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經理人股票選擇權的時間價值、智慧資本及公司特定風險

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摘要：本文首先結合智慧資本與公司特定風險因素於Ohlson model以估計選擇權的價值。其次，進一步檢驗股票選擇權的時間價值與給予公司未來經營績效的關係，以探討股票選擇權的誘因效果。研究結果發現，由Black-Scholes model估計之經理人股票選擇權的價值與公司特定風險及智慧資本呈正相關。藉由市場股價估計時，股票選擇權的時間價值對公司未來績效有同步及遞延之負向影響。然而，當股票選擇權是採用股價與結合公司特定風險及智慧資本來評價時，股票選擇權的時間價值對公司未來兩期經營績效有同步及遞延之正向影響。

關鍵詞：經理人股票選擇權、時間價值、智慧資本、公司特定風險、經營績效

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The Time Value of Executive Stock Option Compensation, Intellectual Capital, and Firm-Specific Risk

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Abstract: This paper estimates stock prices by extending the Ohlson model, which incorporates both intellectual capital and firm-specific risk factors, and reevaluates the value of stock options. We further examine the relationship between the time value of stock options and the future operating performance of the granting firms to understand the incentive effects of stock options. The findings indicate that the value of executive stock options, which are estimated by the Black-Scholes model, is positively related to both firm-specific risk and intellectual capital. The time value of stock options that is estimated from market stock prices has both concurrent and deferred negative effect on the future operating performance of a company. However, when stock options are valued by method combines firm-specific risk and intellectual capital, the time value of the stock options also has both concurrent and deferred positive effects on operating performance for the next two years.

Keywords: executive stock options, time value, intellectual capital, firm-specific risk, operating performance

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I. Introduction

This paper extends existing research on the valuation and incentive effects of stock option grants in two aspects. First, prior studies typically have used market stock prices and the Black-Scholes (hereafter, BS) option pricing model to estimate the value of stock option grants (Veliyath, 1999; Hanlon, Rajgopal, and Shelvin, 2003). We extend these studies by incorporating intellectual capital and firm-specific risk in Ohlson's (1995) model to estimate stock prices and then use the BS model to value stock option grants. Second, existing studies on the incentive effects of stock option grants usually examine the association between the value of option grants and firm performance. We extend these studies by examining the incentive effect of the time value of stock option grants.

Although the best estimate of fair value for stock options is the market price of identical or similar instruments traded in the market, such information is usually unavailable.[1] The granting firm can estimate the fair value using an option pricing model, such as the commonly used BS model.[2] Statement 123 (R) also suggests that firms adopt the BS option pricing model or another similar method to estimate the fair value of stock options. Because the value of the underlying shares is a direct input required in the option pricing model, an accurate estimate of stock option values depends on accurately inputted stock prices. Prior studies have generally used market stock prices and the BS model to evaluate stock option values.[3] If a stock option is valued with the current stock price, the short-term and noisy information contained in the stock price will affect calculation of the value. The BS model adopts the market price of a stock to estimate the option value, so it causes a bias in the estimated option value.[4] Some articles indicate that the BS model

[1] Firms can use the intrinsic value method to recognize stock option compensation expenses based on APB Opinion No. 25; however, this method has been eliminated and firms are required to recognize a compensation expense based on the option's fair value following the release of Statement No. 123(R) on December 16, 2004. To use the fair value method, firms weigh compensation expenses against the incentive effects of stock options. Given the expensing requirements, determining how to estimate fair value of stock options is an important issue.

[2] Black and Scholes (1973) derive the option pricing formula by assuming that the underlying stock price follows a geometric Brownian motion in which the price distribution is lognormal, ignoring the time effect, and assuming that volatility is constant. However, in general, empirical evidence supports neither the lognormal distribution nor the constant volatility. To deal with these problems, some authors have suggested alternative underlying processes, such as Merton's jump-diffusion model (Merton, 1976); Cox and Ross's CEV model (Cox and Ross,1976), which allows the volatility to change with the underlying price; and Cox, Ross and Rubinstein's (1979) binomial options pricing model, which uses a "discrete-time" model of the varying price of the underlying financial instrument over time.

[3] Murphy (1993) shows that nearly 98% of firms adopt the Black-Scholes option pricing model to assess the current value of stock options.

[4] Although the BS model is one of the most widely used models in practice, it makes some strong assumptions, for example, stock returns are normally distributed with a known mean and variance. These assumptions are inconsistent with the true environment and usually lead to significant differences between option prices from the BS model and the true market price of call options.

overestimates the true value of stock options,[5] and therefore they revise the model based on different conditions (Aboody, 1996; Carpenter, 1998).

Jackson and Pitman (2001) find that managers affect current and future earnings to gain more compensation through earnings management. Cheng and Warfield (2005) suggest that managers with higher equity incentives are likely to sell stock in the future and unlikely to report higher abnormal current earnings, indicating that manager wealth is more sensitive to future stock performance. Hence, we infer that the option value cannot be reasonably estimated through the market price when managers engage in earnings manipulation. This paper attempts to provide a better estimator of stock prices and thus obtain a better estimated value of stock options by inputting revised stock prices into the BS model.

