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承銷商與投資人關心智慧資本嗎？－台灣 IPO 公司之實證研究

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本研究旨在探討智慧資本如何左右承銷商之訂價決策及新股折價之現象，本文根據 Edvinsson 和 Malone (1997) 所提出斯堪地亞 (Skandia) 智慧資本領航者的觀念架構，探究智慧資本對於初次上市 (櫃) 公司之承銷價及新股折價之影響。該智慧資本觀念架構甚為完整，其中涵括人力資本、顧客資本、流程資本與創新資本四個構面，本研究同時納入此四個構面，參酌過去文獻找出各個構面之衡量指標，並利用主成份分析法整合多項衡量代理變數，以補足過去文獻僅考量單一構面，或每一個構面僅考量單一指標之研究缺口；最後，利用複迴歸分析檢定智慧資本對初次上市 (櫃) 公司之承銷價與新股折價之影響。本研究實證結果指出，當公司所報導的資訊中顯示其所擁有的智慧資本愈多時，則投資人會賦予該公司較高的評價，故承銷商會訂定較高的承銷價格；另外，也會降低與投資人間的資訊不對稱程度，因此新股折價的幅度也會減少。

關鍵詞：智慧資本、初次上市 (櫃) 公司、資訊不對稱、承銷價、新股折價

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Are Underwriters and Investors Concerned Regarding Intellectual Capital? Evidence from IPOs in Taiwan

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This study discusses how intellectual capital (IC) influences the pricing decisions of underwriters, and the underpricing phenomenon. Based on the theoretical framework of Skandia's intellectual capital navigator, proposed by Edvinsson and Malone (1997), this research discusses the effect of IC on the offer price and underpricing of initial public offerings (IPOs). The IC concept suggested by Edvinsson and Malone (1997) is comprehensive and holistic, comprising four dimensions: human capital, customer capital, process capital, and innovation capital. Considering the four dimensions proposed, this research examines previous literature to obtain appropriate proxy variables to measure each dimension. For each dimension, we employ principal component analysis to integrate these proxy variables into a single evaluation index. This will compensate for the shortfalls of past research, which only considered a single dimension or a single variable in each dimension. Finally, we use multiple regression analysis to examine the effect of IC on the offer price and underpricing of IPOs. Results from empirical research indicate that the higher the intellectual capital reported by companies is, the better the investors evaluate the company, and subsequently, the higher the offer price set by underwriters is. In addition, a higher intellectual capital reduces information asymmetry between the company and its investors. Thus, the extent of underpricing will also subsequently decrease.

Keywords: Intellectual Capital, Initial Public Offerings (IPOs), Information Asymmetry, Offer Price, Underpricing

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1. Introduction

The rise of the knowledge economy has resulted in the focus of enterprise values shifting from tangible assets, such as land, factories, and cash, to more intangible assets, that is, intellectual capital (IC). Several scholars (Abeysekera 2008; Bontis 2001; Edvinsson and Malone 1997; Stewart 1997; Young and Tsai 2006) commonly believe that IC is the main motivator of enterprise value and, thus, the biggest contributor toward competitive advantages. This is why IC investments and disclosures are becoming increasingly important for organizations. However, the value of this type of intangible asset cannot be demonstrated easily in financial reports, which are based on accounting principles emphasizing historical costs and reliability (Brännström et al. 2009). Despite the inability of financial reports to demonstrate the true value of IC, the intangible benefits derived from valuable resources, such as staff, customers, and brands, are all factors that determine a company's success and significantly influence its core values. Thus, theoretically, an investment and disclosure of such information communicates a valuable message to investors, which subsequently affects how they value the company, and reduces the information asymmetry between initial public offerings (IPOs) and investors. Using IPOs as a sample, this study examines whether underwriters and investors are concerned regarding IC, explores how intangible assets such as IC may affect the IPO offer price, and investigates whether the disclosure of IC effectively reduces information asymmetry between IPOs and investors.

The IPO process requires an underwriter to conduct a company valuation based on relevant information and data, and then set a reasonable offer price. The fundamental information the offer price is most commonly based on is the company's financial reports. However, as highlighted by Bukh et al. (2005), IC has become an imperative part of the IPO prospectus. IC can effectively enhance the value of a company (Barney 1991; Bontis 2001; Bukh, Larsen, and Mouritsen 2001; Edvinsson and Malone 1997). This means that the traditional method of basing a company's value on the information provided in its financial report is no longer appropriate because this method cannot demonstrate the true value of a company. Underwriters should consider IC when conducting a valuation because IC offers future economic benefits. Compared with investors, underwriters have access to significantly more information to valuate a company for listing. This is because during the process of listing the company, underwriters collect all the relevant company information, and constantly communicate with the company's senior management, providing them with greater information to evaluate the worth of the company's IC. Despite disclosing all information relating to a company's IC in the prospectus, one of the objectives of this research is to investigate whether the value of IC is reflected in the offer price.

The majority of previous research argued that the inability to provide a company's IC in financial reports is the primary cause of accounting-related information asymmetry (Aboody and Lev 2000; Barron et al. 2002; Chin, Lin, and Hong 2003; Chin et al. 2006; Yau, Chun, and Balaraman 2009). To minimize asymmetry, companies preparing for listing tend to publish abundant related non-financial information with the compulsory financial data in their prospectus. The related non-financial information comprises aspects such as IC, patents, reputation, innovation, and human capital, and the purpose of disclosing this information is to narrow the information gap between the investors and the company to lower the cost of capital. Theoretically, because the disclosure of IC can convey valuable messages and information to investors regarding the company's future direction and outlook, this disclosure should reduce information asymmetry and uncertainty between the two parties. Thus, investors can make more accurate assessments of company value (Kamath 2008; Lu and Chen 2010; Sun et al. 2010; Van der Zahn, Singh, and Singh 2008).

Topics related to the underpricing of IPOs are still regularly discussed by scholars. Significant research regarding the topic of IPO underpricing has been conducted in more than 40 countries (Engelen and van Essen 2010). The results have shown that the underpricing phenomenon has spread to the capital market worldwide. The majority of previous studies adopted information asymmetry and signaling theory to discuss and explain underpricing issues (Ritter and Welch 2002). The high ex ante uncertainty frequently causes information asymmetry between the IPOs and investors, leading to underpricing (Rock 1986). The higher the information asymmetry is, the more companies must underprice their shares to encourage investors to purchase them. Signaling theory argues that companies may send signals to potential investors through underpricing to indicate that the company is actually worth more (Allen and Faulhaber 1989; Grinblatt and Hwang 1989). Furthermore, Ljungqvist (2007) suggested that companies use underpricing to attract uninformed investors who expect to earn profits. Some studies also discovered that to become a widely-held corporation, a number of companies issue their stocks by underpricing (Booth and Chua 1996; Brennan and Franks 1997). Scholars have proposed other motivations for underpricing, and developed various models to explain the reasons for underpricing and the subsequent effects. This research explores the relationship between IC and IPO underpricing from the concept of the effect of IC on information asymmetry. Therefore, this research aims to understand whether the IC information published in prospectuses conveys useful messages to investors, reduces information asymmetry, and minimizes the extent of IPO underpricing.

Because much greater uncertainty is involved in the valuation of intangible assets, such as IC, than of tangible assets, numerous scholars have attempted to define IC to develop a comprehensive framework for IC. Edvinsson and Malone (1997) defined IC as the possession of the specific knowledge, applied experience, organizational technology, customer relationships, and professional skills that provide companies with a com-

petitive advantage in the market. Stewart (1997) declared that IC is the knowledge and skills a person can offer their companies that provide a competitive advantage. IC includes all intellectual components that contribute toward wealth, including knowledge, information, intellectual properties, and experience. Roos et al. (1998) regarded IC as the sum of all staff knowledge, which is then transformed into intangible assets, such as patents, brands, and processes. In other words, anything intangible that can ultimately create value can be regarded as IC. Different scholars have focused on different aspects in IC research; therefore, their categorizations of IC, and the dimensions investigated, differ also. However, the majority of the proposed categories and dimensions have stemmed from Skandia's intellectual capital navigator developed by Edvinsson and Malone (1997). The IC conceptual framework mentioned in this model states that IC comprises human capital, customer capital, process capital, and innovation capital. This research developed a comprehensive and holistic IC measurement method, adopting Skandia's intellectual capital navigator to investigate data collected from the sample, which includes IPOs listed on the Taiwan Stock Exchange Corporation (TWSE) and Gre Tai Securities Market (GTSM) between 2003 and 2008. The IC discussed in this paper comprises the four dimensions previously mentioned: human capital, customer capital, process capital, and innovation capital. The aim of this study is to explore the impact of IC on the offer price of IPOs and their underpricing to understand whether underwriters and investors are concerned regarding the value of IC. We hope the findings provide practical reference information for IPOs.

