How firm size, firm liquidity and recognition policy affect the pricing effect of employee stock options-An application of self-selection model controlling for endogeneity

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This version: Aug. 20, 2013

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Abstract

We examine whether and how firm characteristics, including firm size and liquidity, affect the relation between the employee stock option (ESO) grants (as proxied by the disclosed ESO expenses) and firm value. We also investigate how the implementation of a new share-based compensation recognition rule affects the pricing effect of ESOs. Prior studies have provided mixed results concerning how ESOs affect firm value. We argue that their findings could be attributable to self-selection and a non-uniform ESO-share price relation. We use the threshold model to address our research questions after controlling for self-selection bias. We find that markets tend to positively price ESOs in the case of firms of large size and with low liquidity. In addition, we find that after the new rule came into effect, ESOs became positively associated with firm value. These results are congruent with the ownership and symbolic value theories, the lifecycle stages hypothesis and the contention that the ESO expensing policy enhances the quality of financial statements.

JEL classification: J33; M41; C24

Keywords: Employee stock option; Threshold model; Self-selection model

Data Availability: From the sources identified in this paper

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1. Introduction

The purpose of this study is to examine under what circumstances employee stock options (ESOs) are granted in an efficient manner, thereby motivating executives or employees to act in the best interests of shareholders and thus enhancing firm value. By an efficient option plan we mean that a contemporaneous significant positive association between an ESO value and share prices (i.e., a positive pricing effect of ESOs) can be established.

Option plans can take many forms and the way options are granted has an enormous effect on a firm's efforts to achieve its goals (Hall 2010). Further, option granting has been considered an important decision related to financing and operating transactions (Li 2002). As such, decisions of this kind generally are not made randomly but rather are made deliberately by firms. Namely, managers self-select their preferred choices (Li and Prabhala 2006). We argue that the self-selection effect needs to be controlled for when examining the option grants-firm value relation. Moreover, not every firm chooses to adopt option plans to incentivize their executives and employees. We note that a large proportion of the ESO value in the dataset is made up of zero-valued observations. Therefore, we also need to take into account the censored data issue when assessing the pricing effect of

ESOs. Notably, none of the prior studies have considered these two issues simultaneously, and thus, their inferences could be misleading. More importantly, a failure to control for both self-selection bias and endogeneity could account for the inconsistent results documented in the prior studies.[1]

We focus our investigate of the pricing effect of ESOs on two aspects of firm characteristics, firm size and firm liquidity, and examine whether a cut-off point exists beyond which the pricing effect of an ESO changes significantly. Additionally, we also examine how the recognition rule of ESO expense affect the pricing effect of an ESO after controlling for both self-selection and endogeneity effects.[2]

Prior studies have examined how firm size affect the relation between incentive pay and firm value but no consensus has been reached. For example, psychology theory suggested that the use of share-based pay can produce greater levels of employee-level output because granting equity pay may generate a

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[1] Because the more ESO firms grant to their executives and employees, the greater ESO expenses firms disclose in their footnotes to financial statements, we in this study use the disclosed ESO expenses as a proxy for the level of ESO grants. Some prior studies have shown that disclosed ESO expense is negatively related to stock price and therefore suggested that investors consider ESO expense an expense of the company (Chamberlain and Hsieh 1999; Li 2002; Aboody et al. 2004 and Balsam et al. 2006). Conversely, others have found a positive disclosed ESO expense-share price relation and thus noted that investors view disclosed option expense as an intangible asset of firms (Rees and Stott 2001; Bell et al. 2002).

[2] A related stream of study addresses the differential pricing effect of derivative financial instruments. For example, Ahmed et al. (2006) documented how valuation effect of derivative financial instruments differs between whether their fair value is recognized or disclosed. In addition, other studies documented that the level of disclosure transparency regarding their compensation information could also affect firm value (e.g., Sheu et al. 2010).

"psychological ownership" effect, which can boost higher productivity in larger firms.[3] As such, the larger the firm size is, the greater psychological ownership effect an ESO creates. In addition, since in the U.S. stock options have long been granted only at the executive-level, rank-and-file employees may place a higher level of "symbolic value" to an ESO (Gerhart and Rynes 2003). This symbolic value may induce productivity-enhancing actions, such as increasing effort or information sharing, in particular in the case of firms having greater size.[4] Larger-sized firms in general have more rank-and-file employees as opposed to the executives and therefore ESO grants for larger firms may create greater symbolic value effect. Consequently, under the psychological ownership or symbolic value view, we expect ESO expense to be positively associated with share prices for larger firms.

Likewise, Baker and Hall (2004) found that CEO marginal products increase significantly with firm size. Their findings support Rosen's (1992) argument that CEOs of large firms have a "chain letter" effect on firm performance. This suggests that the incentive strength of CEOs for a given level of option grants increases with firm size. Further, Watts and Zimmerman (1978, 1990) suggest an accounting standard that decreases earnings lowers the political costs related to regulatory

[3] Pierce et al. (2001), Rousseau and Shperling (2003) and Sesil and Kroumova (2007).
[4] Shperling and Rousseau (2001) and Sesil and Kroumova (2007).

pressures.[5] Therefore, a lower *pro forma* earnings are expected to have larger decreases in political costs, particularly for larger-sized firms (Espahbodi et al. 2002; Subramaniam and Tsay 2012). Accordingly, this line of literature has suggested a positive pricing effect of ESOs for larger firms. Alternatively, broad-based stock options are group incentive plans, and such plans could generate the free rider problem,[6] which hurts employee incentive and thus weakens the pricing effect of ESOs. The larger the firm size, the more grave the free rider issue (Olson, 1965).

Taken together, although how firm size affects the direction of the net stock price reaction to disclosed ESO expense is virtually an empirical question, granting options to executives is a critical decision concerning operating and financial transactions and such decisions are made cautiously by firms. If the offsetting effect could adversely affect firm value, it is less likely for managers to self-select into such choices (Li and Prabhala 2006). Therefore, based on the findings of prior studies (e.g., Shperling and Rousseau 2001; Sesil and Kroumova 2007; Baker and Hall 2004; Rosen's 1992), we formulate the first hypothesis in the alternative form

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[5] Even though the option-based expense is disclosed in footnotes to the financial statements, the standard setters believe that the value of stock-based compensation is an expense that should be recognized in net income (FASB 1995). Congruent with this position, Standard & Poor's incorporates stock-based compensation expense into consideration when determining "core earnings," which it introduced as a benchmark number that represents ongoing operating earnings (Aboody et al. 2004). Consistently, Balsam et al. (2005) found that markets negatively price the cost associated with ESOs regardless of whether the option expense is only disclosed in the footnotes or is also recognized in the income statement.

[6] Weitzman and Kruse (1990), Zenger and Marshall (2000) and Sesil et al. (2003).

listed as follows: For large firms, there is a positive association between disclosed ESO expense and stock price.

To help form a testable prediction regarding how firm liquidity affects the pricing effect of an ESO, in this study we employ firm liquidity as a proxy for firm life cycle. Prior studies (e.g., Dickinson 2011) argued that cash flow captures differences in a firm's growth opportunity, profitability, and risk. Accordingly, cash flow pattern can better serve as a measure of firm life cycle stages. Specifically, firms in the introductory phase require the establishment of customer relationships and suffer from shortage of knowledge regarding potential revenue and cost, both leading to negative operating cash flow (Jovanovic 1982). In addition, growth-stage firms may make early investments that deter competitive peers from entering into the market (Jovanovic 1982; Spence 1977, 1979, 1981) and thereby cause negative cash flow from investing activities for introduction and growth firms. Consequently, firm in the introduction and growth stages are more likely to face a shortage of cash.[7]

Stock options may provide such firms with a way to economize cash (Yermack 1995). Because stock options represent non-cash compensation, startup and growth firms, starving for cash and relying heavily on ESO plans (Akresh and

[7] Jovanovic (1982), Spence (1977, 1979, 1981) and Dickinson (2011).

Fuersich, 1994; Yermack 1995; Kedia and Mozumdar 2002; Core and Guay 2001), and in particular, this is also true for those with more investment opportunities (Smith and Watts 1992; Gaver and Gaver 1993; Oyer and Schaefer 2005).[8]

Under the assumption that cash flow patterns can effectively capture firm life cycles, low liquidity firms are most likely undergoing the introduction and/or growth stages. Since option grants are more effective for these firms, (Rees and Stott 2001; Bell et al. 2002), they are very likely to self-select into such decisions. We therefore formulate our second hypothesis in alternative form shown as follows: There is a positive relation between disclosed ESO expense and share price for firms with lower level of liquidity.