On the other hand, Malkiel and Xu (1997) find that idiosyncratic risk (firm-specific risk) is a proxy for a wide range of systematic factors. Xu and Malkiel (2003) argue that idiosyncratic risk could be priced to compensate investors who are not fully diversified. Campbell, Lettau, Malkiel, and Xu (2001) finds that idiosyncratic volatility is the largest component in the total volatility, and there is a positive significant trend in idiosyncratic volatility but no trend in market volatility. Hence, this paper expects that the estimated stock option value will be more correct when we incorporate idiosyncratic risk in the estimated stock price.

Intellectual capital is another important factor related to the firm value. Roos, Roos, Dragonetti, and Edvinsson (1998) maintain that a firm's value is composed of traditional physical capital, financial capital, and intangible intellectual capital. Lev (2001) suggests that the physical and financial assets of firms only generate normal earnings but intangible assets can create abnormal earnings. Tayles, Pike, and Sofian (2007) suggest that firms with greater intellectual capital are better able to respond to unanticipated economic and market changes and perform more highly. Ritter and Wells (2006) find that voluntarily disclosed identifiable intangible assets reveal the potential profitability of a firm. DeFond, Konchitchki, McMullin, and O'Leary (2011) suggest that firms receiving the award of knowledge management experience positive abnormal returns around the award announcement, consistent with knowledge management increasing shareholder value. Zéghal and Maaloul (2010) also find that a firm's intellectual capital has a positive impact on economic and financial performance. These findings document that intellectual

[5] McLaughlin, Safieddine, and Vasudevan (1996) show that firm value may be overestimated when a firm has serious agency problems and, because the firm's future performance will decline, the CEO will exercise the option early when the stock price is still high. Accordingly, the CEO's willingness to hold stock options is negatively related to the agency cost of a firm, and unhedgeable firm-specific risk will lead to the option pricing model overestimating the value of a stock option.

capital has been a determinant in the study of equity valuation. If managers recognize that intellectual capital of firm is not yet booked, then their knowledge about the potential for earnings increases because intellectual capital may or may not influence the options' incentive effects. As mentioned above, our paper first estimates stock prices by extending the Ohlson model, which incorporates both intellectual capital and firm-specific risk factors, and then reevaluates the value of stock options as an incentive tool.

The value of stock options is composed of the intrinsic value and the time value. The intrinsic value is fixed as the difference between the exercise price and the stock price, whereas the time value varies with different types of options. Holding other factors constant, at-the-money stock options have the highest time value because the time value of the in-the-money option will decrease in terms of the stock price and the time value of the out-of-money option will increase in terms of the stock price. Hence, this paper further examines the relationship between the time value of the stock options that are estimated by our proposed model and the future operating performance of the granting firms to understand the incentive effects of stock options.

The empirical findings indicate that the value of executive stock options, calculated from market stock prices (the BS model), is positively related to firm-specific risk and intellectual capital. When the value of a stock option is estimated based on the market stock price, the time value of the stock option has concurrent and deferred negative effects on future firm performance.[6] However, when the stock option is valued with the stock price estimated by considering firm-specific risk and intellectual capital, the time value of the stock option is positively related to future operating performance. The results have significant implications for the granting firms; that is, if stock option grants are valued based on market stock prices, the time value would induce an inverse incentive effect. Moreover, because at-the-money stock options have the highest time value, the negative incentive effect would be the greatest for firms granting stock options at the money. Apparently, at-the-money stock options are not a good choice as incentive compensation.[7] Furthermore, the finding of a positive incentive effect associated with the time value of stock option grants when valued with stock prices estimated by considering firm-specific risk and intellectual capital highlights the importance of using a proper valuation method to value stock option grants, which means stock option can be more effective in motivating employees by adopting an appropriate valuation method.

[6] Because the time value of at-the-money stock options is larger than those of out-of-the-money and in-the-money options, at-the-money stock options are no longer the best choice following Statement No. 123 (R).

[7] After the issuance of Statement No. 123 (R), firms should consider granting out-of-money stock options instead because they can reduce not only the inverse incentive effect associated with the time value of stock options but also the recognized compensation expenses in financial statements.

The remainder of the paper is organized into four sections. Section 2 briefly reviews the previous literatures and develops our hypotheses. Section 3 explains the research design, research periods, sampling criteria and variable definitions and proposes the empirical models. Section 4 presents the empirical results. The conclusion and suggestions are provided in Section 5.

II. Hypothesis Development

The relationships between stock option value, firm-specific risk, and intellectual capital

With information technology developing at a tremendous pace and knowledge circulating more rapidly, intellectual capital has become the foundation of increasing competitiveness and continuous growth in firms. Masoulas (1998) shows that intellectual capital is the combination of intangible assets and can increase the added value of a firm. Bontis (1999) asserts that intellectual capital is the effective application of information and knowledge and is an intangible resource that can offer competitive advantages to the firm. Shaikh (2004) advocates that appropriate management, strengthening and employing intellectual capital can increase the firm value. In addition, the agent theory suggests that CEO compensation incentives can align managers' personal goals and the overall goals of firms, thereby increasing firms' performance. Jensen and Meckling (1976) conclude that stock option contracts can motivate executives to pursue maximum profit for firms. Kroumova and Sesil (2006) use cross-sectional analysis to examine the association of firm characteristics and the adoption and maintenance of broad-based stock option plans. They find that firms with higher levels of intellectual capital and capital intensity are more likely to adopt and maintain employee stock option plans. Accordingly, this paper expects that both stock prices and stock option values are positively related to intellectual capital and their estimations will be imprecise when intellectual capital is ignored.

