpha_6 \cdot B/P + \alpha_7 \cdot CT + \alpha_8 \cdot EDU + \alpha_9 \cdot LABOR + \alpha_{10} \cdot RD + \alpha_{11} \cdot ROYALTY + \alpha_{12} \cdot WORKING + \alpha_{13} \cdot FIXED + \alpha_{14} \cdot PROMOTION + \alpha_{15} \cdot GROWTH + \varepsilon \quad (1)$$

| Variables[a] | Low-ownership Group | | High-ownership Group | |
|---|---|---|---|---|
| | Standardized Coefficients | *t* statistics[b] | Standardized Coefficients | *t* statistics[b] |
| *Beta* | 0.014 | 0.234 | 0.095 | 1.314# |
| *Ivolatility* | 0.292 | 5.735*** | 0.147 | 2.378** |
| *D/M* | 0.107 | 2.042** | 0.049 | 0.750 |
| *Ln (ME)* | 0.106 | 1.507# | -0.016 | -0.223 |
| *Altman's Z* | 0.039 | 0.517 | -0.046 | -0.556 |
| *B/P* | 0.498 | 6.949*** | 0.118 | 1.611# |
| *CT* | -0.023 | -0.434 | -0.086 | -1.510# |
| *EDU* | -0.123 | -1.674* | -0.067 | -0.871 |
| *LABOR* | -0.174 | -2.505** | -0.104 | -1.241 |
| *RD* | 0.173 | 2.832*** | 0.118 | 1.637# |
| *ROYALTY* | 0.047 | 0.772 | 0.075 | 0.935 |
| *WORKING* | -0.081 | -1.661* | -0.054 | -0.967 |
| *FIXED* | -0.016 | -0.266 | 0.010 | 0.140 |
| *PROMOTION* | -0.106 | -1.358# | -0.018 | -0.198 |
| *GROWTH* | -0.111 | -2.012** | -0.062 | -1.046 |
| Fixed Effects | Included | | Included | |
| N | 375 | | 376 | |
| *F* value | 5.870*** | | 2.257*** | |
| Adj. $R^2$ | 0.246 | | 0.077 | |

[a] See Table 1 for the definitions of the variables.

[b] Arterisks ***, **, * indicate two-tailed significance at the 0.01, 0.05, 0.10 levels, respectively; pound key # indicates one-tailed significance at the 0.10 levels.