Prior studies (e.g., Chamberlain and Hsieh 1999; Li 2002; Aboody et al 2004) used only disclosed ESO compensation data and have found a negative association between disclosed ESO expenses and stock prices. However, there are several reasons that markets may price the disclosed and recognized option expense differently.

First, the recognition of ESO cost decreases reported earnings and thus lessens political cost associated with regulatory pressure (Watts and Zimmerman

[8] Prior studies have found that disclosed ESO expense is a value-relevant measure and that the incentives derived from ESO plans provide value-increasing benefits to firms (Rees and Stott 2001; Bell et al. 2002). They have also indicated that this positive market valuation in ESOs is greater for firms having more investment opportunities (Rees and Stott 2001).

1978, 1990), causing share price to increase (Espahbodi et al. 2002). In addition, under the contracting perspective, share prices could also increase for firms with earnings-based compensation scheme, since recognition of option cost would weaken executive's ability to increase their compensation (Watts and Zimmerman 1986, Espahbodi et al. 2002). Moreover, the mandated recognition of option-based cost may improve the perceived quality of earnings and thereby cause a positive market reaction (Aboody et al. 2004; Subramaniam and Tsay 2012). Consistent with this position, Niu and Xu (2009) found that investors value an ESO expense differently prior to and after the enforcement of the equity-based compensation expense recognition rule. Specifically, they found *pro forma* stock-based expenses prior to the new regulation to be negatively associated with annual stock returns. By contrast, stock option expenses recognized have been found to be positively related to stock returns. Niu and Xu (2009) interpret the results as the mandatory expensing of ESOs may improve the perceived quality of financial statements. Consequently, the market may translate the incentive effect of ESOs into firm value.

Alternatively, contracting theory suggests that accounting reporting is an integral part of the contacts that define the firm (Watts and Zimmerman 1978, 1986, Armstrong et al. 2010). Recognition of ESO cost may reduce retained earnings. Thus, debt covenants based on retained earnings would have tightened, possibly increasing the firm cost of capital and leading to a decline in stock prices (Watts and Zimmerman 1978; Subramaniam and Tsay 2012; Espahbodi et al., 2002).

Since ESOs have offsetting effects on firm value, it is not surprising that the literature has not reached the consensus in this regard. Failure to control for self-selection effect could also account for the inconsistent findings. If granting options after the mandated recognition rule becomes enforced can only drive share prices to drop, it is very unlikely for firms to self-select into such decisions. Taken together, based on prior studies (Aboody et al. 2004; Niu and Xu 2009), we formulate the third hypothesis as follows: After the enforcement of the ESO expense recognition rule, the disclosed option expense is positively related to stock price.

To address our research questions, we adopt a threshold regression to endogenously determine whether a cut-off point exists beyond which the ESO expense-share price relation changes significantly. In addition, we use the self-selection model to control for unobservable private information that influences decisions to grant options (Li and Prabhala 2005).[9]

We use a sample composed of 701 hi-tech firms in Taiwan over a sample period from 2004 to 2009. We first find that, after controlling for both the

[9] Granting options to employees essentially combines two transactions: operating and financing (Li 2002). These corporate finance decisions are not usually made randomly, but are premeditated choices made by managers to self-select their preferred choices (Li and Prabhala 2005; Lennox et al. 2012). See Section 2 for detailed discussion.

self-selection bias and the censored data problem using a Tobit model, disclosed ESO expense is positively but insignificantly related to share price. This result suggests that disclosed ESO expenses are not significantly related to share price when only one regime is considered.

Second, we find a significant positive association between disclosed ESO expense and share price for larger-sized firms. This result indicates that ownership and/or symbolic value effect outweighs the free rider effect and thus is consistent with the first hypothesis. In addition, congruent with the second hypothesis, we find a significant positive relation between disclosed ESO expense and share price for firms with relatively low liquidity. Under the assumption that cash flow patterns can effectively capture firm lifecycle stages, this result provides additional evidence supporting the position that option grants are more effective for firms in the introduction or growth stages of their development. Further, we find a significant positive association between disclosed ESO expense and share price for the Post-2008 period. The result supports the third hypothesis and supports the idea that a mandatory ESO expensing policy can increase the perceived quality of financial statements and thus mitigate the perception that firms use ESOs opportunistically.

Third, when we use firm size and liquidity as the threshold variables, the results show that the regime switch does happen, as is evidenced by the maximum likelihood ratio (LR) test statistics. More importantly, the findings from the non-threshold model disguise the nonlinear association between disclosed ESO expense and share price. Similarly, we also find a structural change in the disclosed ESO expense-share price relation after the new accounting rule becomes effective. Further, the R-squared statistics suggest that the threshold model generally could better fit the data.

This study provides incremental contributions to the extant literature in several ways. Firstly, to the best of our knowledge, this is the first paper using Heckman's two-step estimator to examine the pricing effect of disclosed ESO expense before and after an ESO expense recognition rule implementation. Not every classification into two groups justifies the use of self-selection model (Maddala 1991). However, in this setting, we can make a case for the self-selection model because firms do have a choice of belonging to either one of the two groups (issuing or not issuing ESOs).[10] More importantly, we argue that, when using Heckman's two-step estimator controls for self-selection bias, we should employ a Tobit model to account for the censored data related to the disclosed ESO

[10] Self-selection bias arises when managers make decisions that are influenced by their own interests. Econometric analyses, such as ordinary least square, failing to account for the self-selection issue will lead to biased estimates and thus corresponding statistical inferences (Maddala 1991). To obtain consistent estimates of coefficients, Heckman developed a two-step estimation procedure (Heckman 1976; Heckman 1979), which has been widely applied to control for sample selection bias. See Section 3 for detailed discussion.

expenses.[11] Our results show that the Tobit model is empirically relevant and that it does change the main results.

Secondly, when assessing the pricing of the disclosed ESO expense, we need to address the issue of simultaneity, a positive mechanical relation between the disclosed ESO expenses and share prices (Aboody 1996; Bell et al. 2002; Aboody et al. 2004; Li and Wong 2005). Without controlling for the simultaneity problem, the inferences based on results from OLS analyses could be misleading (Li 2002; Aboody et al. 2004; Li and Wong 2005). Our estimation differs from the aforementioned prior studies in that previous researchers have utilized a standard two-stage least squares method (2SLS) to control for the endogeneity problem but have ignored the zero observation problem. However, since a large proportion of the disclosed ESO expense is censored at zero, it is inappropriate to directly employ a 2SLS to analyze the entire sample. To account for the censored data related to the disclosed ESO expense, we suggest using a Tobit model instead of OLS. Our results show that a 2SLS estimation procedure is sensitive to the censored data. More importantly, failing to control for the self-selection and simultaneity may help explain the differences in prior findings.

[11] Such censoring problem can make the population distribution severely skewed, resulting in estimation bias (Tobin 1958). In this paper, we employ a Tobit model to analyze the censored data for the purpose of obtaining a consistent estimate of the disclosed ESO expense. In addition, we adopt a sample selection model (Heckman 1976; Heckman 1979) to control for self-selection bias.

Thirdly, in this study we use a different but more flexible estimation method (i.e., the threshold regression model) to investigate the non-uniform relation between ESO and share price. To examine such nonlinear relations, previous researchers have employed researcher-constructed benchmarks to partition sample sets into several subgroups before conducting a traditional optimization technique to fit their datasets.[12] The major drawback of these approaches dwells in the subjectively determined sample partition procedures. We adopt the threshold regression approach, which allows the data themselves to determine whether there is a cut-off point (threshold). Consequently, this approach may largely mitigate the problem of exogenously determined sample partition criteria.

Fourthly, we apply the life cycle concept developed by Dickinson (2011) to help form our expectations regarding the market valuation of disclosed ESO expense. Our findings are consistent with our hypothesis formulated under the Dickinson (2011) framework and thus provide incremental evidence supporting the effectiveness of the use of cash flow patterns as a proxy for firm life cycle stages. In addition, prior studies have suggested that financial constraint is related to the use of ESOs. We extend this line of study by further assessing how the pricing effect of

[12] For example, Rees and Stott (2001) partitioned their data into growth and non-growth firms by the market value of equity. Further, Ittner, *et al.* (2003) used standard industry classification codes to separate their data into old and new economy firms. Additionally, Oyer and Schaefer (2005) grouped the data based on the number of employees.

ESO expense changes across different levels of firm liquidity, which may provide additional insight as to under what firm liquidity condition (as a proxy for firm life cycle stage) ESOs can be utilized most effectively.

The remainder of this paper proceeds as follows: Section 2 describes prior studies and hypotheses development. Section 3 presents the econometric models. Section 4 details the data obtained. Section 5 shows the empirical results. Lastly, Section 6 summarizes and concludes the study.