Firm risk can be divided into systematic risk and non-system risk. The latter is also called idiosyncratic or firm-specific risk. Malkiel and Xu (1997) find that idiosyncratic risk is a useful substitution variable for firm risk, and portfolio managers usually attribute the demand of risk premium for stocks with higher firm-specific risk as the reason why they increase or reduce investment in these stocks. Xu and Malkiel (2003) find that idiosyncratic risk (or idiosyncratic volatility) is stronger than beta risk or firm size in explaining the cross-sectional variation of stock returns; therefore, idiosyncratic risk is

one of the determinants of stock returns. From the perspective of risk diversification, Cheng and Warfield (2005) indicate that risk-averse managers want to reduce their exposure to a firm's idiosyncratic risk; thus, managers sell shares if the level of risk exposure is higher than the equilibrium level.[8]

Most related research on stock options focuses on firms' beta risk and ignores the importance of idiosyncratic risk, so we attempt to examine the relationship between these two factors.[9] We expect that the value of executive stock option is positively related to both firm-specific risk and intellectual capital.

The relation between firm performance and the time value of stock options

The system of rewarding using stock options can make firm performance the goal of executives and thus align the interests of executives and shareholders. Many listed firms in the U.S. offer stock options as compensation for managers; in fact, the value of stock option grants accounts for more than half of the total reward granted to managers (Murphy, 1993), which is often called the "incentive effect." Anthony, Dearden, and Govindarajan (1992) find that stock option rewarding systems could encourage managers to make more proactive investment decisions, helpful to the long-term growth of a firm. Hence, the main purpose of stock options is to alleviate the agency problem and set up a long-term incentive mechanism for management. Gaver and Gaver (1993) show that firms with many growth opportunities pays higher compensation for managers and is more likely to implement stock option plans. Under the incentive alignment hypothesis, Rajgopal and Shevlin (2002) and Duan and Wei (2005) demonstrate that the contract of stock options has a high incentive effect for top managers.[10]

According to the above-mentioned, when the values of managers' stock option holdings are higher, they can motivate managers' efforts to increase firm performance. The value of stock options is comprised of the intrinsic value and the time value. While the intrinsic value is decided by the exercise price and stock market price, the time value

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[8] Fu (2009) finds that current stock returns and firm size have a positive correlation after controlling for current idiosyncratic risk.

[9] Schrand and Unal (1998), Aggarwal and Samwick (1999), Rajgopal and Shevlin (2002), and Duan and Wei (2005) also find that executives who are compensated with stock options may take actions to increase company risk because an increase in stock price volatility increases the value of the stock option. Chen, Steiner, and Whyte (2006) examine the impact of option-based compensation on several market-based measures of bank risk: Total, systematic, idiosyncratic, and interest rate risks.

[10] The original intention of the stock option-related reward systems was to offer performance incentives that would coordinate the interests of shareholders and managers to alleviate the agency problem and motivate managers or employees to pursue maximum profits for the firm. However, the evidence regarding the incentive effect of stock options is inconclusive. Sesil, Kroumova, Kruse, and Blasi (2007) find that firms with stock option plans perform better, whereas Aboody, Barth, and Kasznik (2004) document a negative relationship between the value of stock options and equity market values.

reflects the amount that the market stock price could rise above the exercise price in the duration period. Therefore, we expect the time value of stock options to provide the incentive effect. According to these concepts, this paper extends the relation between the value of stock option and the growth of a firm, which has been examined by related articles, to investigate the relation between the time value of stock option and the future operating performance of a firm. We formulate the following hypothesis:[11]

H1: The time value of a stock option value estimated under the BS model is positively related to the future operating performance of the firm.

The relation between firm performance and the time value of stock options considering firm-specific risk and intellectual capital

Masoulas (1998) shows that intellectual capital is the combination of intangible assets and can increase the added value of a firm. Shaikh (2004) shows that greater intellectual capital can increase firm value. Aquila (2006) indicates that a firm's future success depends on its ability to both manage and maximize three distinct and significant practice areas: intellectual capital, organizational capital, and client capital.[12] Ritter and Wells (2006) find that voluntarily disclosed identifiable intangible assets reveal a firm's potential profitability and induce the rise of stock prices. Zéghal and Maaloul (2010) find that intellectual capital has a positive impact on the economic and financial performance of a firm. These findings imply that intellectual capital is an important element in evaluating the value of firms.

By contrast, firm-specific risk (Idiosyncratic risk) is generally affected by firm characteristics. Merton (1987) suggests that past studies on stock returns ignore firm-specific risk and focus instead on the relation between beta risk and stock returns. Henderson (2002) proposes a continuous time utility maximization model to value stock and option compensation from the executive's perspective and to examine the effect of

[11] The value of stock options is composed of the intrinsic value and the time value. Whereas the intrinsic value is fixed as the difference between the exercise price and the stock price, the time value varies with different types of options. Holding other factors constant, at-the-money and out-of-the-money stock options have the highest time value (due to zero intrinsic value); that is, the fair value of a stock option equals the time value of the stock option. However, in-the-money stock options have positive intrinsic value; that is, the fair value of stock options include the intrinsic value and the time value. Hence, we adopt the time value of stock options rather than the total value (fair value) to examine the relationship between the time value of stock options and the operating performance of the granting firms to understand the incentive effects of stock options and weigh the benefits of continuing to grant at-the-money stock options.