The empirical results suggest that the three dimensions, human capital, process capital, and innovation capital, positively influence the offer price. Customer capital did not significantly influence offer price because sales concentration risks were considered. In addition to underwriters setting better offer prices for companies when they recognize the value of IC, our research also indicates that when investors consider purchasing new shares they assess the positive influence the company's IC will have on their own value. Therefore, they are more willing to purchase shares at a higher offer price if the value of IC is higher. The probability of the underwriter's offer being withdrawn is low and a higher offer price can be set. In addition, the four dimensions of IC are negatively correlated to the extent of underpricing. Companies attempt to publish as much news and information regarding their IC as possible, and send messages to investors to reduce the information asymmetry. Thus, companies are not required to resort to drastic underpricing to attract investors to buy their shares. This finding suggests that both underwriters and investors value IC, and that by disclosing information on the company's IC to investors, the IPO offer price can be increased, underpricing can be reduced, and the indirect issuing costs can be consequently reduced. Lastly, we compared the influence of IC on offer prices and underpricing during the global financial crisis and the preceding (non-crisis) period. Results showed that during the global financial crisis, underwriters failed to consider IC when setting offer prices. Under such circumstances, most of IC information did not reduce information asymmetry for investors and therefore did not reduce the extent of underpricing.

This research provides three main contributions. First, because of the increasing importance of IC to companies, this research used IPOs as the sample to test whether the value of IC is priced during the IPO process. The findings should compensate for the information gaps of previous research regarding this topic. Second, regarding information asymmetry, existing literature rarely adopts the perspective of IC. However, in addition to the factors suggested by previous research, such as company size and age, our findings suggest that IC is another significant determinant of information asymmetry, and the disclosure of IC can effectively reduce this asymmetry, reducing the extent of underpricing. This empirical result develops the findings of existing IPO research and provides more comprehensive explanations and better predictions. Third, regarding the proxy variables for measuring IC, unlike previous research that only examined a single dimension (for instance, only considering innovation capital or only considering human capital) or a single proxy variable (for instance, using the single proxy variable of patent for innovation capital), the measurement of IC in this study is significantly more holistic and comprehensive. We adopted principal component analysis to construct the four main dimensions of IC and investigated each dimension to examine how they affect the offer price and underpricing of IPOs.

2. Literature Review and Hypothesis Development

Numerous existing studies have discussed the correlation between IC and company values. For instance, Sullivan (2000) and Hurwitz et al. (2002) suggested that the reason the market value of companies in knowledge -based industries is higher than their book values is because of investors' recognition and appreciation of IC. From the perspective of resource-based theory, intangible assets, such as IC, are valuable, rare, and difficult to transfer or replicate. This is why the value-added of numerous corporations are closely connected to their IC (Barney 1991; Deol 2009; Mavridis and Kyrmizoglou 2005; Wernerfelt 1984). Investors are willing to purchase shares at a higher price if they can see a favorable future outlook for the company because they wish to profit from the company's future growth. This is why the richer the IC content is, the better investors rate a company's value. Furthermore, Bukh et al. (2005) also reported that the importance of IC to IPOs has been increasing. This growth indicates that IC has become an indispensable factor for the companies, underwriters, and investors to consider when conducting a valuation of the IPOs. As a result, a growing number of companies are becoming more aggressive in publishing news regarding their IC in annual financial reports. They believe that

this type of information will hint to informed investors that the potential to make abnormal returns exists, and that even uninformed investors can incur substantial wealth transfers. Summarizing the above, we can apply the same concept to the effect on offer price. Thus, the more a company's reported IC is worth, the more valuable they signal to investors they are worth. This subsequently affects investors' valuation of companies to be listed, and affects the setting of an IPO offer price. Therefore, this study infers that the more IC an IPO has, the better the investors rate them, and the more willing the investors are to purchase their shares, meaning the IPO underwriter can set a higher offer price.

From studying previous literature we found that past research tended to measure IC in one dimension, or used a single measuring index for each dimension, because of the difficulty of collecting data. Among the numerous definitions and measuring indices available regarding IC, the definition proposed by Edvinsson and Malone (1997) is the most comprehensive and thus the most widely adopted by scholars. We also adopted Edvinsson and Malone's (1997) framework, and regarded IC as having four main dimensions. By studying past research we compiled a range of proxy variables that measure the different dimensions:

2.1 Human Capital (HC)

In this era of a knowledge economy, two thirds of organizations' total value is from IC, in which human capital (HC) contributes the most; therefore, HC is regarded the most significant intangible asset for organizations (O'Donnell et al. 2003; Royal and O'Donnell 2008). Organizations with greater human capital are capable of reducing operating costs and increasing customer satisfaction. Greater human capital can lead to better planning and effective problem-solving, which contributes to the enhancement of organization value. In other words, competent employees can achieve higher returns and subsequently increase organization value so the value of organization is determined by human capital (Snell and Dean 1992). Sveiby (1998) explained that the higher the average level of education the employees of an organization have, the better the collective professional knowledge is, and the better equipped the employees are to solve problems and think independently. This means they can adapt to the competitive environment and work more efficiently; thus, they can generate greater value for their organizations (Bukh, Larsen, and Mouritsen 2001; Pennings, Lee, and Witteloostuijn 1998; Van Buren 1999).

Kaplan and Norton (1996) also reported that enterprise value is connected to employee competence, and employee productivity is an important index for measuring employee competence. "Employee productivity" refers to the collective synergy resulting from efforts to enhance employee skills and motivation, drive innovation, improve internal process, and satisfy customers. The more sales revenue each staff generates, the greater their value-added contribution toward enterprise value is. Because of the effects of cost, we deducted cost from the value. We labeled this contribution "value added per employee."

Because the level of each staff's contribution to their organization can usually be reflected in the operating income, by observing the operating income generated by each member of staff we can understand the amount of work each member processes and their competencies. Generally, the operating income generated by each person has a positive effect on the overall business performance. Considering the above points, the proxy variables used in this study to measure HC include the average education level of employees, value added per employee, and operating income per employee.

2.2 Customer Capital (CC)

Because the worldwide marketplace has become increasingly competitive, organizations can no longer survive only on their skills and competencies; instead, the customer resources have become significantly more important to the value of a business. Recognizing this, organizations are striving to develop new markets and increase market share while retaining existing customers (Kamath 2008). Customer capital refers to the value of customers to a firm as well as its relationships with them(Stewart 1997). Customer capital represents customer awareness of and confidence in the firm, which influences their consumer behaviour. Loyal customers may also recommend the company to other consumer groups, creating word of mouth effects and increasing the market value of the business. Customer capital contributes to the future value of the firm. Previously, some research used sales expense ratio as an indicator of brand awareness and customer loyalty. This is because marketing expenses are expected to result in customers having greater familiarity with the products or brand image, enhancing their purchase intentions and shortening the gap between the organization and the customers (El-Bannany 2008; Kamath 2008).

The most critical concern for companies is ensuring their mass-produced product has a market because profit is only earned upon sale. If products have defects or are problematic and are returned by customers, then not only will the company fail to earn a profit, the adverse situation will also affect the customer relationship and the company's image. Therefore, the product acceptance rate can also be used as a proxy variable for measuring customer capital (Wang and Chang 2004).

In a business operation, the more important customers a company has, the higher the customer satisfaction and trust it enjoys. Such a collaborative relationship is beneficial to long-term development and enhances the business performance. The higher the sales ratio the better and stronger the relationship between the company and its customers is, which ensure the business performance remains stable and develops. Therefore, the proxy variables used in this study to measure CC include the sales expense ratio, product acceptance rate, and the ratio of sales from important customers.

2.3 Process Capital (PC)

The internal processes of an organization relate to whether it can conduct business smoothly and create value. A company with a more integrated organizational structure and standardized procedures is better able to conduct business smoothly and ensure quality control, which enhances the competitiveness and operational performance of the company. This demonstrates that greater process capital can enhance the overall value of a company. Generally, the longer a company has been operating, the more stable its internal operation is, and the better the relationship it enjoys with external stakeholders and other organizations. When a company has been stable over a long period of time, the accumulated staff knowledge can help the company's internal process operate more efficiently. In other words, the longer the average employee tenure, the more professionals skills and experience staff accumulate (experience and learning curve effects), enabling them to execute tasks effectively and improve organizational performance, thereby creating a more favorable impression of the company among external parties. Hence, organizational stability is an important variable for measuring process capital (Lin and Chen 2005; Wang and Chang 2004).