2. Prior studies and hypotheses development

2.1 Firm size and pricing of disclosed ESO expense

Incentive plans in Taiwan allow firms to distribute ESOs at both the executive and non-executive levels and thus are broad-based by nature.[13] Under the agency theory, broad-based stock options are group incentive plans designed to align interests between employees and shareholders.[14]

From a psychological perspective, prior researchers argue that the use of share-based pay could produce greater levels of employee-level output because

[13] According to the Financial Supervisory Committee (FSC) of Taiwan, an ESO plan applies to only full-time employees of the option-issuing firms. Directors and supervisors are generally not qualified for such incentive programs unless they are hired to perform managerial functions and thus meet the definition of “employee”.

[14] ESOs generate a positive impact on employee wealth only if the exercise-date share price exceeds that at grant date. This incentive pushes employees to participate in activities increasing the output of the firm and ultimately its market value. Consistent with this position, prior studies have argued that to the extent that the incentive benefits inherent in ESOs outweigh their dilutive effects on claims on firm resources, ESOs will provide value-increasing benefits to the firm and thereby correlate positively to stock price (e.g., Rees and Stott 2001; Bell et al. 2002; Niu and Xu 2009).

granting equity pay may generate a “psychological ownership” effect, encouraging employees to gain more knowledge about firm operations or motivating them to stay longer with the company.[15] Consequently, the larger the firm size is, the greater psychological ownership effect an ESO generates. Congruent with this concept, Sesil and Kroumova (2007) found that stock ownership can promote higher productivity in larger firms despite the free rider problem. Moreover, since in the U.S. stock options have long been granted only at the executive-level, rank-and-file employees may attach a higher level of “symbolic value” to an ESO (Gerhart and Rynes 2003). The concept of symbolic value may create a sense of affiliation, leading to productivity-enhancing actions, such as increasing effort or information sharing (Shperling and Rousseau 2001; Sesil and Kroumova 2007). Compared to small-sized firms, larger-sized firms in general have more rank-and-file employees as opposed to the executives, and thus ESO grants for larger firms may create greater symbolic value effect. As such, under the psychological ownership or symbolic value view, we expect to observe a positive association between ESO expense and share prices for larger firms.

[15] For example, Pierce et al. (2001) and Rousseau and Shperling (2003). According to Pierce et al. (2001), owning something (e.g., a business or a property) serves as a major motive to foster powerful emotions and encourage ownership behaviors such as increasing its value and protecting one’s property.

Consistent with arguments from the psychological perspective, Baker and Hall (2004) found that CEO marginal products increase significantly with firm size. Baker and Hall's finding confirms Rosen’s (1992) position that CEOs of large firms have a “chain letter” effect on firm performance. This implies that the incentive strength of CEOs provided by a given level of option grants increases with firm size. In addition, Watts and Zimmerman (1978, 1990) suggest an accounting standard that decreases earnings reduces the political costs associated with regulatory pressures. As such, a lower *pro forma* earnings are expected to have larger decreases in political costs, especially for larger-sized firms (Espahbodi et al. 2002; Subramaniam and Tsay 2012).

However, group performance-based pay systems have their disadvantages. One major issue is the free-rider problem (Weitzman and Kruse 1990; Zenger and Marshall 2000; Sesil et al. 2003). Under broad-based incentive plans, each individual employee stands to obtain his benefit if the stock price increases. However, a rational, self-interested employee is expected to make less than optimal levels of effort towards this firm-level goal since the costs of increased effort are assumed by the individual, whereas the rewards would be shared with his/her co-workers (Weitzman and Kruse 1990; Zenger and Marshall 2000). As such, agency theory suggests that the larger the firm size, the more grave the free rider issue (Olson, 1965), implying a weaker link between ESOs and firm value for larger firms.[16]

Taken together, although how firm size affects the direction of the net stock price reaction to disclosed ESO expense is an empirical issue, granting options to executives is a critical decision concerning operating and financial transactions and such decisions are made cautiously by firms. If the offsetting effect could adversely affect firm value, it is less likely for managers to self-select into such choices (Li and Prabhala 2006). Therefore, based on the findings of prior studies (e.g., Shperling and Rousseau 2001; Sesil and Kroumova 2007; Baker and Hall 2004; Rosen's 1992), we formulate the first hypothesis in the alternative form listed as follows:

Hypothesis1: For large firms, there is a positive association between disclosed ESO expense and stock price.

2.2 Firm liquidity and pricing of disclosed ESO expense

[16] Relatedly, prior studies have argued that a successful incentive plan needs not only to avoid free riding, but also must make a good "line of sight", i.e., a connection between employee actions and firm value (Brandes et al. 2003; Lawler and Jenkins 1992; Milkovich and Newman 2002). With broadly distributed ESOs, how employee effort is compensated depends not only on individual employee performance, but also on the firm-level performance and on the stock prices as well as on some other factors that are beyond the control of the employees. Though overall employee effort may enhance a firm's financial performance, it is hard to establish a direct link between individual effort and company-level performance (Bartol and Locke, 2000), creating a "line of sight" problem and therefore weaken the pricing effect of ESOs. This line of sight problem may be more severe in large-size firms, since they have more complex value chains, are more likely to compete in a multi-product market with a greater product line and have multiple organizational objectives when compared to small-size firms. Therefore, we also expect the ESO-share price relation to be less salient for large-sized firms.

In this study, we use firm liquidity as a proxy for firm life cycle. Dickinson (2011) suggested that cash flow captures differences in a firm's profitability, growth and risk and thus can better serve as a robust approach to measure firm life cycle stages.[17] Firms in the introductory phase require the establishment of customer relationships and suffer from shortage of knowledge regarding potential revenue and cost, both leading to negative operating cash flow (Jovanovic 1982). Further, managerial optimism drives growth-stage firms to make early investments that discourage rivals from entering into the market (Jovanovic 1982; Spence 1977, 1979, 1981) and thereby cause negative cash flow from investing activities for introduction and growth firms. Consequently, firm in the introduction and growth stages are more likely to face a shortage of cash or low liquidity.

Stock options may provide firms with a feasible way to conserve cash (Yermack 1995). Because stock options represent non-cash compensation, startup and growth firms, starving for cash and relying heavily on ESO plans (Akresh and Fuersich, 1994; Yermack 1995; Kedia and Mozumdar 2002; Core and Guay 2001), and in particular, this is also true for those with more investment opportunities (Smith and Watts 1992; Gaver and Gaver 1993; Oyer and Schaefer 2005).[18]

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[17] Specifically, Dickinson (2011) argued that in contrast to other alternative classification schemes of firm lifecycle stages, the cash flow pattern proxy is better aligned with the functional form of firm profitability, identifies differential behavior in the persistence and convergence patterns of profitability over time and possesses explanatory power for future profitability.

[18] Prior studies have found that disclosed ESO expense is a value-relevant measure and that the incentives derived from ESO plans provide value-increasing benefits to firms (Rees and Stott 2001;

If cash flow patterns can effectively capture firm life cycles, firms with lower levels of liquidity are most likely undergoing the introduction and/or growth stages. Since option grants are more effective for these firms, (Rees and Stott 2001; Bell et al. 2002), they are very likely to self-select into such decisions. We therefore formulate our second hypothesis in alternative form shown as follows:

> Hypothesis 2: There is a positive relation between disclosed ESO expense and share price for firms with lower level of liquidity.

2.3 Implementation of the ESO expense recognition policy and the pricing of disclosed ESO expense

Prior studies (e.g., Chamberlain and Hsieh 1999; Li 2002; Aboody et al 2004) have found a negative association between disclosed ESO expenses and stock prices. Notably, the above studies used only disclosed ESO compensation data. There are several reasons why markets may price the disclosed and recognized option expense differently.

First, the recognition of ESO cost lowers reported earnings and thus reduces political cost associated with regulatory pressure (Watts and Zimmerman 1978, 1990), leading to share price increases (Espahbodi et al. 2002). In addition, under the contracting perspective, share prices could also increase for firms with earnings-based compensation scheme, since recognition of option cost would

Bell et al. 2002). They have also indicated that this positive market valuation in ESOs is greater for firms having more investment opportunities (Rees and Stott 2001).

weaken executive's ability to increase their compensation (Watts and Zimmerman 1986, Espahbodi et al. 2002). Furthermore, the mandated recognition of option-based cost may improve the perceived quality of earnings and thereby cause a positive market reaction (Aboody et al. 2004; Subramaniam and Tsay 2012). Consistently, Niu and Xu (2009) found that investors value an ESO expense differently prior to and after the enforcement of the equity-based compensation expense recognition rule. Specifically, they found *pro forma* stock-based expenses prior to the new regulation to be negatively associated with annual stock returns. By contrast, stock option expenses recognized as a result of using the fair value approach have been found to be positively associated with stock returns.[19] Niu and Xu (2009) argued that the mandatory expensing of ESOs could increase the perceived quality of financial statements and thus mitigate the perception that firms use ESOs opportunistically. Consequently, the market may translate the incentive effect of ESOs into firm value.[20]

On the other hand, contracting theory suggests that accounting reporting is an integral part of the contacts that define the firm (Watts and Zimmerman 1978, 1986, Armstrong et al. 2010). Recognition of ESO cost may reduce retained

[19] Their sample is composed of Canadian public firms traded on the Toronto Stock Exchange (TSX). The fair value approach is similar to SFAS No. 123R and is specified in the Canadian Institute of Chartered Accounts Handbook section (CICA HB) 3870.