[12] Jones, Kalmi, and Makinen (2004) find that smaller firms and those with higher measures of intellectual capital are more likely to have broad-based plans.

stock volatility, firm-specific risk, and market risk on the value to the executive.[13] Core, Guay, and Thomas (2005) find that conventional stocks and options may provide an optimal solution to two conflicting demands: shareholders' demand for executive rewards tied to company performance and executives' preference to diversify their wealth when viewed as a combination of market risk and firm-specific risk. Jin and Myers (2006) suggest that lower idiosyncratic volatility and high stock returns will occur when accounting information is not transparent and when investor protection is weaker. These findings document that firm-specific risk and intellectual capital has been a determinant in the study of equity valuation, especially in high-tech industry.

Feltham and Ohlson (1999) first incorporate risk and random interest rate in the RIV model. Nonetheless, their residual income valuation model was never applied in empirical research. There are no other empirical models that take risk into account. Due to our sample being focused on high-tech industry, we extend Ohlson's model by incorporating firm-specific risk and intellectual capital. Although Ohlson (1995) regards the dividend and information variable of modified future profitability as the intercept, we add two important factors affecting stock price, firm-specific risk and intellectual capital, to ensure that the valuation model is more consistent with empirical implications in our high-tech sample. From the premise of a positive relationship between stock price and intellectual capital, if intellectual capital is missed in firms' valuation, stock prices will be misestimated, so our paper will consider firm-specific risk and intellectual capital in estimating the time value of stock options. Hence, we form the following hypothesis:[14]

H2: The time value of a stock option value is positively related to the future operating performance of the firm when the value of the stock option is evaluated with an estimated stock price that considers both firm-specific risk and intellectual capital.

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[13] The model allows the executive to invest non-option wealth in the market and in riskless assets but not in the company stock itself. This restriction enables executives to adjust exposure to market risk, but they are subject to firm-specific risk for incentive purposes. Because executives are risk averse in terms of their stock options, this unhedgeable firm risk leads them to place less value on the options than their cost to the company, given by their market or Black-Scholes value.

[14] The value of a stock option is comprised of the intrinsic value and the time value. The intrinsic value is decided by the exercise price and stock market price, whereas the time value reflects the amount that the market stock price would possibly rise above the exercise price in the duration period. Therefore, we expect the time value of the stock option to perhaps provide greater incentive effect. H1 posits that the time value of a stock option value is positively related to the future operating performance of the firm when the value of the stock option is evaluated by the stock market price. H2 posits that the time value of a stock option value is positively related to the future operating performance of the firm when the value of the stock option is evaluated with an estimated stock price that consider both firm-specific risk and intellectual capital. The purpose of using the estimated stock price from Ohlson's model in H2 is to reduce the noise from managers manipulating stock prices around stock option grant dates.

III. Research Design

Sample

Because more than 94% of the firms listed on NASDAQ employ stock option plans, our research sample consists of the firms listed on NASDAQ. We collect firm-year data on executives' stock-based compensation and ownership from the Standard & Poor's Compustat database and ExecuComp database for the period of 1992–2004. We exclude financial institutions and utilities because they are regulated industries. Firms without complete data are also excluded. Based on these selected criteria, our final sample consists of 3670 firm-year observations from 489 sample firms.

Models

We first examine the relationships between the value of stock options, firm-specific risk, and intellectual capital using equation (1):

$$BS_{it} = a_0 + a_1 RISK_{it} + a_2 IC_{it} + a_3 ROA_{it} + a_4 SIZE_{it} + a_5 SHARE_{it} + a_6 VOL_{it} + e_{it} \quad (1)$$

where *BS* stands for the stock option value from the Black-Scholes model, *RISK* is firm-specific risk, *IC* represents intellectual capital, *ROA* is the operating performance, *SIZE* is firm size, *SHARE* stands for executive ownership, and *VOL* is the stock return volatility. Measurements of the variables are described in Table 1.

Bontis (2001) suggests that although the concept of intellectual capital has been subject over the years to diverse interpretations, the proposed patterns of its representation found in the literature are based on classifications that are very similar to one another. Lev and Radhakrishnan (2003) find that several articles about business economics use the terms intangibles, intangible resources, intangible goods, knowledge assets, and intellectual capital as synonyms. Simply, a firm's market value exceeding its book value has been defined as intellectual capital (Edvinsson and Malone, 1997). The intellectual capital of firms plays an important role in the modern method of value creation. Extensive research has been carried out on intellectual capital because financial accounting does not explain the increasing gap between a firm's market value and its book value (Lev, 2001; Lev and Radhakrishnan, 2003).[15]

[15] Stewart (1997) suggests that intellectual capital can be regarded as the knowledge, information, intellectual property, and experience that create the wealth of shareholders. Bontis, Keow, and Richardson (2000) find that intellectual capital means individual workers' and organizational knowledge that induce a competitive advantage. Pulic (2000) suggests that intellectual capital includes all employees and their abilities that can create value added. Therefore, we can find different interpretations of intellectual capital from literature.

