EVIDENCE THAT EXECUTIVE PRODUCTIVITY MATTERS WHEN DETERMINING OPTIMAL INCENTIVE LEVELS

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Abstract

We document evidence that (absolute) grant size and exercise price choices in determining optimal pay-performance sensitivity are moderated by executive productivity. Specifically, we find that larger grants are associated with lower productivity, but we also find that in-the-money (ITM) grants are associated higher executive productivity. Given that large-firm CEOs in our Australian data set are less productive than small-firm CEOs in our sample, we show empirically that ITM grants rather than larger grants are preferred to incentivize less-productive CEOs.

JEL Classification: G39, G34

I. Introduction

Despite its seminal significance, the Hall and Murphy (2000, 2002) (hereafter, HM) model of optimal stock option compensation for executives has yet to be tested empirically, particularly their recommendation that executive incentive is optimized by at-the-money (ATM) grants. Their model incorporates a positive relation between grant value and the exercise price in recognizing that risk-averse and poorly-diversified executives value options below their Black-Scholes value.[1] The HM model does not embrace executive effort. This has been addressed separately by Baker and Hall (2004) within a pay-

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[1] Meulbroek (2001) addresses the same issue in a utility framework.

performance sensitivity framework and extended by Palmon, Bar-Yosef, Chen and Venezia (2007) and Chance and Yang (2008) where executive effort is explicitly modelled and shareholders have access to a wider range of compensation devices.[2] The aim and contribution of the present paper is to test both the internal arguments and external application of HM as well as testing an extension to endogenize the marginal productivity of executive effort consistent with Baker and Hall (2004).[3]

In the HM model, shareholders incentivize risk-averse executives with a lower exercise price (in tandem with a smaller grant) as an executive's level of risk aversion increases, reinforced by declining diversification on private account. Pay-performance sensitivity is the dollar change in option value for a one percentage change in the underlying stock price. Since pay-performance sensitivity/exercise price tends invariant as the degree of risk aversion declines, HM prescribe ATM grants to optimize incentive. Even so, the HM model specifies scenarios in which in-the-money (ITM) and out-of-the-money (OTM) stock option grants remain optimal. For example, OTM grants are predicated for low levels of risk aversion and increasing private diversification, while ITM options are optimal for high levels of risk aversion reinforced by declining private diversification. The prescriptions of the HM model are subject to modification when CEO productivity is recognized because optimal pay-performance sensitivity is moderated as CEO productivity increases. Baker and Hall (2004) argue that optimal incentive is decreasing in risk aversion and stock volatility but increasing in executive productivity. In other words, more-productive CEOs require lower incentive per unit of marginal productivity.[4]

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[2] A related paper is Cadenillas, Cvitanic and Zapatero (2004) where the choice of optimal leverage with a stock grant is analogous to exercise price choice. Comprehensive principal-agent models (for example, Feltham and Wu, 2001; Lambert and Larcker, 2004) represent a separate strand of research relative to HM, as do earlier stock vs. stock option models (for example, Young and Quintero, 1995).

[3] We do not test the optimality of early exercise. HM demonstrate that the propensity for early exercise is higher for executives with higher risk aversion and lower private diversification. Chance and Yang (2008) propose an entirely different rationale: that early exercise is always optimal for executives who can influence the underlying stock price.

[4] Baker and Hall (2004) conjecture that large-firm CEOs are more productive than small-firm CEOs.

A successful test of the HM model requires that granting companies are free to vary grant size and the exercise price to deliver the targeted pay-performance sensitivity. Such flexibility is arguably lacking for U.S. companies, where mandated option expensing and tax considerations combine to favor ATM grants, and documented backdating distorts the exercise price because future stock price movements may be higher or lower than expected. [5] In contrast, in our Australian data set all three intervening factors are either absent or minimal for the sample period. For Australian option grants prior to 2000 variation in the exercise price was not costly in the sense that (i) Accounting Standards were yet to mandate the expensing either of the grant value or at least any grant discount (as for U.S. firms), and (ii) there were no immediate income tax consequences for the company or the recipient in granting non-ATM options. Only about one-third of our sampled grants to Australian CEOs are ATM grants, compared with the 94% observed for the U.S. by HM themselves. Finally, Australian option grants are comparatively free of backdating, so ATM grants do not mask an *ex post* discount.