[20] Consistent with this view, Libby et al. (2006) find auditors require greater correction of misstatements in recognized than in disclosed accounting numbers. This finding suggests different perceived reliability between disclosed and recognized amounts.

earnings. Thus, debt covenants based on retained earnings would have tightened, possibly increasing the firm cost of capital and leading to a decline in stock prices (Watts and Zimmerman 1978; Subramaniam and Tsay 2012; Espahbodi et al., 2002).[21]

Since ESOs have competing impact on firm value, it is not surprising that the previous studies have provided mixed results in this regard. Another possible interpretation for the inconsistent findings is that prior studies fail to take into consideration self-selection issue on ESOs. Whether or not to grant stock options to executives and employees is an important decision related to financing and operating transactions (Li 2002), and such decisions in general are not made randomly but rather are made deliberately by firms. That is, managers self-select their preferred choices (Li and Prabhala 2006). If granting options after the mandated recognition rule becomes enforced can only cause share prices to drop, it is very unlikely that firms will self-select such decisions. Taken together, based on prior studies (Aboody et al. 2004; Niu and Xu 2009), we hypothesize that after the implementation of the new ESO expense recognition rule, markets positively value disclosed ESO expense. We formulate the third hypothesis as follows:

[21] Similarly, Viger et al. (2008) find that "loan officers estimated a higher risk rating and more pessimistic trend rating, were less inclined to grant the loan, and charged a higher risk premium when the stock option expense was recognized in the income statement." This also suggests recognition of ESO expense could negatively affect firm value.

Hypothesis 3: After the enforcement of the ESO expense recognition rule, the disclosed option expense is positively related to stock price.

3. Econometric model

3.1 Sample selection model

We use a sample selection model to account for self-selection bias and to test the pricing of disclosed ESO compensation expense. Following Ohlson (1995, 2001), Li (2002) and Landsman et al. (2006), we first specify an ESO valuation model listed as follows:

$$\begin{aligned} SP_{i,t} = {} & \beta_0 + \beta_1 BVE_{i,t} + \beta_2 RI1_{i,t} + \beta_3 RI2_{i,t} \\ & + \beta_4 ESOEXP_{i,t} \\ & + \beta_5 FVO_{i,t} \\ & + \textstyle\sum(Y{=}2005 \text{ to } 2009)\ \lambda_Y YEAR_{Y,i,t} \\ & + \textstyle\sum(I{=}25 \text{ to } 31)\ \delta_I IND_{I,i,t} \\ & + \varepsilon_{i,t.} \end{aligned} \quad (1)$$

SP is the per share market value of common stock outstanding at the fiscal year-end. *BVE* is the book value of shareholder equity divided by the number of common shares outstanding at the fiscal year-end. *RI1* is the residual income for year t+1, measured as net income minus the beginning balance of book value of equity times the risk-free interest rate (2%). *RI2* is *RI1* times one plus the earnings growth rate, measured as the annual growth rate of operating income. *ESOEXP* is the disclosed ESO expense per share, measured as reported net income minus *pro forma* net income scaled by the number of common shares outstanding. *FVO* is the

Black and Schole (BS) value outstanding per share at the fiscal year-end.[22] *YEAR* is a dummy, which equals one if *YEAR* equals year, and zero otherwise. *IND* is another dummy, equal to one if *IND* equals the Taiwan Security Exchange (TSE) industry classification code, and zero otherwise. Finally, *i* and *t* index for firms and years, respectively.

Since *ESOEXP* and *FVO* contain many observations of zero value, we employ a Tobit model to account for the censored data problem (Tobin 1958).[23] Moreover, option-pricing theory suggests Equation (1) has endogeneity problems because the *ESO* value increases with the price of underlying stock.[24] In addition, the decision of granting stock options to employees is not usually random. Therefore, we also need to address the self-selection issue. In the paper, we modify Heckman's

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[22] To estimate FVO, we first need to estimate the expected option-pricing model input assumptions. We use the weighted average remaining option life as the expected option life. Next, share return volatility is calculated based on the annualized standard deviation of monthly stock returns over the past 60 months. If the historical stock returns are shorter than 60 months, we use the available data instead. The risk-free interest rate is the weighted average yield on treasury bonds with a term equal to the weighted average remaining option life. In addition, we use the average dividend yield over the last two years as the expected dividend yield. We set share price equal to the sample mean price for each year and use the weighted average striking price as the exercise price. Finally, we plug in the BS formula the above input assumptions to estimate the fair value per option outstanding at year-end. In the case that firms have ESOs outstanding at the year-end but fail to disclose complete information on input assumptions, we adopt the following estimation procedures to approximate individual firm per option value outstanding at year-end. First, for each year we calculate the sample average per option value outstanding at year-end for firms in each of the eight industry sectors. This estimation procedure is necessary because we would otherwise lose about half of the data, thus weakening the test power. In addition, this approximation procedure is sensible because the missing data are measured based on the peer-firm per option value within the same year. Moreover, firms generally do not disclose the number of options outstanding if the option number at the year-end is zero. We thus assume that no options are outstanding at year-end if such information is missing.

[23] Tobit models have been widely applied in economic and financial studies that involve a censored data problem (Amemiya 1985).

[24] Aboody (1996), Bell et al. (2002), Aboody et al. (2004) and Li and Wong (2005).

two-step estimator by using a three-stage least square (3SLS) method to address the simultaneity issue, the censored data problem and sample selection bias.[25]

In the first stage, we use Equation (2) and (3) to model firms' decision to grant options, as shown below.

$$\begin{aligned} ESOEXP^*_{i,t} = {} & \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} \\ & + \beta_4\, RD_{i,t} \\ & + \beta_5\, MGROWN_{i,t} \\ & + \beta_6\, NOISE_{i,t} \\ & + \beta_7\, LEV_{i,t} \\ & + \beta_8\, LIQU_{i,t} \\ & + \textstyle\sum(Y=2005 \text{ to } 2009)\ \theta_Y YEAR_{Y,i,t} \\ & + \textstyle\sum(I=25 \text{ to } 31)\ \varphi_I IND_{I,i,t} + u_{i,t} \qquad (2) \end{aligned}$$

$$ESOEXP_{i,t} = \begin{cases} ESOEXP^* & \text{if } ESOEXP^*_{i,t} > 0 \\ 0 & \text{if } ESOEXP^*_{i,t} \leq 0. \end{cases} \qquad (3)$$

In Equation (2), *ESOEXP** is a latent variable with an observed counterpart disclosed ESO expense (*ESOEXP*), where *ESOEXP** is only observed if *ESOEXP** > 0, otherwise *ESOEXP* = 0.