Table 1 Summary of Abbreviations, Proxies and Definitions for Variables

Variable	Proxy	Definition
BS	The value of Black-Scholes stock options	The value of stock options is calculated by plugging market price per share into the Black-Scholes option pricing model.
BST	The time value of Black-Scholes stock options	*BS* minus the intrinsic value. The intrinsic value is the amount 0 or the difference between the market price of the stock and the strike price of stock options, whichever is larger.
NBST	The time value of the stock option granted calculated with the estimated stock price. The estimated stock price is obtained by considering firm-specific risk and intellectual capital in the Ohlson valuation model	The value of stock option grants is calculated by plugging the estimated stock price into the Black-Scholes option pricing model. The time value of the stock options granted is then obtained by subtracting the intrinsic value from the value of the stock options. The intrinsic value is the amount 0 or the difference between the market price of the stock and the strike price of stock options, whichever is larger.
RISK	Firm-specific risk	It is estimated by the market model: $R_i = \alpha + \beta_i R_m + \varepsilon_i$, where R_i = the stock return of firm i, R_m = market returns. The stock returns of firm i in the past 36 months are used to estimate the regression coefficients (i.e., beta risk and intercept), which are substituted into the market model to calculate abnormal returns between the monthly returns of firm i and the monthly returns of the market. This study uses the volatility of the abnormal returns of 36 months to measure firm-specific risk (idiosyncratic risk).
IC	Intellectual Capital	Tobin's Q is the sum of the market value of common stock, the market value of preferred stock, and the book value of total debt scaled by the book value of total assets.
SIZE	Firm size	The natural log of total assets.

Table 1 Summary of Abbreviations, Proxies and Definitions for Variables (Continued)

Variable	Proxy	Definition
VOL	Volatility of stock return	The standard deviation of annual stock returns for the five years prior.
SHARE	Executives' ownership ratio	The percentage of a firm's common stocks held by executives.
ROA	Operating performance	Operating income divided by total assets.
CASH	Cash compensation	The natural log of the sum of salary and bonus.

From the literature on intellectual capital, Seetharaman, Low, and Saravanan (2004) find that quantifying intellectual capital is usually based on recognizing the discrepancy between the market capitalization of a firm and the replacement value of the firm's tangible assets. Because the replacement value of assets can be difficult to measure, book value is used as a proxy. Boedker, Guthrie, and Cuganesan (2005) and Dumay (2009) discuss a similar approach. Based on the above-mentioned, to simplify the measure of intellectual capital, we use the gap between the market value and book value, that is, the market-to-book ratio, to obtain an approximation of intellectual capital. Although estimating intellectual capital using the market-to-book ratio presents a bias, finding a precise measurement of intellectual capital is not the main focus of this paper.[16]

Next, we examine the incentive effect associated with the time value of stock option grants. To capture the effects of firm-specific risk and intellectual capital on the stock option value, we adopt two valuation methods. The first method uses actual stock prices in the Black-Scholes model to estimate the value of stock option grants.[17] The second method substitutes the estimated stock price for the actual stock price in the Black-Scholes model to value stock option grants, in which the estimated stock price of a firm is measured by incorporating intellectual capital and idiosyncratic risk in Ohlson's (1995) linear valuation model.[18] The stock price estimation model is as follows:[19]

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[16] We are very thankful for the reminder of the reviewer and editor.

[17] The Black-Scholes valuation model: $C_{i,t} = P_{i,t}e^{-\delta T}N(d_1) - K_t e^{-rT}N(d_2)$, where $C_{i,t}$ = option value, $P_{i,t}$ = market price per share, K_i = exercise price per share, δ = expected annual dividend yield, r = risk-free rate of interest, T = residual period until expiration of stock option, $N(.)$ = cumulative probability function of normal distribution, $d_2 = d_1 - \sigma\sqrt{T}$, σ = standard deviation of underlying stock returns, e^{-rT} = discount factor of period T, and $d_1 = \dfrac{\ln\left(\dfrac{P_{i,t}}{K}\right) + T\left(r - \delta + \dfrac{\sigma^2}{2}\right)}{\sigma\sqrt{T}}$.

[18] Ohlson's (1995) valuation model regards the dividend and information variable of modified future profitability as the intercept and forms an equity valuation model that contains the book value and earnings:

$$P_{it} = a_0 + a_1 y_{it} + a_2 x_{it} + a_3 IC_{it} + a_4 RISK_{it} + e_{it} \quad (2)$$

where P stands for stock price, y represents book value, x is abnormal earnings, and *RISK* and *IC* stand for firm-specific risk and intellectual capital, respectively.

Dechow, Hutton, and Sloan (1999) combine the residual income valuation model with information dynamics. Some articles adopt current earnings to replace abnormal earnings in Ohlson's equity valuation model (Aboody, 1996; Barth, Clement, Foster, and Kasznik, 1998; Chen, 2003). Chen, Chang, Wang, and Lee (2005) also use current EPS to proxy for abnormal earnings because there is a high correlation between current earnings and abnormal earnings according to the correlation analysis. Wu and Wang (2008) take the volatilities of price level, the interest rate, the exchange rate, and the real economic growth rate as proxy variables of systematic risk and add them to the original Ohlson valuation model to replace "non-accounting information" to evaluate the equity value. Tsay, Lin, and Wang (2008) introduce firm-specific information regarding financial risk and potential agency problems into the residual income model and further explore how bankruptcy probability and agency costs influence the equity price of a firm.

Therefore, by incorporating intellectual capital and firm-specific risk in the other information of Ohlson's valuation model and then estimating stock option values, we intend to explore and highlight the impact of the estimated value of stock options on a firm's future performance. In our revised Ohlson valuation model, we also try to compare the results of the revised Ohlson model with the original Ohlson model.