If a company's products have short life cycles, the company is under pressure to sell them quickly once they are produced. Organizations with a higher inventory turnover are less susceptible to the adverse consequences posed by capital lock-up and reduction of inventory. Consequently, they are better equipped to compete with their competitors and improve business performance (Lin and Chen 2005; Wang and Chang 2004). Therefore, the proxy variables used in this study to measure PC include organizational stability and inventory turnover.

2.4 Innovation Capital (IC)

We are currently in an era where information technology advances at a significant rate; industries and the macro environment is complex and dynamic. A key to the success or failure of an organization is its ability to use innovation to improve its business performance and maintain its long-term competitive advantages. Innovation capital, referring to innovative capability and activities, is an important asset to businesses and a key contributor to the future development of companies. Particularly in this era of globalized competition, as products and technology are rapidly updated and previous models made obsolete, the extent of innovation capital indicates whether a company has the potential for future growth and excess earnings. Innovation capital is a key factor in the evaluation of company value. R&D expenditure demonstrates the amount a company invests in innovation, which can subsequently affect its future profit and value. Investment in R&D activities contributes to new and competitive products created within a shorter period of time. Greater R&D expenditure increases the opportunity for real benefit to the company and enhances company value. Additionally, a patent can also reflect a company's innovation capabilities. Empirical results from previous research also indicated that R&D expenditure and patents have a strong correlation with business operation and a company's value (Chiou and Hung 2008; Hung and Huang 2008; Kuo 2009; Liu 2001; Ou 1998; Schumpeter 2000). Furthermore, Chin et al. (2006) also reported that R&D expenditure and the number of patents issued are positively correlated with the market returns of an IPO.

The ultimate purpose of R&D expenditure is profit; thus, the better the R&D results are, the better the business performance is. This leads to another important indicator of performance – R&D productivity. This shows the amount of profit each unit of R&D expenditure can generate. Empirical results from past research also discovered a positive correlation between R&D productivity and business performance (Kuo 2009; Wang and Chang 2004). Therefore, the proxy variables used in this study to measure IC include R&D expenditure, the number of patents and R&D productivity.

As previously mentioned, this study discusses the impact of IC on the offer price of IPOs considering IC's four main dimensions. This study assumes that underwriters consider the value of IC when setting the offer price, and that investors are more willing to purchase shares of IPOs that demonstrate a higher level of intellectual capital, which provides a good reason for underwriters to set a higher offer price. Therefore, we propose the following hypotheses:

H_1: Human capital has a positive effect on the offer price of IPOs.

H_2: Customer capital has a positive effect on the offer price of IPOs.

H_3: Process capital has a positive effect on the offer price of IPOs.

H_4: Innovation capital has a positive effect on the offer price of IPOs.

In addition, Rock (1986) proposed the hypothetical concept of the "winner's curse," which suggests that underpricing is inevitable because investors always experience information asymmetry. Ritter (1984) emphasized that information asymmetry is the main cause of underpricing, and that the greater the asymmetry is, the more the companies must underprice their shares to incentivize investors to purchase them. Numerous scholars, including Beatty and Ritter (1986), Jog and McConomy (2003), and Schrand and Verrecchia (2004), reported that sufficient disclosure of information regarding IC in the prospectus reduces information asymmetry and the

extent of underpricing. Additionally, Friedlan (1994), Beatty and Welch (1996) pointed out that providing detailed information and disclosing risks and potential revenue streams in the prospectus can reduce the extent of information asymmetry and underpricing.

Many scholars (Chauvin and Hirschey 1993; Deeds 2001; Hall 1993; Pennings, Lee, and Witteloostuijn 1998) have verified that the individual elements of IC can positively influence a company; however, IC is intangible, uncertain and often not presented in financial statements. If prospectuses provided more information about IC and its key elements, which have the potential to generate revenue and enhance competitive capacity, this could reduce the public information gap and information asymmetry. The underpricing of IPOs is reduced when investors have more information to judge the real value. Put simply, when investors are facing future uncertainties, their basic understanding of a company and the content and accuracy of public information provided by the company affect the required risk premium. Capital markets have developed steadily in recent years and the extent of information disclosed by listed companies has been continually monitored and improved; as a result, the annual reports and prospectuses of companies have become a key decision-making basis for investors. In particular, IC information provided in the prospectuses of IPOs plays a crucial role in how investors judge value.

Chin et al. (2006) examined the effect of IC on underpricing by conducting a study of 623 IPOs listed on the TWSE between 1990 and 2000. They found that the more innovation capital the companies invested, the greater the underpricing they experienced was, and the longer the honeymoon period they enjoyed was. Nevertheless, in their empirical research, Lu and Chen (2010) discovered an U-shaped relationship between R&D expenditure and underpricing. They found that when R&D expenditure was at a moderate level, investors considered it to be a signal of quality; thus, underpricing was reduced. However, though R&D expenditure continued to increase, eventually exceeding a specific amount, the uncertainty concerning R&D outcomes rose. This worsened the asymmetry of accounting information, leading to higher underpricing.

Previous empirical research using only one index to measure IC has provided differing opinions and findings regarding the effect of IC on underpricing. We believe that information asymmetry is the primary cause of underpriced offer prices. Therefore, if investors are concerned regarding IC, the information gap investors perceive will be smaller the more IC companies demonstrate they have. The reduced information asymmetry will eventually lead to reduced underpricing. Put simply, to attract uninformed investors to the IPO market, issuers underprice new shares to compensate for the loss that may be incurred by investors who do not have comprehensive information. Greater information asymmetry increases the extent of underpricing. By contrast, the disclosure of relevant information on intangible assets such as IC in prospectuses can reduce the information gap and uncertainty among investors; thereby reduce the extent of underpricing. This study constructs the IC framework with four dimensions comprising numerous different proxy variables to better explain the influence of IC on underpricing. This study develops the following hypotheses:

H_5: Human capital has a negative effect on the underpricing of IPOs.

H_6: Customer capital has a negative effect on the underpricing of IPOs.

H_7: Process capital has a negative effect on the underpricing of IPOs.

H_8: Innovation capital has a negative effect on the underpricing of IPOs.

3. Research Methodology

3.1 Measuring Underpricing under A Price Limit

Previous studies used the initial return on the first trading day as the proxy variable for measuring underpricing. However, a daily price limit of 7% in each direction is imposed on all publicly traded stocks in Taiwan before the implementation of the new underwriting system on 25th October 2005. Because of price limit, the closing price of an IPO stock on the first trading day cannot fully reflect the value of IPO shares. Thus, the underpricing measuring method used during this period must be adjusted.

On the 1 March 2005, Taiwan's Financial Supervisory Commission (FSC), Executive Yuan, promulgated the New System for Underwriting Initial Public Offerings. Since the new system became effective, the price limit of IPO stocks during the first five days of trading no longer exists. On 25th October 2005, the first IPO under the new system was listed on the stock market. When measuring the underpricing of IPOs that began trading before the implementation of the new underwriting system, we adjusted the outcome considering the effect the price limit had. By contrast, for IPOs that began trading under the new underwriting system, we adopted the method suggested by previous studies, using the initial return on the first trading day as the proxy to measure the extent of underpricing. Regarding the adjustment method for IPOs affected by the price limit, we used the method suggested by previous studies, which use the closing price of the first non-hit day

instead of the closing price on the first trading day to measure the extent of underpricing (Chen, Lee, and Lin 1999; Chen, Yeh, and Chen 2003; Lin, Shiue, and Chen 1999; Ma and Hu 2003). Furthermore, to minimize the influence of market, we used the underpricing value adjusted with the market returns, as detailed in formula (1):

$$UP = \frac{P_t - OFFP}{OFFP} - \frac{INDEX_t - INDEX_0}{INDEX_0} \quad \text{.....(1)}$$

UP denotes IPO underpricing; P_t is the closing price of an IPO stock on the first non-hit day (applicable to IPOs listed before the implementation of the new underwriting system), or the closing price on the first trading day (applicable to IPOs listed after the implementation of the new underwriting system)[1]; *OFFP* denotes the offer price of IPO; $INDEX_t$ represents the market-weighted index on the first non-hit day (applicable to IPOs listed before the implementation of the new underwriting system), or the market-weighted index on the first trading day (applicable to IPOs listed after the implementation of the new underwriting system); and $INDEX_0$ denotes the market-weighted index of on the issue date.