Analogously, Equation (4) shows the decision model for *FVO** and the relation between *FVO* and *FVO**, which is expressed in Equation (5). We list Equations (4) and (5) as follows:

25 Given the assumption of a bivariate normal distribution, Heckman (1976, 1979) proposed a two-step procedure to control for self-selection by adding an inverse Mills' ratio (IMR) adjusting for self-selection bias as an independent variable and then estimated β consistently. Renders et al. (2010) proposed a three-stage estimation procedure (3SLS) to control for sample selection bias and simultaneity. In their second stage, they suggested using an endogenous variable that is regressed on the instrumental variables. A standard 2SLS for Heckman's two-step procedure such as Renders et al. (2010) may not be appropriate due to the censored data problem.

$$
\begin{aligned}
FVO^*_{i,t} = {} & \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} \\
& + \beta_4\, RD_{i,t} \\
& + \beta_5\, MGROWN_{i,t} \\
& + \beta_6\, NOISE_{i,t} \\
& + \beta_7\, LEV_{i,t} \\
& + \beta_8\, LIQU_{i,t} \\
& + \textstyle\sum(Y{=}2005 \text{ to } 2009)\ \theta_Y YEAR_{Y,i,t} \\
& + \textstyle\sum(I{=}25 \text{ to } 31)\ \varphi_I IND_{I,i,t} + u_{i,t}
\end{aligned}
\tag{4}
$$

$$
FVO_{i,t} = \begin{cases} FVO^* & \text{if } FVO^*_{i,t} > 0 \\ 0 & \text{if } FVO^*_{i,t} \leq 0. \end{cases}
\tag{5}
$$

BVE, *RI1* and *RI2* are as defined in Equation (1). In addition, prior studies have suggested that firms with greater investment opportunities are more likely to rely on incentive compensation (Smith and Watts 1992; Bryan et al. 2000). We therefore incorporate R&D expense as a percentage of total sales (RD) into our regression. Further, previous studies have suggested that when managers hold a greater fraction of ownership, the need for the design of a share-based incentive plan decreases (Jensen and Meckling 1976; Yermack 1995). As such, we add to the regression the manager ownership (MGROWN). Moreover, prior researchers (e.g., Lambert and Larcker 1987; Yermack 1995) have suggested that firms with higher noisiness of accounting returns relative to share returns depend more heavily on share-based incentives. Thus, we include the ratio of variance of return of asset calculated over the sample period to that of stock annual return measured over the same period (NOISE). Furthermore, John and John (1993) argued that as firm leverage increases, equity holders can reduce the cost of debt by decreasing pay-performance sensitivity, implying a negative association between the intensity of incentives and leverage. We thus incorporate into our model the leverage variable (LEV) measured as total liabilities divided by total assets. Finally, several studies (e.g., Yermack 1995; Bryan et al. 2000) have found that stock option awards are positively associated with firm financial constraints. Accordingly, we also include a firm liquidity constraint variable (LIQU) in our regression, which is defined as the cash flow from operating activities minus cash outflow for investing activities and then divided by the total assets (Dechow at al. 1996; Bryan et al. 2000).[26] We then obtain the fitted values of *ESOEXP* and *FVO*, i.e., *ESOEXP_hat* and *FVO_hat*, from estimating the coefficients in Equations (2) and (4) (the maximum likelihood estimators) by using the Tobit model.

In the second stage, following Heckman's two-step procedure, we estimate the coefficients of Equation (2) by using the Probit model to obtain consistent estimates of the inverse Mills' ratio (IMR), called the *IMR_hat.*

In the third stage, we substitute the *ESOEXP_hat* and *FVO_hat* obtained from the first stage for *ESOEXP* and *FVO* in Equation (1) and add the *IMR_hat*

[26] The error terms in Equations (1) and (2) ($\varepsilon_{i,t}$ and $u_{i,t}$) are a bivariate normal distribution with the correlation coefficient ρ. All the independent variables listed in Equations (1) and (2) are public information, while the error terms, u and ε, are private information. Investors only observe public information rather than private information.

estimated from the second stage to Equation (1). As the second stage of Heckman's two-step procedure, we use observations in which *ESOEXP** > 0 and run regression (6) shown as follows:

$$
\begin{aligned}
SP_{i,t} = {} & \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} \\
& + \beta_3\, ESOEXP\_hat_{i,t} \\
& + \beta_4\, FVO\_hat_{i,t} \\
& + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \lambda_Y YEAR_{Y,i,t} \\
& + \textstyle\sum(I{=}25 \text{ to } 31)\, \delta_I IND_{I,i,t} \\
& + \rho\sigma IMR\_hat_{i,t} \\
& + \xi_{i,t}. \qquad (6)
\end{aligned}
$$

Where ρ is the correlation between $\varepsilon_{i,t}$ and $u_{i,t}$; σ is the standard deviation of $\varepsilon_{i,t}$. White's (1980) robust variance estimates are employed to adjust for the standard error of the estimates because $\xi_{i,t}$ is a heteroskedastic error.

3.2 Sample selection model with a threshold variable and two regimes

The reasons we use the threshold model to address our research questions are two-fold. First, to assess the non-linear pricing effect of an ESO, prior studies have adopted arbitrary, researcher-determined benchmarks to group the data set into several subsets before conducting a traditional optimization technique to fit the data. One main concern with these approaches lies in the problematic sample partition procedure. To deal with this issue, we introduce a two-regime threshold regression model where the regime in this study is determined by one threshold variable, either firm size or firm liquidity. The benefit of using the regime-switching framework is to permit data themselves to locate the critical points, thereby effectively resolving the issue caused by exogenously imposed sample splitting criteria.

Furthermore, the threshold approach allows researchers to use the LR statistics and the incremental R-square to test the effectiveness of model. The test results show that the threshold model can better fit the data relative to the non-threshold model.

Following Hansen (1999), we use the threshold model with one threshold variable to account for the nonlinear relation between the disclosed ESO compensation expense and share price listed as follows:

For $q_{i,t} \leq \gamma$,

$$\begin{aligned} SP_{i,t} = {} & \beta_{10} + \beta_{11}\, BVE_{i,t} + \beta_{12}\, RI1_{i,t} + \beta_{13}\, RI2_{i,t} \\ & + \beta_{14}\, ESOEXP_{i,t} \\ & + \beta_{15}\, FVO_{i,t} \\ & + \textstyle\sum(Y{=}2005 \text{ to } 2009)\ \lambda_{1Y} YEAR_{Y,i,t} \\ & + \textstyle\sum(I{=}25 \text{ to } 31)\ \delta_{1I} IND_{I,i,t} \\ & + \varepsilon_{i,t} \end{aligned} \tag{7}$$

and for $q_{i,t} > \gamma$,

$$\begin{aligned} SP_{i,t} = {} & \beta_{20} + \beta_{21}\, BVE_{i,t} + \beta_{22}\, RI1_{i,t} + \beta_{23}\, RI2_{i,t} \\ & + \beta_{24}\, ESOEXP_{i,t} \\ & + \beta_{25}\, FVO_{i,t} \\ & + \textstyle\sum(Y{=}2005 \text{ to } 2009)\ \lambda_{2Y} YEAR_{Y,i,t} \\ & + \textstyle\sum(I{=}25 \text{ to } 31)\ \delta_{2I} IND_{I,i,t} \\ & + \varepsilon_{i,t.} \end{aligned} \tag{8}$$

where $q_{i,t}$ is defined as a threshold variable and γ is the threshold parameter. Equation (7) represents the setting of regime I for $q_{i,t} \leq \gamma$, while Equation (8) stands for that of regime II for $q_{i,t} > \gamma$. We choose $q_{i,t}$ as firm size and liquidity.[27]

To control for the simultaneity issue, censored data problem and self-selection bias, we list the estimation model of Equations (9) and (10) as follows:

For $q_{i,t} \leq \gamma$,

$$\begin{aligned} SP_{i,t} = {} & \beta_{10} + \beta_{11}\, BVE_{i,t} + \beta_{12}\, RI1_{i,t} + \beta_{13}\, RI2_{i,t} \\ & + \beta_{14}\, ESOEXP\_hat_{i,t} \\ & + \beta_{15}\, FVO\_hat_{i,t} \\ & + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \lambda_{1Y} YEAR_{Y,i,t} \\ & + \textstyle\sum(I{=}25 \text{ to } 31)\, \delta_{1I} IND_{I,i,t} \\ & + \rho_1 \sigma IMR\_hat_{\,i,t} \\ & + \xi_{i,t} \end{aligned} \tag{9}$$

and for $q_{i,t} > \gamma$,

$$\begin{aligned} SP_{i,t} = {} & \beta_{20} + \beta_{21}\, BVE_{i,t} + \beta_{22}\, RI1_{i,t} + \beta_{23}\, RI2_{i,t} \\ & + \beta_{24}\, ESOEXP\_hat_{i,t} \\ & + \beta_{25}\, FVO\_hat_{i,t} \\ & + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \lambda_{2Y} YEAR_{Y,i,t} \\ & + \textstyle\sum(I{=}25 \text{ to } 31)\, \delta_{2I} IND_{I,i,t} \\ & + \rho_2 \sigma IMR\_hat_{\,i,t} \\ & + \xi_{i,t} \end{aligned} \tag{10}$$

To test whether the threshold effect is statistically significant, we can conduct a likelihood ratio (LR) test to test the null hypothesis that all of coefficients in Equation (9) are equal to those in Equation (10). As such, the test results can

[27] Following prior studies (e.g., Kasznik and McNichols 2002; Bowen 1981; Beaver, Griffin, and Landsman 1982), in this study, we use the book value of equity as a proxy for firm size.

show whether the ESO-share price relation significant changes contingent upon the two threshold variables.

4. Data and sample

4.1 Data selection criteria

The sample includes all listed firms within the Taiwan Stock Exchange (TSE) industry classification codes (IC) from 24-31, the "high-tech" sector, over the period 2004-2009.[28] We collect financial and stock option-related data from the Taiwan Economic Journal (TEJ) database and the Market Observation Posting System (MOPS).