CEO annual total compensation is measured as the sum of salaries, bonuses, granted restricted stocks, granted stock options (Black–Schole value), long-term incentive payouts, and other compensation. Jensen and Murphy (1990) find that both CEO annual cash compensation and total compensation are positively correlated with current accounting and stock performance measures. Jackson, Lopez, and Reitenga (2008) suggest that bonus compensation represents, on average, 35% of cash compensation and 21% of total compensation for their CEO sample. Ibrahim and Lloyd (2011) find that based on a Wall Street survey of CEO compensation in public firms performed by the

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$P_{i,t} = a_0 + a_1 y_{i,t} + a_2 x_{i,t} + \varepsilon_{1i,t}$, where $P_{i,t}$ = stock price per share of firm i at time t, $y_{i,t}$ = book value per share of firm i at time t, $x_{i,t}$ = earnings per share of firm i at time t (we adopt earnings before discontinued and extraordinary items), and $\varepsilon_{1i,t}$ = residual item.

[19] We extend Ohlson's (1995) valuation model: $P_{it} = a_0 + a_1 y_{it} + a_2 x_{it} + a_3 IC_{it} + a_4 RISK_{it} + e_{it}$, where P_{it} = stock price per share of firm i at time t, y_{it} = book value of equity per share of firm i at time t, x_{it} = earnings per share, IC_{it} = intellectual capital, and $RISK_{it}$ = firm-specific risk. We first estimate $\hat{a}_0 \sim \hat{a}_4$ of $a_0 \sim a_4$ in the above model through sample firms during 1992~1999. Assume coefficients $\hat{a}_0 \sim \hat{a}_4$ are stable in the estimation period (1992~1999) and observations (2000~2004). Further, estimate the stock price per shares of sample firms from 2000 to 2004. The estimated model is as follows: $\hat{P}_{it} = \hat{a}_0 + \hat{a}_1 y_{it} + \hat{a}_2 x_{it} + \hat{a}_3 IC_{it} + \hat{a}_4 RISK_{it}$, where $\hat{P}_{it}$ = estimated stock price per share.

consulting firm Hay Group, the cash bonus component constitutes a significant amount of compensation. These cash bonus payments represented, on average, 44% of the total cash compensation and 18.22% of the total compensation for their sample. Hence, in this paper, we investigate whether cash compensation (*CASH*), including salaries and cash bonuses, affects current accounting performance (i.e., the executives' effort) in models (3) and (4).

After estimating the values of stock option grants with the two methods, to examine the relationship between the time value of stock option and operating income of the firm, we use the time values of the stock options from a three-period lag to capture the time effects of stock options on the future firm performance.

$$FuPerfor_{it+1} = b_0 + b_1 BST_{it} + b_2 BST_{it-1} + b_3 BST_{it-2} + b_4 BST_{it-3} + b_5 SIZE_{it} + b_6 CASH_{it} + e_i \quad (3)$$

$$FuPerfor_{it+1} = b_0 + b_1 NBST_{it} + b_2 NBST_{it-1} + b_3 NBST_{it-2} + b_4 NBST_{it-3} + b_5 SIZE_{it} + b_6 CASH_{it} + e_i \quad (4)$$

where *FuPerfor* denotes future operating performance, *SIZE* is firm size, *CASH* represents annual cash compensation including salaries and bonuses, and *BST* and *NBST* represent the time values of stock option grants calculated based on market stock prices and estimated stock prices, respectively. Measurements of the variables are described in Table 1.

IV. Results

Descriptive Statistics and Correlation Analysis

The descriptive statistics in Table 2 show that the mean stock option value (*BS*) is 2,746.842, which is much greater than the mean cash compensation (*CASH*), 790.514. This finding demonstrates that the values of employee stock options are, on average, 68% of the total compensation. The mean intellectual capital (*IC*) is 2.0284, and its standard deviation is 2.0534, showing that differences in intellectual capital exist among firms.

The Pearson correlation analysis in Table 3 reveals that executive stock option value (calculated from market stock price), *BS*, is significantly and positively related to firm-specific risk (*RISK*) and intellectual capital (*IC*). Moreover, the operation performance of a firm (*ROA*) is significantly and positively related to both firm-specific risk (*RISK*) and intellectual capital (*IC*). The preliminary results support the relationship between operation performance, firm-specific risk, and intellectual capital.

Table 2 Descriptive Statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
BS (thousand)	0.0000	600,347.3620	2,746.8420	14,373.5780
SIZE	1.6192	13.8362	7.9043	1.6831
ROA (%)	-80.4720	59.5900	4.5314	9.1817
SHARE	0.0060	56.9900	2.4816	4.9658
VOL	0.0375	4.6281	0.4524	0.4013
RISK	3.7700	3.9400	3.8553	0.0850
IC	0.0812	25.0104	2.0284	2.0534
CASH (thousand)	0.0000	43,511.5350	790.5140	980.8960

Note: *BS* and *CASH* are raw data which have not yet been taken the natural log.