3.2 Measuring Intellectual Capital

Although IC is the driver and creator of company value, it is inherently difficult to measure. To date, no consistent criteria have been established for the categorization and measurement of the various constructs of IC. Based on the four dimensions of IC proposed by Edvinsson and Malone (1997), we studied all the proxy variables of different dimensions adopted in previous research, and used them as a reference to develop variables for measuring IC. This study focused on whether underwriters and investors are concerned about the disclosure of IC in prospectuses; therefore, we based the selection of variables not only on measurement concepts proposed in previous literature but also on data obtainable from prospectuses. We employed principal component analysis to extract a single indicator for each dimension of IC from the many proxy variables. In conducting principal component analysis, we retained only those components that had an eigenvalue exceeding 1 and increased cumulative variance explained. The basis of literature for each proxy variable used is compiled in Table 1.

For human capital, the proxy variables we used include the average education level of employees, value added per employee, and operating income per employee. For customer capital, the proxy variables we used include sales expense ratio, product acceptance rate, and ratio of sales from important customers. For process capital, the proxy variables we used include organizational stability and inventory turnover. Finally, for innovation capital, the proxy variables we used include R&D expenditure, number of patents, and R&D productivity. Because of the lagged effect of IC, we used the values from the previous year as the proxy variables to measure the IC of IPOs. The calculation method for the range of proxy variables adopted is detailed below.

3.2.1 Human Capital

(1) Average education level of employees:
The education levels are "postgraduate level," "university," and "senior high school or college and below." We gave each of these levels a score (3, 2, and 1) to calculate the overall average education level of employees.

(2) Value added per employee
= net income/total number of employees

(3) Operating income per employee
= operating income/total number of employees

3.2.2 Customer Capital

(1) Sales expense ratio = sales expense/net sales

(2) Product acceptance rate
= 1-sales return and allowance/net sales

(3) Ratio of sales from important customers
= net sales from the three biggest customers/net sales

3.2.3 Process Capital

(1) Organizational stability
= average years of employment / company's age

(2) Inventory turnover
= cost of goods sold/average inventory

3.2.4 Innovation Capital

(1) R&D expenditure: R&D expense

(2) Number of patents: number of registered patents

(3) R&D productivity = net income/R&D expense

[1] If dividends are paid out between the pricing date and "the first non-hit day", then P_t is the adjusted share price on "the first non-hit day" (i.e. after the weight is undone). However, there is no such case in our sample.

Table 1 The Basis of Literature for Each Proxy Variable

Dimension	Proxy Variable	Reference
HC	Average education level of employees	Bukh et al. (2005); Lim and Dallimore (2004); Lin et al. (1998) ; Tsai and Yu (2000); Wang and Chang (2004)
	Value added per employee	Bukh et al. (2005); Edvinsson and Malone (1997); Lim and Dallimore (2004); Van Buren (1999); Wang and Chang (2004);
	Operating income per employee	Bukh et al. (2005); Edvinsson and Malone (1997); Van Buren (1999); Wang and Chang (2004);
CC	Sales expense ratio	Edvinsson and Malone (1997); Van Buren (1999); Wang and Chang (2004)
	Product acceptance rate	Edvinsson and Malone (1997); Mavrinac and Siesfeld (1997); Van Buren (1999); Wang and Chang (2004)
	Ratio of sales from important customers	Van Buren (1999); Wang and Chang (2004)
PC	Organizational stability	Lin and Shih (2003); Wang and Chang (2004)
	Inventory turnover	Van Buren (1999); Wang and Chang (2004)
IC	R&D expenditure	Barron et al. (2002); Barth and Kasznik (1999); Barth, Kasznik, and McNichols (2001); Chauvin and Hirschey (1993); Chin, Lin, and Hong (2003); Cockburn and Griliches (1988); Connolly and Hirschey (1990); Deeds (2001); Doukas and Switzer (1992); Hirschey and Weygandt (1985); Lev and Sougiannis (1999); Liu (2002); Ou (1998); Shyu and Huang (2007); Wang and Chang (2004)
	Number of patents	Connolly and Hirschey (1990); Doukas and Switzer (1992); Dzinknowski (2000); Edvinsson and Malone (1997); Hirschey and Weygandt (1985); Lev and Sougiannis (1999); Lim and Dallimore (2004); Van Buren (1999)
	R&D productivity	Dzinknowski (2000); Edvinsson and Malone (1997); Van Buren (1999); Wang and Chang (2004)

Note: HC: human capital. CC: customer capital. PC: process capital. IC: innovation capital.

3.3 Statistical Model

3.3.1 Principal Component Analysis

Principal component analysis is used chiefly to integrate multiple variables into a single indicator. The new indicator accounts for as much of the variability in the original variables as possible. Compared to conventional weighted average in which only the same units and variables of the same concept can be summed up, the weighted average of principal component analysis can add up different units and different concept variables into a single indicator. Each variable comprising this indicator should have the same construct, meaning that the variables must be homogenous (Chow 2002). This study uses some proxy variables to measure each of the four IC dimensions. However, because of the high correlation between these proxy variables, if we simply use all of these variables to conduct a regression analysis, the independent variables will display an extremely high correlation. To avoid this issue, we use principal component analysis to compile and integrate the variables in each of the IC dimensions into one consolidated measuring index, ensuring only critical information is retained in the results and other distracting figures are eliminated. Then we conducted regression analysis on the integrated index of each dimension, the formulae used in principal component analysis is detailed below.

(1) Human capital value index (HC_i):

$HC_i = W_1$ average education level of employees$_i$ $+W_2$ value added per employee$_i$$+W_3$ operating income per employee$_i$

(2) Customer capital value index (CC_i):

CC_i = W4 sales expense ratio$_i$+W5 product acceptance rate$_i$+W6 ratio of sales from important customers$_i$

(3) Process capital value index (PC_i):

PC_i = W7 organizational stability$_i$+W8 inventory turnover$_i$

(4) Innovation capital value index (IC_i):

IC_i = W9 R&D expenditure$_i$+W10 number of patents$_i$+W11 R&D productivity$_i$

3.3.2 Regression Analysis

Models 1 and 2 are the regression models employed in this research. The first model examines whether the setting of the IPO offer price is affected by the company's IC (hypotheses H_1 to H_4). The second model examines whether the extent of IPO underpricing is affected by the company's IC (hypotheses H_5 to H_8).

Model 1: The effect of IC on the IPO offer price

$$OFFP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} MARKET_i + b_{14} EVA_i + b_{15} PROFIT_i + \varepsilon_i$$

Model 2: The effect of IC on IPO underpricing

$$UP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} OFFP_i + b_{14} LDAY_i + b_{15} RATIO_i + \varepsilon_i$$

In Model 1, $OFFP_i$ is the offer price of the IPO company i. In model 2, the dependent variable UP_i is the market-adjusted underpricing of the IPO company i. The calculation methods are explained in Section 3.1. The main independent variables in both models are the variables of the four IC dimensions. HC_i is the value index for company i's human capital, CC_i is the value index for company i's customer capital, PC_i is the value index for company i's process capital, and IC_i is the value index for company i's innovation capital. In Sections 3.2 and 3.3.1, we provide detailed explanations of the IC constructs.

Using the findings of past research, we also include a number of control variables. Ritter (1991) reported that the longer a company has been established, the more information investors can collect on the company, which reduces information asymmetry and the extent of IPO underpricing. For the model employed in this study, we use AGE_i to represent the number of years company i has been established. Beatty and Ritter (1986) used company size to measure uncertainty, and found that the bigger the IPO company is, the smaller the extent of underpricing will be. This study used the natural logarithm of the company's total assets ($SIZE_i$) as the proxy variable for measuring company size. Mak and Akhtar (2003) used the debt to equity ratio ($DEBT_i$) to measure the effect of corporate governance variables on the offer price and market price, and found that the lower the debt to equity ratio was, the more solid the company's financial structure was; thus, investors felt less uncertain.

Carter and Manaster (1990) argued that underwriters use their reputation to guarantee the quality of newly listed stocks. Therefore, underwriters with a good reputation set an appropriate offer price in consideration of their reputation. This study assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. We used this dummy variable as a proxy for underwriter reputation (UND_i). In their research, Michaely and Shaw (1995) found that IPO underwriting audited by reputable accountancy firms displayed better performance, and made investors feel less uncertain and more secure, which reduces the extent of underpricing. We used dummy variables to measure the reputation of the accountancy firm (CPA_i). When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y, and KPMG), we assigned it a value of 1; otherwise we assigned it a value of 0. In addition, we also controlled three dummy variables, industry type (IND_i), exchange ($EXCH_i$), and new/old system (SYS_i). When the company was in the electronics industry, we assigned it a value of 1 in IND_i; otherwise, we assigned it a value of 0. When the company was listed on TWSE, we assigned it a value of 1 in $EXCH_i$; when listed on GTSM, we assigned it a value of 0. When the company was listed under the new underwriting system, we assigned it a value of 1 in SYS_i; otherwise, the company was assigned a value of 0.