The reasons we use this dataset are twofold. First, the Accounting Research and Development Foundation (ARDF) of Taiwan in 2003 issued Interpretations No. 70, 71, 72 and 205, requiring all public firms to use the *fair value* method or the *intrinsic value* method to account for their ESOs. Almost all hi-tech companies in Taiwan choose to use the intrinsic value approach, under which firms need to disclose what net incomes would have been if they had adopted the fair value method, i.e., the *pro forma* earnings information. In 2008, the ARDF of Taiwan issued a new accounting rule, Statement of Financial Accounting Standard No. 39 (SFAS No. 39), *Accounting for Stock-Based Compensation*, which mandated all public firms in Taiwan adopt the *fair value method* for options granted on or after January 1, 2008. This setting provides researchers a unique opportunity to investigate how the implementation of the mandated ESO expense recognition rule

[28] We focus our analysis mainly on high-tech firms in that the number of ESO-issuing firms in the non-electronic sector is on average 39 each year, representing only 3% of all listed firms for each sample year.

affects the valuation effect of disclosed ESO expense. According to No. 39, firms still need to disclose ESO expense for options granted prior to 2008, which makes it possible to detect differential pricing effects of ESOs , if any.

Second, the accounting rules for share-based compensation specified in the Interpretations and SFAS No. 39 of Taiwan are quite comparable to International Financial Reporting Standards (IFRS, No. 2, *Share-based payment*.) and the U.S. GAAPs (No. 123R, *Accounting for Stock-based Compensation*). Therefore, the setting allows us to compare our findings with those in prior results internationally.[29]

701 firms meet the data selection criteria, and the number of firm-year observations is 4,206. Further, from MOPS, we hand collect input assumptions of the option pricing model from the footnote disclosures to estimate the per option value outstanding at year-end. For those firms disclosing incomplete input assumptions, we use an approximated option value instead, as discussed in Section 3.

Next, if firms do not disclose *pro forma* earnings information, we then assume the disclosed ESO expense to be zero. Further, we exclude 357, 141 and 2 observations from the dataset due to missing equity market value of equity, book value of equity and explanatory variable data, respectively. The final sample

[29] The accounting standards for ESOs in Taiwan are similar to the U. S. Financial Accounting Standard Board (FASB) SFAS No. 123, *Accounting for Stock-based Compensation*, Accounting Principle Board (APB) Opinion No. 25, *Accounting for Stock Issued to Employees*, and International Financial Reporting Standard No. 2, *Share-based payment*.

consists of 3,706 firm-year observations representing 701 distinct firms, as represented in Panel A of Table 1. Panel B of Table 1 shows that more than 60% of the sample firms were collected from the sectors of Semiconductor (IC=24), Computer and Peripheral Equipment (IC=25), Optoelectronic (IC=26) and Electronic Parts and Components (IC=28).

[Insert Table 1 here]

4.2 Descriptive statistics

Table 2 shows that the mean closing price of common share (*SP*) is NT $35.20, which more than doubles the book value of equity per share. This confirms that Taiwanese high-tech firms demonstrate great growth potential. In addition, the mean *BVE* is NT$ 17.03, which implies that our sample set is comprised of mainly large-sized firms. Next, the mean value of *RI1* and *RI2* are NT$ 7.14 and NT$ 13.37, respectively. These statistics are congruent with the position that firms with price-to-book ratio greater than one are more likely to generate positive future residual income. Additionally, in contrast to *RI1*, *RI2* shows greater standard deviation, indicating that *RI2* is more uncertain than *RI1*. Next, the mean value of *ESOEXP* is NT$ 0.04, and the mean of BS value of option outstanding per share is NT$ 0.80, accounting for 5% of the book value of common equity.

[Insert Table 2 here]

Furthermore, RD is 4.98%, meaning that sample firms on average spend 5% of their sales revenues on R&D. In addition, MGROWN is 5.66%, indicating that top managers on average hold 6% of ownership. Next, NOISE is 0.02, which shows that the noisiness of accounting returns compared to stock returns is relatively small. The mean LEV is 0.37, suggesting that the debt-to-total asset ratio on average is 37%. Lastly, the mean *LIQU* is 0.03, meaning that the ratio of net operating cash inflows to total assets on average is about 3%.

5. Empirical Results

5.1. The pricing of disclosed ESO expense

Using all observations, we first run the regression of Equation (1) using OLS without controlling for self-selection bias and simultaneity and report the results in column (1) of Table 3. Column (1) shows that *BVE* and *RI1* are positively associated with stock prices as expected; however, *RI2* is negatively related to stock prices. Notably, we find significantly positive results for *ESOEXP* (estimated coefficient=24.22, t=10.37), which are consistent with Rees and Stott (2001) and Bell et al. (2002). We conjecture that these results could be attributable to self-selection bias, simultaneity or both.

To examine how the simultaneity issue affects the relation between *ESOEXP* and *SP*, we use 2SLS to re-run the regression.[30] As documented in column (2), the coefficient estimates on *BVE*, *RI1* and *RI2* show a similar pattern as those reported in column (1). By contrast, the estimated coefficient on *ESOEXP_hat* (coefficient estimate=-49.46; t=-0.60) becomes negatively related to *SP*. The result is consistent with Chamberlain and Hsieh (1999), Li (2002), Aboody et al. (2004) and Balsam et al. (2006). Though column (2) reports an insignificant negative result, this suggests that the positive *ESOEXP*-*SP* relation documented in column (1) is most likely driven by the simultaneity problem (Li 2002; Aboody et al. 2004; Kuo and Yu 2013). Lastly, *FVO_hat* is positively associated with *SP* but it is insignificant.

Next, we conduct a 2SLS regression using Heckman's two-step procedures and report the results in column (3).[31] Interestingly, after controlling for both the self-selection bias and censored data problem using a Tobit model, we find the estimated coefficient on *ESOEXP_hat* (coefficient estimate=188.06, t=1.15) becomes positive but insignificant. This result suggests that *ESOEXP* is not

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[30] Based on Hausman tests, we confirm the existence of endogeneity of the *ESOEXP* (t=-2.39) and *FVO* (*t*=-2.58). In addition, the instrument variables for 2SLS are all variables listed in Equation (2).

[31] The literature suggests that Heckman's two-step estimator is vulnerable to collinearity. To assess if our results are sensitive to the collinearity issue, we calculate the variance inflation factor (VIF). We find that VIFs in Table 3 do not exceed 10, indicating that the collinearity should not seriously affect our inferences. This result is consistent with the findings of Leung and Yu (1996), which suggest that the selection bias term (IMR) is not highly collinear with other independent variables if instrumental variables satisfy the exclusion restriction condition.

significantly related to *SP* when only one regime is considered.[32] We conjecture that this result could be driven by an asymmetric impact of firm characteristics on ESO-share price association. We test and discuss this conjecture later in this section.

[Insert Table 3 here]

Finally, we notice that the estimated coefficient on IMR is also insignificantly negative (coefficient estimate=-35.28, t=-1.48), implying that the unobserved errors in Equation (1) are negatively correlated with those in Equation (2) but insignificant. Again, the insignificant estimate on the coefficient of IMR could be attributed by the nonlinear relation between *ESOEXP* and *SP*. We next examine how firm size, liquidity and the enforcement of the new recognition rule affect such relations.

5.2 The effect of firm size on the pricing of disclosed ESO expense

Columns (1) and (2) of Table 4 report the results of Equations (9) and (10), in which we define the threshold variable as the firm size. To test our first hypothesis, we calculate and report the *LR* statistic (=822.52) in Table 4. The result shows that the null that no regime switches is rejected at the 1% significance level,

[32] Although we do not find significant results, the positive sign has some implications. First, this insignificantly positive result seems consistent with the position that outside investors may positively price the *ESOEXP* since managers may have ability to access to private information indicating firms may benefit from the issuance of ESOs, motivating them to self-select to grant ESOs to their employees. Second, this result could also be driven by a non-uniform relation between *ESOEXP* and *SP*. It is likely that the *ESOEXP*-*SP* relation changes conditional on other firm characteristics variables, for example firm size and liquidity. In addition, the implementation of recognition of *ESO* expense starting in 2008 could also affect such relation. As such, the insignificant positive result could be the net effect of the two competing forces of *ESOEXP* that act on *SP*. We further examine these issues in Section 5.2.

indicating that the *ESOEXP-SP* relation exhibits a significant threshold effect. Namely, a “regime switch” does happen in this case. We notice that the switch happens when the *BVE* is NY $29.86, which is much greater than its mean (NT $17.03). This finding suggests that the offsetting impact of firm size on the pricing of ESOs is significantly positive only for a group composed of fairly large sized companies, accounting for 10% of the observations.