Table 3 Pearson Correlation Analysis of Selected Variables

	SIZE	*RISK*	*IC*	*SHARE*	*ROA*	*VOL*	*CASH*	*BS*
SIZE	1.000							
RISK	0.202*** (<0.001)	1.000						
IC	0.149*** (<0.001)	0.112*** (<0.001)	1.000					
SHARE	-0.026 (0.132)	-0.011 (0.316)	0.009 (0.350)	1.000				
ROA	0.307*** (<0.001)	0.143*** (<0.001)	0.076*** (0.001)	0.116*** (<0.001)	1.000			
VOL	-0.029 (0.107)	0.153*** (<0.001)	-0.013 (0.287)	-0.097*** (<0.001)	-0.147*** (<0.001)	1.000		
CASH	0.001 (0.481)	0.010 (0.342)	0.003 (0.444)	0.021 (0.113)	-0.004 (0.440)	-0.269*** (<0.001)	1.000	
BS	0.128*** (<0.001)	0.311*** (<0.001)	0.079*** (<0.001)	-0.079*** (<0.001)	0.048** (0.020)	0.221*** (<0.001)	-0.023 (0.163)	1.000

Note: *, **, *** Denote Significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Regression Results

Stock option value, firm-specific risk, and intellectual capital

Table 4 shows the regression results of firm-specific risk and intellectual capital on the value of stock options estimated by the Black-Schole model. According to the

variance inflation factors, the regression does not have collinearity problems. The estimates on firm-specific risk (*RISK*) and intellectual capital (*IC*) are both significant and positive, indicating that the executive stock option value (*BS*, calculated from market stock price) is significantly and positively related to both firm-specific risk and intellectual capital.

Table 4 Regression Result: Stock option value, Firm-specific risk and Intellectual capital

$BS_{it} = a_0 + a_1 RISK_{it} + a_2 IC_{it} + a_3 ROA_{it} + a_4 SIZE_{it} + a_5 SHARE_{it} + a_6 VOL_{it} + e_{it}$

Variables	Coefficients	p-value	VIF
Constant	-5.773***	<0.001	
$RISK_{it}$	0.069***	<0.001	1.096
IC_{it}	0.037**	0.035	1.035
ROA_{it}	-0.004	0.880	1.179
$SIZE_{it}$	0.620***	<0.001	1.165
$SHARE_{it}$	-0.064***	0.005	1.029
VOL_{it}	7.500***	<0.001	1.066
	R^2	0.383	
Description	Adjusted R^2	0.147	
	F statistic	61.121	

1. *, **, *** Denote Significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
2. *BS* is deflated by total assets and *SIZE* is the logarithm of stock market value.

Firm performance and the time value of stock options

The empirical results show that the time values (*BST,* calculated from the market stock price) for the current period and a one-period lag are significantly and negatively related to the firm's operating performance for next year (ROA_{it+1}). The results are inconsistent with hypothesis H1, showing that the time values of stock option grants estimated with market stock prices have the expected negative effects on firm performance for the next year.[20] However, the time value of stock options in the current period and one-period lag are unrelated to the future operating performance of the year after the next. The evidence implies that the time value cannot induce the desired

[20] The results also imply that because at-the-money stock options have higher time value, they lead to the largest negative effect on future firm performance. Following the release of Statement No. 123 (R), granting firms recognize the fair value of option grants as compensation expenses; the policy of granting at-the-money stock options to employees can no longer avoid recognizing expenses.

inventive effects; the policy only increases compensation costs. With regard to control variables, firm size (*SIZE*) is significantly and positively related to future operating performance (ROA_{it+1}), suggesting that larger firms have better future operating performances. By contrast, cash compensation (*CASH*) is significantly and negatively related to future operating performance (ROA_{it+1}), showing that higher cash compensation for executives in the current period will induce a worse operating performance in the next year.

Table 5 Regression Result of Future Performance – BS model

$FuPerfor_{it+1} = b_0 + b_1BST_{it} + b_2BST_{it-1} + b_3BST_{it-2} + b_4BST_{it-3} + b_5SIZE_{it} + b_6CASH_{it} + e_i$

	ROA_{it+1}		ROA_{it+2}	
Variables	Coef.	p-value	Coef.	p-value
Constant	-2.8255	0.324	-3.5055	0.101
BST_{it}	-0.0014	0.092	-0.0001	0.837
BST_{it-1}	-0.0017	0.039	-0.0006	0.350
BST_{it-2}	-0.0004	0.558	-0.0006	0.302
BST_{it-3}	-0.0014	0.032	-0.0009	0.059
$SIZE_{it}$	1.4800	0.000	1.4471	0.000
$CASH_{it}$	-0.8070	0.000	-0.4452	0.000
R^2	0.2265		0.1701	
Adj. R^2	0.2219		0.1651	
F statistic	48.38		33.86	

Note: *CASH* is deflated by total assets and *SIZE* is the logarithm of stock market value. $FuPerfor_{t+1}$ is measured by ROA_{t+1}.

The relationships between firm performance and the time value of stock options considering firm-specific risk and intellectual capital

In Table 6, we show the effects of the time values of stock options on future performance in which the time values of stock option are estimated using our proposed valuation model. The calculation incorporates intellectual capital and firm-specific risk in the other information of Ohlson's (1995) model to estimate the stock price and then uses the Black-Sholes option pricing model to estimate the value of stock options. We also show the effects of the time values of stock option that are estimated by the original Ohlson model on future performance.