Finally, in Model 1, we also adopted the TWSE weighted stock index on the issue date considering market conditions (*MARKET*), incorporating book value per share（EVA_i）to control company value and profitability index ($PROFIT_i$) to control company profitability. Due to plenty of variables that can be used to measure company profitability, this study selected dividend per share, earnings per share (EPS), return on equity (ROE), return on assets (ROA) and cash flow ratios in the previous year of IPO, which are commonly used to evaluate profitability, as proxy variables. To account for the serious problem of collinearity among these variables, we employed principal component analysis to integrate these variables into a profitability index. We considered the arguments proposed in other studies, such as that by Aggarwal and Rivoli (1990), namely that IPOs with a smaller offer price offer a bigger initial return, and that by Loughran, Ritter, and Rydqvist (1994), namely that the longer the period between the date the offer price is set, and the first trading day, the more uncertainty the investors feel, the greater risk premium they expect, and the bigger the extent of underpricing. Additionally, economic supply and demand theory, which states that the lower the IPO lot winning rate is, the more the investors expect the stock price to increase in the future, and the higher the initial return is. Therefore, in Model 2 we included a number of control variables to measure underpricing. These variables include offer price ($OFFP_i$), the period between the price setting date and the first trading day ($LDAY_i$), and lot winning rate ($RATIO_i$).

Table 2 Descriptive Statistics

Variable		Minimum	Mean	Maximum	Median	Std. Dev.
Panel A: Basic Characteristics of IPOs[2]						
OFFP (TWD)		10.50	44.39	250.00	33.00	38.01
UP (%)		-36.78	24.12	720.59	10.88	55.59
AGE		1.16	13.72	51.15	11.53	8.78
SIZE		18.84	21.03	26.47	20.85	1.01
RATIO		0.00	0.23	1.00	0.03	0.36
DEBT		0.05	0.39	0.79	0.38	0.16
UND		0.00	0.33	1.00	0.00	0.47
CPA		0.00	0.89	1.00	1.00	0.31
IND		0.00	0.81	1.00	1.00	0.39
EXCH		0.00	0.19	1.00	0.00	0.39
SYS		0.00	0.40	1.00	0.00	0.49
MARKET		4,160.54	6,553.79	9,740.13	6,142.12	1,447.16
EVA		5.03	17.65	52.99	16.04	6.43
Dividend per share		0.00	2.55	20.37	2.00	2.38
EPS		-2.62	3.91	23.94	3.14	3.38
ROA (%)		-22.32	11.77	42.58	10.55	8.09
ROE (%)		-26.84	19.33	64.54	18.54	11.74
Cash Flow Ratio (%)		-212.72	48.35	433.53	35.93	69.74
Panel B: IC variables of IPOs						
HC	Average education level of employees	1.04	1.72	2.69	1.69	0.33
	Value added per employee (thousand TWD)	-1,123.11	1,164.90	14,469.42	745.57	1,569.66
	Operating income per employee (thousand TWD)	-1,349.27	1,451.08	19,044.83	892.37	2,028.54
CC	Sales expense ratio	0.00	0.06	0.51	0.04	0.08
	Product acceptance rate	-0.01	0.98	1.00	0.99	0.06
	Ratio of sales from important customers[3]	0.00	0.48	1.00	0.46	0.22
PC	Organizational stability	0.05	0.35	5.01	0.28	0.42
	Inventory turnover	0.00	25.66	4,466.70	5.72	248.27
IC	R&D expenditure (thousand TWD)	0.00	67,224.35	2,277,734.00	31,135.50	171,167.23
	Number of patents	0.00	19.31	752.00	2.00	68.17
	R&D productivity[4]	-6.25	28.99	6,779.05	3.64	371.91

Note: (1) N = 291. (2) OFFP: the offer price of IPOs. UP: the market-adjusted initial return of IPOs. AGE: the number of years that the company had been established before the IPO. SIZE: the natural logarithm of the company's total assets in the previous year of IPO. RATIO: the odds of winning the IPO lottery. DEBT is the debts to equity ratio of company in the previous year of IPO. UND represents the reputation of the underwriter and is a dummy variable. We assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. CPA is the reputation of the accountancy firm and is a dummy variable. When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y,

[2] Of the 291 IPO companies sampled, 175 used the old underwriting system and 116 employed the new system. The IPO companies using the old underwriting system had mean offer price of 38.16 and mean underpricing of 7.2%, while the companies employing the new underwriting system had a mean offer price of 55.47 and underpricing of 54.4%.

[3] Minimum value = 0.0045.

[4] For R&D productivity, it will be a concern that R&D productivity will be unreasonably high when a firm has a very low R&D expense. To avoid this problem, when conducting principal component analysis and regression analysis, we replaced all observations above the 99th percentile of R&D productivity by the 99th percentile (winsorized at 99%). Our main empirical results were unaffected by this adjustment.

and KPMG), we assigned it a value of 1; otherwise, we assigned it a value of 0. IND is the industry dummy. If the company was in the electronics industry at the time of listing, we assigned it a value of 1; otherwise, we assigned it a value of 0. EXCH is a dummy variable, which is equal to 1 if the company is listed on TWSE, and 0 if it is listed on GTSM. SYS is the new or old underwriting system dummy. When the company was listed under the new underwriting system, we assigned it a value of 1; otherwise, it was assigned a value of 0. MARKET is the TWSE weighted stock index on the issue date. EVA is the net worth per share of the company in the previous year of IPO. Dividend per share is the dividend per share in the previous year of IPO. EPS is the earnings per share in the previous year of IPO. ROA is return on assets in the previous year of IPO. ROE is return on equity in the previous year of IPO. Cash flow ratio is cash flow from operation to current liabilities ratio in the previous year of IPO. Variables of the IC dimensions: Human capital: for the average education level of employees we categorized the education levels into "postgraduate level," "university," and "senior high school or college and below." We gave each of these levels a score (3, 2, and 1) to calculate the overall average education level of employee. Value added per employee = net income/total number of employees. Operating income per employee = operating income/total number of employees. Customer capital: sales expense ratio = sales expense/net sales. Product acceptance rate = 1-(sales return and allowance/net sales). Ratio of sales from important customers = net sales from the three biggest customers/net sales. Process capital: Organizational stability = average years of employment/company's age. Inventory turnover = cost of goods sold/average inventory. Innovation capital: R&D expenditure is the amount of R&D expenditure. Number of patents is the number of patents registered. R&D productivity = net income/R&D expense.

4. Empirical Results

This section describes the empirical results and analyzes the effect of IC on the offer price and underpricing of IPOs.

4.1 Sample and Descriptive Statistics

The sample used in this study primarily comprises IPOs listed on the TWSE and GTSM. Recently, the disclosure of IC becomes a recognized topic. In addition, we had to manually collect information on IC variables from prospectuses for this study. We focused on more recent data, 1 January 2003 to 31 December 2008. We excluded IPOs in the financial industry because of their differences to other industries. We also excluded subjects that could not provide all the important variable values to ensure the completeness of the data. The final sample consists of 291 IPOs. The variables we employed include basic company data, information on stock price, financial report data, and a range of IPO related variables obtained from the databank of the Taiwan Economic Journal (TEJ). We also used the information provided by Taiwan Securities Association to complete and verify the research data. Additionally, we manually gathered and extracted data regarding companies' IC from prospectuses.

Table 2 is the descriptive statistics of basic characteristics and IC variables of IPOs. The average variable value for offer price was 44.39, and for underpricing was 24.12 %, with the smallest underpricing variable value was -36.78 %, and the largest was 720.59 %. Despite the huge difference between the smallest and largest value, generally there exists underpricing in most of IPOs. The average age of IPOs was 14. The average lot winning rate was 23 %; however, the median value of the lot winning rate was only 3 % and half the sample companies had a rate below 3 %, which shows that the majority of IPOs possess a low lot winning rate.

The variable value for the human capital dimension of "average education level of employees" was 1.72, which indicates that the average education level of employees is between senior high school and university. The value added per employee was 1,164,900 TWD, and the operating income per employee was 1,451,080 TWD. Regarding customer capital, the average ratio values for sales expense ratio, product acceptance rate, and ratio of sales from important customers was 6 %, 98 %, and 48 %, respectively. The sales expense accounts for a small percentage of the company sales. For the other two dimensions, process capital and innovation capital, the value of proxy variables differ obviously across these samples.