More importantly, we find that *ESOEXP* is significantly and negatively related to *SP* at the 1% significance level when the book value of equity per share falls below NT $29.86. These results support the position that the psychological ownership or symbolic value effect outweigh the free rider effect when the firm size goes beyond the threshold level, consistent with our first hypothesis.

Moreover, in the case of Regime II (column (2)), we find that the coefficient estimate on *ESOEXP_hat*, 846.00 (t=3.54), is greater than that using the non-threshold model (i.e., column (3) in Table 3). This suggests that the use of a non-threshold model could mask the significantly positive pricing effect of ESO on firm value for large-sized firms and thereby could lead to incorrect inferences.

Finally, we find that threshold model has a greater R-squared value (0.52) than the non-threshold model (0.32). The percentage of the incremental R-squared value of the threshold model is 62.50%, suggesting that the threshold model can better fit the data.

5.3 The effect of firm liquidity on the pricing of disclosed ESO expense

Columns (3) and (4) of Table 4 document the results of Equations (9) and (10), where the threshold variable is defined as firm liquidity. Consistent with our second hypothesis, we find the *ESOEXP_hat* (coefficient estimate=439.73, t=2.97) to be significantly and positively related to *SP* when *LIQU* decreases to below the level of 0.08. We conjecture that option grants are most effective for firms in their start-up and growth stages. If the cash flow patterns can effectively map to the firm lifecycle stages, firms with lower level of liquidity are most likely experiencing introduction or growth periods. Our finding of a significant positive *ESOEXP_hat-SP* relation for low-*LIQU* firms corroborates this argument.

Notably, we also find that the coefficient estimate on IMR is significantly negative (coefficient estimate=-96.67, t=-2.56) in the low-*LIQU* case. The result suggests that the self-selection bias could have a significant impact on the relation between disclosed ESO expense and firm value, which needs to be controlled for before we examine the pricing effect of ESOs.

By contrast, we find the *ESOEXP_hat-SP* relation turns out to be negative when the *LIQU* rises above the threshold of 0.08. The *LR* statistic (=259.16) again suggests that no regime switch null is rejected at the 1% significance level, indicating that the *ESOEXP-hat-SP* relation exhibits a regime switch when *LIQU* moves across the threshold of 8%.

This result together with those in column (3) suggests that the adoption of a non-threshold model may understate (overstate) the pricing of *ESOEXP_hat* and that the references based on the non-threshold model could be misleading. Lastly, we also find that threshold model has a greater R-squared value (0.49). The percentage of the incremental R-squared value of the threshold model is 53.13%. Again, this result indicates that the threshold model can better fit the data.

5.4 The effect of the recognition rule on the pricing of disclosed ESO expense

To address our third research question, we run Equation (6) for the Pre-2008 and post-2008 periods separately and report the results in columns (5) and (6) of Table 4. We find that after the new recognition rule comes into effect, disclosed ESO expenses are significantly and positively related to firm value (coefficient estimate=446.04, t=3.00). This result is consistent with the notion that the mandatory expensing rule of share-based compensation can increase the perceived quality of financial statements and mitigate the perception that firms opportunistically grant their employees stock options. By contrast, we do not find a significant pricing effect for the Pre-2008 period.

In addition, we find the coefficient estimates on *IMR* are significant for both the Pre-2008 and Post-2008 periods. This suggests that the inference regarding the pricing effect of *ESOEXP_hat* without controlling for the self-selection issue could be problematic. Relatedly, this result also indicates that the non-threshold model may underestimate the positive *ESOEXP_hat-SP* relation for the Post-2008 period.

Lastly, we also calculate and report the *LR* statistic (=351.84) in Table 4. The result suggests that the null of no structure change is rejected at the 1% significance level, indicating that the *ESOEXP_hat-SP* relation exhibits a significant structural change after the new accounting rule becomes enforced.

6. Conclusions

The purpose of this study is to examine how the relation between ESO (as proxied by the disclosed ESO expense) and share price alters conditional upon firm size and the levels of financial constraints. In addition, we also assess how a newly announced ESO expense recognition rule affects the ESO-firm value association.

We adopt a threshold regression after controlling for self-selection bias. The sample is comprised of 701 hi-tech firms in Taiwan over a sample period from 2004 to 2009. We find a significant positive association between disclosed ESO expense and share price for large-sized and low liquidity firms. Further, we also find a significant positive ESO-share price relation for the Post-2008 period. These results are consistent with the psychological ownership and symbolic value theory, lifecycle stage hypothesis and the contention that the share-based compensation expensing policy improves the quality of financial statements.

This paper provides additional contributions to the existing literature in the following aspects: First, to our knowledge, this is the first paper employing Heckman's two-step technique to correct the self-selection bias when assessing the pricing of ESO before and after the enforcement of the new expensing policy. The results suggest that our approach is empirically important and that it does change the main results. Second, we show that a 2SLS estimation procedure is sensitive to censored data. More importantly, failing to control for self-selection and endogeneity could help reconcile the differences in the findings of prior studies. Third, we use a threshold regression methodology to endogenously determine whether there is a cut-off point (threshold), which effectively fixes the problem of subjectively determined sample partition criteria. Finally, the literature suggests that firm liquidity is an important determinant of ESOs. We extend this line of study by further examining how the pricing of ESOs changes across different levels of financial constraint. Our findings can provide practitioners useful insights regarding under what firm liquidity condition ESOs can be granted most effectively.

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Table 1
Data selection and sample firm distribution across Taiwan Stock Exchange (TSE) industry classifications

Panel A: Data selection

Number of firm-year observations for 701 high-tech companies in Taiwan during 2004-2009		4,206
Less:	Number of observations missing share prices data	357
	Number of observations missing book value of equity	141
	Number of observations missing value of explanatory variables	2
Number of observations of final dataset		3,706

Panel B: Distribution of sample firms across TSE industry classifications

		Sample firms	
Ind. classification code	Industry name	N	%
24	Semiconductor	117	16
25	Computer and Peripheral Equipment	102	15
26	Optoelectronic	95	14
27	Communications and Internet	66	9
28	Electronic Parts and Components	165	23
29	Electronic Products Distribution	48	7
30	Information Services	40	6
31	Other Electronics	68	10
	Total	701	100

Note: 3,706 firm-year observations represent 701 distinct firms. The Black-Schole (BS) inputs are collected from footnotes to annual reports. Financial data are obtained from TEJ data bank. In addition, the percentage of the number of observations for each year to total number of observations ranges from 15% to 19%, which indicates that the sample distributes evenly over the sample period

Table 2
Descriptive statistics of main variables (N=3,706)

Variable	Units	Mean	Std. dev.	Minimum	Maximum
SP	NT$	35.20	50.46	0.20	645.00
BVE	NT$	17.03	10.78	-1.97	308.70
RI1	NT$	7.14	15.14	-9.59	211.33
RI2	NT$	13.37	29.65	-15.64	399.55
ESOEXP	NT$	0.04	0.26	0.00	13.82
FVO	NT$	0.80	23.07	0.00	1404.20
RD	%	4.98	9.39	0.00	309.16
MGROWN	%	5.66	6.04	0.00	50.30
NOISE	%	1.90	6.50	0.02	100.30
LEV	%	36.70	17.10	1.80	114.50
LIQU	%	3.30	13.90	-84.70	156.40

Note: We collect financial share price data from TEJ data bank. The Black-Schole (BS) input assumptions are collected from footnotes to annual reports. *SP* is the market value of common stock outstanding as of fiscal year-end. *BVE* is the book value of common equity as of fiscal year-end. *RI1* is the residual income measured as net income, minus the beginning value of book value of equity times the risk-free interest rate (2%). *RI2* is *RI1* times one plus the earnings growth rate, measured as the annual growth rate of operating income. *ESO* is the disclosed ESO expense, measured as reported net income minus *pro forma* net income collected from the annual reports. *FVOPT* is the BS value of employee stock options outstanding at the fiscal year-end. First, we estimate per option value, using the sample mean of closing stock prices at annual report date in each year as the stock prices and the weighted average exercise prices as the striking prices. The risk-free interest rate is measured as the weighted average yield on treasury bonds with a term equal to the weighted average remaining option life. Next, we use the average dividend yield over the past two years as the expected dividend yield. Stock return volatility is measured as the annualized standard deviation of monthly stock return calculated back over the past 60 months. We use the weighted average remaining option life as a proxy for expected option life. Lastly, *FVOP* is obtained by timing the BS per option value by the number of options outstanding at fiscal year-end. If the above input assumptions are missing, for each year, we calculate the average per option value outstanding at year-end for firms in each of eight industry sectors. Then, the firm's estimated option value outstanding at year-end is obtained by multiplying the industry-year average per option value by the number of options outstanding at year-end. RD is the R&D expense divided by total sales and then times 100. MGROWN is manager ownership expressed as a percentage of total ownership. NOISE is measured by the variance of return of asset (calculated over the sample period) as a percentage of the variance of stock annual return (calculated over the sample period). LEV is the total liabilities divided by total assets and then times 100. LIQU is the cash flows from operating activities minus cash outflows for investing activities divided by the total assets and then times 100.