In the revised Ohlson model, the estimates on *NBST* for the periods of t and t-1, where the time values of option grants are calculated with estimated stock prices, are

significantly and positively related to future firm performance for the next year and the year after next. The results are consistent with H2, suggesting that that the time value of stock option grants estimated by considering firm-specific risk and intellectual capital has concurrent and deferred positive effects on future firm performance. The evidence has significant implications for the granting firms. They need to adopt an appropriate option

Table 6 Regression Result of Future Performance—ROA

$FuPerfor_{it+1} = b_0 + b_1NBST_{it} + b_2NBST_{it-1} + b_3NBST_{it-2} + b_4NBST_{it-3} + b_5SIZE_{it} + b_6CASH_{it} + e_i$

Variables	ROA_{it+1}		ROA_{it+2}		ROA_{it+3}	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Panel A: Revised Ohlson model						
Constants	1.8888	0.444	-0.1947	0.916	-2.2521	0.173
$NBST_{it}$	0.0586	0.012	0.0331	0.056	0.0199	0.201
$NBST_{it-1}$	0.0284	0.032	0.0261	0.022	-0.0275	0.152
$NBST_{it-2}$	-0.0241	0.399	0.0036	0.865	0.0238	0.213
$NBST_{it-3}$	0.0079	0.759	0.0018	0.925	-0.0085	0.621
$SIZE_{it}$	0.5849	0.074	0.8152	0.001	1.0205	0.000
$CASH_{it}$	-0.8275	0.000	-0.4596	0.000	-0.2823	0.000
R^2	0.2237		0.1681		0.1232	
Adjusted R^2	0.2190		0.1631		0.1179	
F-Statistic	47.59		33.37		23.21	
Panel B: Ohlson model						
Constants	-0.0801	0.974	-1.3863	0.449	-2.7778	0.091
$NBST_{it}$	0.0233	0.306	0.0163	0.337	0.0141	0.353
$NBST_{it-1}$	-0.0041	0.892	-0.0061	0.788	-0.0131	0.523
$NBST_{it-2}$	-0.0176	0.522	-0.0165	0.421	-0.0012	0.948
$NBST_{it-3}$	-0.0207	0.340	-0.0047	0.771	-0.0052	0.721
$SIZE_{it}$	1.0309	0.001	1.0922	0.000	1.1511	0.000
$CASH_{it}$	-0.8115	0.000	-0.4499	0.000	-0.2778	0.000
R^2	0.2203		0.1660		0.1206	
Adjusted R^2	0.2156		0.1610		0.1153	
F-Statistic	46.66		32.88		22.65	

Note: *CASH* is deflated by total assets and *SIZE* is the logarithm of stock market value. $FuPerfor_{t+1}$ is measured by ROA_{t+1}.

valuation model so that they can adequately estimate the incentive effects associated with option grants. As for control variables, firm size (*SIZE*) is significantly and positively related to future operating performance (*ROA*), but cash compensation (*CASH*) is significantly and negatively related to the future performance of a firm (*ROA*).

However, we do not find that the time values of stock option grants for the periods of t and t-1, which are calculated with estimated stock prices from the original Ohlson model, are significantly and positively related to the firm's operating performance for the next year and the year after next.

V. Conclusions

As firms grant stock options to their employees as incentive compensation, they should recognize compensation expenses based on the fair value for share-based payments. Hence, granting firms need to know how to estimate the fair value of their option grants so that they can appropriately evaluate the incentive effects of such grants.

The empirical results show that the value of executive stock options, which are calculated from market stock prices, is significantly and positively related to firm-specific risk and intellectual capital. We further incorporate these two variables in Ohlson's (1995) model to estimate stock prices and use the Black-Scholes model to estimate the value of stock option grants by either plugging in the market stock price or estimated stock price based on the revised Ohlson model. The incentive effects of the time value of option grants are thus examined under the two above valuation methods. We conclude that the time value of stock option grants induces a negative incentive effect on future firm performance when the time value is estimated with the market stock price. By contrast, when the option grants are valued with estimated stock prices based on the revised Ohlson model, the time value of option grants has a positive effect on future firm performance.

Our evidence has significant implications for granting firms. First, firms need to change their practice of granting at-the-money options because this type of option induces the largest negative effects on future firm performance when valued with market stock prices. Secondly, it is important for granting firms to incorporate intellectual capital and firm-specific risk in estimating firms' stock prices and the value of option grants. This valuation method leads to a positive incentive effect associated with the option grants.

Tobin's Q is the market value of equity and preferred stocks plus the book value of liabilities divided by the book value of total assets. Future research can adopt Tobin's Q to measure the future operating performance of a firm. Lo and Lys (2000) find that most

studies apply a residual income valuation model without the information dynamics that are the key feature of the Feltham and Ohlson framework. Our paper does not include the information dynamics in the extended Ohlson (1995) model, which may lead to the model being implemented incorrectly. Future research can consider the information dynamics. Moreover, we can adopt other pricing models, e.g., Merton's jump-diffusion model (Merton, 1976) and Cox, Ross, and Rubinstein's binomial options pricing model (Cox, Ross, and Rubinstein, 1979), to estimate stock prices and further estimate the value of stock option.

This paper use the gap between market value and book value, that is, the market-to-book ratio, as a proxy for intellectual capital, but it is a biased estimator. In recent years, a series of empirical studies have been performed using ante Pulic's Value added intellectual coefficient (VAIC), which can be calculated from balance sheet data, as a proxy for intellectual capital. Pulic (2000) proposed the value added intellectual coefficient as an indirect measure of efficiency of value added by corporate intellectual capital. The VAIC approach provides information about the efficiency of the tangible and intangible assets that can be used to generate value for a firm (Pulic, 2000). Financial capital (monetary and physical), human capital, and structural capital have been recognized as the major components of VAIC. Hence, future research can incorporate more detailed data on intellectual capital, such as human capital, customer capital, innovation capital, and procedure capital, to more precisely estimate intellectual capital.

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