4.2 Principal Component Analysis

We first conducted a principal component analysis on each dimension of IC, the results are summarized in Table 3. The KMO value of the human capital variables was 0.521, and the cumulative explained variance of the variables average education level of employees, value added per employee, and operating income per employee was 69.144 %. The KMO value of the customer capital variables was 0.540, and the cumulative explained variance of the variables sales expense ratio, product acceptance rate, and ratio of sales from important customers was 45.590 %. The KMO value of the process capital variables was 0.500, and the cumulative explained variance of the variables organizational stability and inventory turnover was 50.445 %. Lastly, the KMO value of the innovation capital variables was 0.536, and the cumulative explained variance of the variables R&D expenditure, number of patents, and R&D productivity was 49.004 %. Table 4 shows principal component analysis of the profitability index (PROFIT), integrating dividend per share, EPS, ROE, ROA and cash flow ratio, which are variables relevant to operational performance. The cumulative explained variance of principal component analysis reached 71.364%; the eigenvalue was 3.568 and the KMO value was 0.737.

Table 3 Principal Component Analysis Results - Intellectual Capital

	Variable	Component	KMO value	Eigen value	Explained variance (%)
HC	Average education level of employees	0.450	0.521	2.074	69.144
	Value added per employee	0.972			
	Operating income per employee	0.963			
CC	Sales expense ratio	-0.773	0.540	1.368	45.590
	Product acceptance rate	0.548			
	ratio of sales from important customers	0.686			
PC	Organizational stability	-0.710	0.500	1.009	50.445
	Inventory turnover	0.711			
IC	R&D expenditure	0.808	0.536	1.470	49.004
	Number of patents	0.786			
	R&D productivity	-0.447			

Note: (1) Human capital: for the average education level of employees we categorized the education levels into "postgraduate level," "university," and "senior high school or college and below." We gave each of these levels a score (3, 2, and 1) to calculate the overall average education level of employee. Value added per employee = net income/total number of employees. Operating income per employee = operating income/total number of employees. Customer capital: sales expense ratio = sales expense/net sales. Product acceptance rate = 1-(sales return and allowance/net sales). Ratio of sales from important customers = net sales from the three biggest customers/net sales. Process capital: Organizational stability = average years of employment/company's age. Inventory turnover = cost of goods sold/average inventory. Innovation capital: R&D expenditure is the amount of R&D expenditure. Number of patents is the number of patents registered. R&D productivity = net income/R&D expense.

Table 4 Principal Component Analysis Results - Profitability

	Variable	Component	KMO value	Eigen value	Explained variance (%)
PROFIT	Dividend per share	0.881	0.737	3.568	71.364
	EPS	0.938			
	ROA	0.929			
	ROE	0.938			
	Cash Flow Ratio	0.412			

Note: Dividend per share is the dividend per share in the previous year of IPO. EPS is the earnings per share in the previous year of IPO. ROA is return on assets in the previous year of IPO. ROE is return on equity in the previous year of IPO. Cash flow ratio is cash flow from operation to current liabilities ratio in the previous year of IPO.

4.3 Regression Analysis

4.3.1 IC and Offer Price

This study uses Model 1 to investigate the correlation between IC and the offer price. The dependent variable is the IPO offer price. We use four consolidated IC indices as independent variables, and factors influencing the offer price as control variables to test hypotheses H_1 to H_4. Results are shown in Table 5.

As Table 5 demonstrates, the values of VIF in Model 1 are all less than 10, showing no collinearity exists in our regression model. Furthermore, the F-value of the overall model is 27.106 (at a 1 % significance level), which means the model demonstrates a desirable goodness of fit. The adjusted R-squared value of 0.575 indicates that the model has a 57.5% explaining power for explaining the IPO offer price. The empirical results prove that the value of human capital has a significant and positive impact on the IPO offer price (with a coefficient value of 3.771, at a 5 % significance level). Next, the results show that the value of process capital has a significant and positive impact on IPO offer price (with a coefficient value of 4.303, at a 5 % significant level), and this result conforms to the viewpoint proposed by Wang and Chang (2004), namely that process capital is positively correlated with business performance. The value of innovation capital has a significant and positive impact on IPO offer price (with a coefficient value of

Table 5 Results of Regression Analysis on Offer Price and IC

Model 1

$$OFFP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} MARKET_i + b_{14} EVA_i + b_{15} PROFIT_i + \varepsilon_i$$

Variable	Coefficient	*t*-value	*p*-value	VIF
Constant	66.678	1.454	0.147	
HC	3.771	1.965	0.050**	1.656
CC	2.522	1.354	0.177	1.293
PC	4.303	1.981	0.049**	1.427
IC	3.898	2.397	0.017**	1.324
AGE	-0.613	-3.136	0.002***	1.307
SIZE	-3.159	-1.363	0.174	2.725
DEBT	8.049	0.703	0.482	1.642
UND	-1.968	-0.609	0.543	1.130
CPA	-1.140	-0.238	0.812	1.072
IND	-4.698	-1.178	0.240	1.183
EXCH	16.130	3.535	0.000***	1.548
SYS	-8.395	-1.945	0.053*	2.197
MARKET	0.004	2.608	0.010***	2.170
EVA	1.751	5.179	0.000***	2.321
PROFIT	15.426	6.881	0.000***	2.483
N		291		
Adj R^2		0.575		
F-value		27.106***		

Note: (1)*** denotes a 1 % significance level, ** denotes a 5 % significant level, and * denotes a 10 % significant level. (2) $OFFP_i$ is the IPO offer price of company i. HC_i is the consolidated index for measuring the human capital of company i. CC_i is the consolidated index for measuring the customer capital of company i. PC_i is the consolidated index for measuring the process capital of company i. IC_i is the consolidated index for measuring the innovation capital of company i. AGE_i is the number of years that company i had been established before the IPO. $SIZE_i$ is the natural logarithm of the company's total assets in the previous year of IPO. $DEBT_i$ is the debts to equity ratio of company i in the previous year of IPO. UND_i represents the reputation of the underwriter and is a dummy variable. We assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. CPA_i is the reputation of the accountancy firm and is a dummy variable. When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y, and KPMG), we assigned it a value of 1; otherwise, we assigned it a value of 0. IND_i is the industry dummy. If company i was in the electronics industry at the time of listing, we assigned it a value of 1; otherwise, we assigned it a value of 0. $EXCH_i$ is a dummy variable, which is equal to 1 if company i is listed on TWSE, and 0 if it is listed on GTSM. SYS_i is the new or old underwriting system dummy. When company i was listed under the new underwriting system, we assigned it a value of 1; otherwise, it was assigned a value of 0. $MARKET_i$ is the TWSE weighted stock index on the issue date. EVA_i is the net worth per share of company i in the previous year of IPO. $PROFIT_i$ is the consolidated index for measuring the profitability of company i .

3.898, at a 5 % significance level), which also agrees with the findings of Huang (2007), namely that the higher the R&D expenditure is, the higher the set offer price will be. However, customer capital did not significantly influence IPO offer price. Customer capital is an important part of a company's IC as an indication of whether a company has loyal customers and a stable client base. One of our proxy variables measures the concentration of customers in a company. Although a stable, concentrated pool of customers usually contributes to profits, it also exposes the company to future sales concentration risk. If customers transfer their business to a more competitive vendor and the company is unable to immediately find new customers, then profits may take a serious hit. When regulatory authorities review a company's suitability for initial, one specified criterion is that company sales must not be overly concentrated. In conclusion, although customer capital is commonly considered an important intangible asset to a company, excessively close relationships to customers can also present risks; therefore, customer capital does not have a significant positive influence on offer price.