Table 3

Regressions of the closing price per share at year-end on book value of equity, expected residual income for year t+1, expected residual income for year t+2, disclosed ESO expense and estimated fair value of options outstanding at fiscal year-end (all independent variable are measured on the per share basis)

$$SP_{i,t} = \beta_0 + \beta_1 BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} + \beta_4\, ESOEXP_{i,t} + \beta_5\, FVO_{i,t} + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \lambda_Y YEAR_{Y,i,t} + \sum(I{=}25 \text{ to } 31)\, \delta_I IND_{I,i,t} + \varepsilon_{i,t} \quad (1)$$

$$ESOEXP^*_{i,t} = \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} + \beta_4\, RD_{i,t} + \beta_5\, MGROWN_{i,t} + \beta_6\, NOISE_{i,t} + \beta_7\, LEV_{i,t} + \beta_8\, LIQU_{i,t} + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \theta_Y YEAR_{Y,i,t} + \sum(I{=}25 \text{ to } 31)\, \varphi_I IND_{I,i,t} + u_{i,t} \quad (2)$$

$$ESOEXP_{i,t} = \begin{cases} ESOEXP^* & \text{if } ESOEXP^*_{i,t} > 0 \\ 0 & \text{if } ESOEXP^*_{i,t} \le 0. \end{cases} \quad (3)$$

$$FVO^*_{i,t} = \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} + \beta_4\, RD_{i,t} + \beta_5\, MGROWN_{i,t} + \beta_6\, NOISE_{i,t} + \beta_7\, LEV_{i,t} + \beta_8\, LIQU_{i,t} + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \theta_Y YEAR_{Y,i,t} + \sum(I{=}25 \text{ to } 31)\, \varphi_I IND_{I,i,t} + u_{i,t} \quad (4)$$

$$FVO_{i,t} = \begin{cases} FVO^* & \text{if } FVO^*_{i,t} > 0 \\ 0 & \text{if } FVO^*_{i,t} \le 0. \end{cases} \quad (5)$$

$$SP_{i,t} = \beta_0 + \beta_1\, BVE_{i,t} + \beta_2\, RI1_{i,t} + \beta_3\, RI2_{i,t} + \beta_3\, ESOEXP\_hat_{i,t} + \beta_4\, FVO\_hat_{i,t} + \textstyle\sum(Y{=}2005 \text{ to } 2009)\, \lambda_Y YEAR_{Y,i,t} + \sum(I{=}25 \text{ to } 31)\, \delta_I IND_{I,i,t} + \rho\sigma IMR\_hat_{i,t} + \xi_{i,t} \quad (6)$$

Indep. variables	Exp. sign	(1) Eq. (1) OLS	(2) Eq. (1) 2SLS	(3) Eq. (6) 2SLS-Tobit
Intercept	?	-10.87*** (2.22)	-17.91 (12.01)	115.62 (59.85)
BVE	+	2.95*** (0.06)	3.12*** (0.71)	0.75 (0.76)
RI1	+	0.92*** (0.12)	0.93** (0.38)	1.77*** (0.75)
RI2	+	-0.37*** (0.06)	-0.36 (0.25)	-0.11 (0.35)
ESOEXP	+/-	24.22*** (2.34)		
FVO	-	0.01 (0.03)		
ESOEXP_hat	+/-		-49.46 (82.36)	188.06 (163.37)
FVO_hat	-		3.32 (3.43)	-6.26 (3.87)
IMR	+/-			-35.28 (23.84)
Industry dummy		controlled	controlled	controlled
Year dummy		controlled	controlled	controlled
R-Squared		0.48	0.48	0.32
N		3,706	3,706	1,133

Note: *, **, and *** stand for statistically significant at 10%, 5%, and 1% levels, respectively, (two-tailed). Standard errors are reported in parentheses. For 2SLS, White's heteroskedasticity-robust standard errors are reported. *ESOEXP_hat* (*FVO_hat*) is the fitted value from Equation (2) (Equation (4)). IMR is the inverse Mills' ratio. All other variables are as defined Table 2. Results for industry dummies are omitted for brevity.

Table 4

Regressions of the closing price per share at year-end on book value of equity, expected residual income for year t+1, expected residual income for year t+2, disclosed ESO expense and estimated fair value of options outstanding at fiscal year-end
(all independent variable are measured on the per share basis)

For $q_{i,t} \leq \gamma$,

$$SP_{i,t} = \beta_{10} + \beta_{11}\,BVE_{i,t} + \beta_{12}\,RI1_{i,t} + \beta_{13}\,RI2_{i,t} + \beta_{14}\,ESOEXP\_hat_{i,t} + \beta_{15}\,FVO\_hat_{i,t} + \sum(Y{=}2005\text{ to }2009)\,\lambda_{1Y}YEAR_{Y,i,t} + \sum(I{=}25\text{ to }31)\,\delta_{1I}IND_{I,i,t} + \rho_1\sigma IMR\_hat_{i,t} + \xi_{i,t} \qquad (9)$$

For $q_{i,t} > \gamma$,

$$SP_{i,t} = \beta_{20} + \beta_{21}\,BVE_{i,t} + \beta_{22}\,RI1_{i,t} + \beta_{23}\,RI2_{i,t} + \beta_{24}\,ESOEXP\_hat_{i,t} + \beta_{25}\,FVO\_hat_{i,t} + \sum(Y{=}2005\text{ to }2009)\,\lambda_{2Y}YEAR_{Y,i,t} + \sum(I{=}25\text{ to }31)\,\delta_{2I}IND_{I,i,t} + \rho_2\sigma IMR\_hat_{i,t} + \xi_{i,t} \qquad (10)$$

Independent variables	Exp. sign	(1) Regime I BVE<29.86	(2) Regime II BVE>29.86	(3) Regime I LIQU<0.08	(4) Regime II LIQU>0.08	(5) Pre-2008	(6) Post-2008
Intercept	?	-17.54	53.12	223.24***	-22.69	-101.72***	120.22***
		(27.46)	(148.15)	(73.35)	(44.95)	(30.83)	(29.89)
BVE	+	2.36***	0.32	-0.48	3.15***	3.51***	-0.05
		(0.32)	(1.61)	(0.69)	(0.59)	(0.40)	(0.46)
RI1	+	0.87**	18.61***	2.20***	3.74***	1.55**	1.82**
		(0.35)	(3.43)	(0.80)	(0.97)	(0.70)	(1.06)
RI2	+	0.36***	-7.86***	0.39	0.14	0.35	0.01
		(0.13)	(1.46)	(0.33)	(0.20)	(0.26)	(0.40)
ESOEXP_hat	+/-	-145.39***	846.00***	439.73***	-412.98***	147.19	446.04***
		(51.72)	(239.10)	(147.92)	(104.83)	(100.42)	(148.52)
FVO_hat	-	3.16***	-18.87***	-9.48***	6.37***	15.20	-7.36***
		(1.11)	(6.97)	(3.17)	(1.82)	(9.36)	(2.25)
IMR	+/-	-5.46	95.92	-96.67***	-14.50	41.00***	-57.96**
		(14.78)	(96.75)	(37.79)	(26.42)	(17.78)	(26.13)

Industry dummy	controlled	controlled	controlled	controlled	controlled	controlled
Year dummy	controlled	controlled	controlled	controlled	controlled	controlled
R-squared	0.52		0.49		0.52	0.41
LR statistic	822.52***		259.16***		351.84***	
N	1,018 (90%)	115 (10%)	755 (67%)	378 (33%)	581 (51%)	552 (49%)

Note: *, **, and *** stand for statistically significant at 10%, 5%, and 1% levels, respectively, (two-tailed). Standard errors are reported in parentheses. For 2SLS, White's heteroskedasticity-robust standard errors are reported. IMR is the inverse Mills' ratio. $q_{i,t}$ in Equations (9) and (10) is defined as a threshold variable; γ is the threshold parameter. We choose $q_{i,t}$ as firm size and liquidity. All other variables are as defined in Table 2. Results for industry dummies are omitted for brevity. Under the null hypothesis, the LR statistic has a χ^2-distributution with 19 degree of freedom.