Table 6 Results of Regression Analysis on Underpricing and IC

Model 2

$$UP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} OFFP_i + b_{14} LDAY_i + b_{15} RATIO_i + \varepsilon_i$$

Variable	Coefficient	t-value	p-value	VIF
Constant	110.946	1.151	0.251	
HC	-6.950	-1.771	0.078*	1.439
CC	-16.046	-3.956	0.000***	1.276
PC	-14.992	-3.138	0.002***	1.436
IC	-7.747	-2.161	0.032**	1.339
AGE	-0.628	-1.451	0.148	1.331
SIZE	-1.498	-0.315	0.753	2.383
DEBT	31.993	1.287	0.199	1.614
UND	-8.976	-1.270	0.205	1.124
CPA	-6.725	-0.640	0.523	1.077
IND	-6.141	-0.707	0.480	1.168
EXCH	-3.740	-0.366	0.715	1.617
SYS	12.944	0.824	0.410	6.051
OFFP	0.194	1.897	0.059*	1.488
LDAY	-2.186	-2.527	0.012**	5.867
RATIO	-0.268	-2.741	0.007***	1.191
N		291		
Adj R^2		0.248		
F-value		7.373***		

Notes: (1) *** denotes a 1 % significance level, ** denotes a 5 % significance level, and * denotes a 10 % significance level. (2) UP_i is the market-adjusted initial return of IPO company i. HC_i is the consolidated index for measuring the human capital of company i. CC_i is the consolidated index for measuring the customer capital of company i. PC_i is the consolidated index for measuring the process capital of company i. IC_i is the consolidated index for measuring the innovation capital of company i. AGE_i is the number of years that company i had been established before the IPO. $SIZE_i$ is the natural logarithm of company i total assets in the previous year of IPO. $DEBT_i$ is the debts to equity ratio of company i in the previous year of IPO. UND_i represents the reputation of the underwriter and is a dummy variable. We assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. CPA_i is the reputation of the accountancy firm and is a dummy variable. When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y, and KPMG), we assigned it a value of 1; otherwise, we assigned it a value of 0. IND_i is the industry dummy. If company i was in the electronics industry at the time of listing, we assigned it a value of 1; otherwise, we assigned it a value of 0. $EXCH_i$ is a dummy variable, which is equal to 1 if company i is listed on TWSE, and 0 if it is listed on GTSM. SYS_i is the new or old underwriting system dummy. When company i was listed under the new underwriting system, we assigned it a value of 1; otherwise, it was assigned a value of 0. $OFFP_i$ is the IPO offer price of company i. $LDAY_i$ is the number of days between the price setting and listing dates. $RATIO_i$ is the odds of winning the IPO lottery for IPO company i.

These results indicate that the empirical results agree with our expectations and support hypotheses H1, H3, and H4. Factors from the three dimensions of IC, namely human capital, process capital, and innovation capital, have a positive effect on offer price. Due to misgivings about sales concentration risk, customer capital was not significantly reflected in the offer price. Except customer capital, this means the more intellectual capital a company possesses, the better the evaluation and rating it receives from the underwriter during the underwriting process, and the higher the set offer price will be. Similarly, the more intellectual capital a company possesses, and if it discloses this information to investors through mediums

such as a prospectus, the more investors will value the company, and the more they are willing to purchase shares at relatively higher prices. Considering the positive effect of this information on investors, underwriters tend to set a higher offer price for IPOs. The findings of this study prove that during the IPO process underwriters do place a financial value on IC.

Regarding the control variables, the years of establishment (*AGE*) and new underwriting system (*SYS*) have a significant and negative impact on IPO offer price, whereas exchange of listing (*EXCH)*, market conditions (*MARKET*), net worth per share (*EVA)*, and profitability index (*PROFIT*) all have a significant and positive impact on IPO offer price.

4.3.2 IC and Underpricing

To investigate and determine the correlation between IC and underpricing, we used IPO underpricing as the dependent variable, four IC dimensions as independent variables, and controlled factors that influence underpricing to test hypotheses H_5 to H_8. The empirical results are shown in Table 6.

As shown in Table 6, the F-value of the overall model was 7.373 (at a 1 % significance level), which means the model demonstrates a desirable goodness of fit. The adjusted R-squared value was 0.248, and the values of VIF statistics shown in the empirical results are all less than 10. Therefore, no issue of collinearity exists in the regression model. The empirical results demonstrate that the value of human capital has a significant and negative impact on IPO underpricing (with a coefficient value of -6.950, at a 10 % significance level); the value of customer capital has a significant and negative impact on IPO underpricing (with a coefficient value of -16.046, at a 1 % significance level); the value of process capital has a significant and negative impact on IPO underpricing (with a coefficient value of -14.992, at a 1 % significance level); and finally, the value of innovation capital also has a significant and negative impact on IPO underpricing (with a coefficient value of -7.747, at a 5 % significance level).

Summarizing the empirical results reveal that the empirical findings agree our expectations and support hypotheses H_5 to H_8. Factors from the four dimensions of IC, namely human capital, customer capital, process capital, and innovation capital, have a negative effect on IPO underpricing. This means that the greater the IC a company possesses, the smaller the extent of underpricing it experiences during the IPO process.

Overall, human capital, customer capital, process capital, and innovation capital all have a significant and negative effect on IPO underpricing. The disclosure of information regarding intellectual capital prior to being listed is a method for companies to communicate valuable messages to investors, and can reduce information asymmetry and the extent of underpricing. In other words, because information asymmetry is the main cause of an underpriced offer price, the disclosure of IC a company can reduce the difference in investors' perceived value and their information asymmetry. Thus, when companies undergo the IPO process, they are not required to resort to significant underpricing to attract investors; therefore, they experience less underpricing.

Regarding the control variables, offer price *(OFFP*) and underpricing show a significant and positive correlation. The period between the price setting date and the first trading day *(LDAY)*, and the lot winning ratio *(RATIO)*, also have a significant and negative impact on underpricing.

4.3.3 Influence of the Global Financial Crisis

Our data was sampled from 1 January 2003 to 31 December 2008, with the last 17 months being a period of global financial crisis. During this crisis, the global stocks markets struggled within an environment of worldwide economic recession. In most academic literature, researchers would exclude this relatively unique period and analyze the market under regular conditions or make a separate study of the market in crisis/non-crisis circumstances. The crisis began in August 2007; therefore, all IPO companies after August 2007 were categorized as samples within the crisis period and all IPO companies prior to August 2007 as samples outside of the crisis period, resulting in a total of 71 and 220 samples respectively. This study conducted separate regression analysis of the offer price and underpricing of these two sub-samples, in order to determine whether the role played by IC differed between these two periods.

Table 7 presents IC and offer price regression during crisis and non-crisis periods, respectively. During the non-crisis period, the four dimensions of IC significantly influenced offer price (as indicated in previous studies, underwriters may consider the sales concentration risk of customer capital; therefore, customer capital had the least significance and smallest extent of influence). By contrast, during the financial crisis period, IC did not significantly affect offer price. We infer that the reason for this may be that with the severe worldwide recession, an imbalance in supply-demand, chaotic markets, and many companies struggling for mere survival, underwriters chose not to incorporate intangible assets into offer prices. In the relatively pessimistic market, it maybe increases the failure possibility of underwriting if underwriters integrate the IC with greater uncertainty into offer price. Table 8 presents IC and underpricing regression during the crisis and non-crisis periods, respectively. During the non-crisis period, human capital, process capital and innovation capital were still important factors in reducing information asymmetry. During the crisis period, however, most IC data was ineffective in reducing information asymmetry, possibly because investors were more focused on definite, tangible assets during this period. Additionally, customer capital is the only influential dimension during the financial crisis period. It shows that investors most evaluate the information of customer relationship and stability of sales; therefore, the disclosure of customer capital could reduce information asymmetry and minimize the extent of IPO underpricing.

Table 7 Results of Regression Analysis on Offer Price and IC - Comparison of the Crisis and Non-crisis Period

Model 1

$$OFFP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} MARKET_i + b_{14} EVA_i + b_{15} PROFIT_i + \varepsilon_i$$

	non-crisis period			crisis period		
Variable	Coefficient	*t*-value	VIF	Coefficient	*t*-value	VIF
Constant	98.802	2.385**		96.154	0.564	
HC	5.200	2.603***	1.607	-1.187	-0.262	2.318
CC	3.322	1.909*	1.327	3.168	0.612	1.491
PC	6.082	3.125***	1.642	-11.198	-1.142	1.387
IC	6.626	3.864***	1.572	-1.712	-0.466	1.314
AGE	-0.315	-1.718*	1.332	-1.133	-1.987*	1.761
SIZE	-3.666	-1.741*	2.793	-8.979	-1.032	4.660
DEBT	-18.898	-1.703*	1.722	77.039	2.551**	1.992
UND	-0.914	-0.302	1.101	2.251	0.261	1.355
CPA	-2.172	-0.524	1.070	-3.205	-0.184	1.205
IND	-5.948	-1.658*	1.127	-6.633	-0.529	1.757
EXCH	12.378	2.630***	1.507	32.416	2.568**	2.668
SYS	3.407	0.789	1.752	-	-	-
MARKET	-0.001	-0.363	1.672	0.011	3.927***	1.207
EVA	2.538	6.000***	2.673	1.575	2.310**	2.480
PROFIT	11.463	4.946***	3.144	22.237	3.503***	2.744
N		220			71	
Adj R^2		0.644			0.579	
F-value		27.455***			7.887***	

Note: (1)*** denotes a 1 % significance level, ** denotes a 5 % significant level, and * denotes a 10 % significant level. (2) $OFFP_i$ is the IPO offer price of company i. HC_i is the consolidated index for measuring the human capital of company i. CC_i is the consolidated index for measuring the customer capital of company i. PC_i is the consolidated index for measuring the process capital of company i. IC_i is the consolidated index for measuring the innovation capital of company i. AGE_i is the number of years that company i had been established before the IPO. $SIZE_i$ is the natural logarithm of the company's total assets in the previous year of IPO. $DEBT_i$ is the debts to equity ratio of company i in the previous year of IPO. UND_i represents the reputation of the underwriter and is a dummy variable. We assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. CPA_i is the reputation of the accountancy firm and is a dummy variable. When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y, and KPMG), we assigned it a value of 1; otherwise, we assigned it a value of 0. IND_i is the industry dummy. If company i was in the electronics industry at the time of listing, we assigned it a value of 1; otherwise, we assigned it a value of 0. $EXCH_i$ is a dummy variable, which is equal to 1 if company i is listed on TWSE, and 0 if it is listed on GTSM. SYS_i is the new or old underwriting system dummy. When company i was listed under the new underwriting system, we assigned it a value of 1; otherwise, it was assigned a value of 0. $MARKET_i$ is the TWSE weighted stock index on the issue date. EVA_i is the net worth per share of company i in the previous year of IPO. $PROFIT_i$ is the consolidated index for measuring the profitability of company i .

Table 8 Results of Regression Analysis on Underpricing and IC - Comparison of the Crisis and Non-crisis Period

Model 2

$$UP_i = b_0 + b_1 HC_i + b_2 CC_i + b_3 PC_i + b_4 IC_i + b_5 AGE_i + b_6 SIZE_i + b_7 DEBT_i + b_8 UND_i + b_9 CPA_i + b_{10} IND_i + b_{11} EXCH_i + b_{12} SYS_i + b_{13} OFFP_i + b_{14} LDAY_i + b_{15} RATIO_i + \varepsilon_i$$

	non-crisis period			crisis period		
Variable	Coefficient	t-value	VIF	Coefficient	t-value	VIF
Constant	61.523	0.823		-65.240	-0.186	
HC	-9.923	-2.746***	1.498	-3.470	-0.412	1.459
CC	-2.742	-0.853	1.290	-56.986	-4.728***	1.474
PC	-20.679	-5.722***	1.613	29.985	1.315	1.368
IC	-12.707	-3.936***	1.587	-11.959	-1.410	1.278
AGE	0.261	0.754	1.346	-3.617	-2.586**	1.932
SIZE	-1.071	-0.294	2.387	13.061	0.731	3.584
DEBT	2.410	0.116	1.724	26.830	0.421	1.619
UND	-3.227	-0.566	1.113	-28.340	-1.429	1.310
CPA	-8.075	-1.041	1.066	20.149	0.496	1.198
IND	9.481	1.410	1.128	-66.876	-2.327**	1.686
EXCH	-4.323	-0.482	1.557	17.186	0.654	2.107
SYS	41.703	3.490***	3.823	-	-	-
OFFP	0.306	3.258***	1.552	0.053	0.224	1.691
LDAY	-1.506	-2.345**	3.688	-5.913	-1.534	1.293
RATIO	-0.181	-2.492**	1.198	-0.394	-0.956	1.308
N	220			71		
Adj R^2	0.440			0.337		
F-value	12.461***			3.544***		

Notes: (1) *** denotes a 1 % significance level, ** denotes a 5 % significance level, and * denotes a 10 % significance level. (2) UP_i is the market-adjusted initial return of IPO company i. HC_i is the consolidated index for measuring the human capital of company i. CC_i is the consolidated index for measuring the customer capital of company i. PC_i is the consolidated index for measuring the process capital of company i. IC_i is the consolidated index for measuring the innovation capital of company i. AGE_i is the number of years that company i had been established before the IPO. $SIZE_i$ is the natural logarithm of company i total assets in the previous year of IPO. $DEBT_i$ is the debts to equity ratio of company i in the previous year of IPO. UND_i represents the reputation of the underwriter and is a dummy variable. We assigned the top three underwriters with the highest underwritten value over the past three years a dummy variable value of 1, whereas the other underwriters were assigned a value of 0. CPA_i is the reputation of the accountancy firm and is a dummy variable. When the accountancy firm used by the IPO was one of the Big Four (Deloitte, PwC, E&Y, and KPMG), we assigned it a value of 1; otherwise, we assigned it a value of 0. IND_i is the industry dummy. If company i was in the electronics industry at the time of listing, we assigned it a value of 1; otherwise, we assigned it a value of 0. $EXCH_i$ is a dummy variable, which is equal to 1 if company i is listed on TWSE, and 0 if it is listed on GTSM. SYS_i is the new or old underwriting system dummy. When company i was listed under the new underwriting system, we assigned it a value of 1; otherwise, it was assigned a value of 0. $OFFP_i$ is the IPO offer price of company i. $LDAY_i$ is the number of days between the price setting and listing dates. $RATIO_i$ is the odds of winning the IPO lottery for IPO company i.

5. Conclusions

The capital market in a competitive knowledge economy is littered with much enterprise information, but whether the provision of this information is reflected in the company valuation remains debatable. Specifically, because companies planning to be listed as IPOs cannot provide historical data for consideration when evaluating and setting a share price, investors often use only the financial report data to assess the company value. Because of the rapid development of the knowledge environment and information technology, intangible intellectual capital has become an important competitive advantage for businesses. Thus, purely evaluating and assessing the data provided in financial reports does not reflect and explain non-financial information. To provide IPOs with practical reference information in the future, we examined the impact of IC on the offer price and underpricing of IPOs to investigate whether underwriters and investors are concerned regarding IC.

This research has developed a holistic IC framework comprising four dimensions including human capital, customer capital, process capital, and innovation capital through adopting Skandia's intellectual capital navigator. Having studied the various definitions of IC proposed in previous literature, we used principal component analysis to integrate these proxy variables for each dimension and constructed a holistic framework of IC. We adopted a more objective and holistic approach when measuring the value of IC to avoid bias from the adapted measurements and to ensure we do not only discuss a single dimension of IC or use just a single proxy variable to measure IC, as past studies have done. We then manually collected non-financial IC data from the sample subjects. The sample includes IPOs listed on the Taiwan Stock Exchange (TWSE) and Gre Tai Securities Market (GTSM) between 2003 and 2008. With the exception of customer capital, which did not significantly influence offer price because sales concentration risk was considered, the empirical results of this study showed that the greater a company's IC is, the more the investors value the company because they are aware of the influence IC has on the value of the company. Thus, investors are willing to purchase the IPO shares at a higher offer price; similarly, underwriters tend to set a higher offer price. Furthermore, the more information regarding its intangible assets, such as IC, a company discloses, the more valuable information it communicates to investors, reducing the information asymmetry between investors and the company. Consequently, during the IPO process, the company will not be required to resort to high underpricing to attract investors. However, during the crisis period, most IC information did not significantly affect offer price and underpricing. We infer that underwriters and investors less concerned about uncertain and intangible assets during this period.

In this dynamic and competitive market environment, the establishment and management of intellectual capital (IC) is vital to the survival of business organizations. Not only is IC related to the value of a company, but it is also a critical element that influences company profit and growth. The findings of this study show that investors rate IC positively; underwriters also place a monetary value on IC, which is reflected in the offer price sets for the company to be listed. Therefore, the disclosure of information regarding IC reduces the information asymmetry experienced by investors, which subsequently leads to a lower cost of capital (underpricing cost) at the IPO stage. These findings demonstrate that IC is at the core of organizational competitiveness. Thus, how to establish, apply, and maintain a firm's IC to elevate its value becomes an extremely significant issue. From the perspective of human capital theory, a company aiming to achieve good business performance and sustainability should emphasize and invest substantially in the cultivation and development of its human resources. This means companies should focus on improving employee skills, knowledge, and capabilities. Next, process capital encompasses the operational process, knowledge, and methods that contribute to the continuous value of a company. In this competitive and dynamic environment, operational processes must be developed based on both the internal and external environments. Thus, the value of process capital and management effectiveness can be improved through stable growth and development. Finally, because incessant growth is vital to business success, companies should strive to accumulate innovation capital by constantly investing to develop new products, new services, and new systems; thus, they can continue to enjoy their competitive advantages.

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