Two key findings emerge. First, with respect to their internal arguments, HM receive empirical support only for the hypothesized inverse relation between risk aversion and the exercise price, but not for the hypothesized inverse relation between absolute grant size and risk aversion. Second, with respect to grant moneyness, we do not uncover any evidence of the hypothesized negative (positive) relation between the likelihood of an ATM (ITM) grant. By recognizing CEO productivity (as defined by Baker and Hall, 2004), we find the potential over-(under-) prescription of ATM (ITM) grants is partially corrected. Given in our sample that large-firm CEOs are less productive than their small-firm counterparts,

[5] Hall and Murphy (2002) report that 94 per cent of options granted to CEOs of S&P 500 companies in 1998 were granted at-the-money.

lower exercise prices rather than larger grants are found to incentivize large-firm CEOs more efficiently.[6]

The remainder of the paper is organized as follows. Tests of the HM are fashioned in the next Section. The data, sample and measures are described in Section III, which is followed by the analysis and conclusions in Sections IV and V, respectively.

II. Hypothesis development

HM model

HM recognize, as do Meulbroek (2001) and others, that risk-averse and poorly-diversified executives value their grants below the Black-Scholes value[7]. In the HM model, risk aversion is a major argument in establishing the relation between the key decision variables of the number of stock options granted per period and the exercise price. The degree of private diversification is subordinate to risk aversion. CEO productivity is assumed constant across risk aversion and private diversification. Assuming a fixed proportion of performance-based compensation, increasing CEO risk aversion calls for a lower exercise price but a smaller grant. The lower exercise price increases the option delta, which measures incentive. Hence, higher exercise prices imply larger grants. The number of options granted and the exercise price are therefore positively related.[8] In the limit, a highly risk-averse executive is most efficiently incentivized by a grant of restricted stock because options then have no incentive value. The impact of private diversification is opposite to risk aversion: diversification is increasing in grant size (as measured by the number of

[6] The opposite is expected for U.S. data, where small-firm CEOs are less productive than large-firm CEOs (Baker and Hall, 2004).

[7] An exception is Chance and Yang (2008), who argue that influential CEOs may actually value their option grants above the Black-Scholes value to the extent that CEOs negotiate an earlier vesting date to avoid the liquidity penalty inherent in the non-tradability of their options.

[8] This positive relation is common to most stock vs. option optimization models: see, for example Lambert and Larcker (2004).

granted options) and the exercise price, and hence decreasing in delta. The intuition is that an executive with low equity ownership (possibly implying a high degree of diversification on private account) values a larger grant more than an executive with high equity ownership. For a given grant size, a poorly-diversified executive requires a lower exercise price (and hence a higher delta) relative to a well-diversified executive to provide the same incentive. Thus, large grants with high exercise prices are predicated for less risk-averse and well-diversified executives, while small grants with low exercise prices are predicated for more risk-averse and poorly-diversified executives. These arguments imply the fully-embracing hypothesis:

> H1: Pay-performance sensitivity per unit of risk aversion is increasing in the exercise price/stock price and decreasing in private diversification.

Pay-performance sensitivity is defined as the product of the number of options granted (*n*) and the option delta, giving the change in grant value per $1 change in the stock price. Thus, in a Black-Scholes option valuation, pay-performance sensitivity is the number of options granted multiplied by the option delta. To reveal the internal roles of risk aversion and private diversification we also test

> H2: Risk aversion is decreasing in the number of options granted and exercise price/stock price.
>
> H3: Private diversification per unit of risk aversion is decreasing in the number of options granted and increasing in exercise price/stock price.

We proceed to form hypotheses relating to the explanatory power of the model. For low values of absolute risk aversion ($\rho \leq 2$) HM prescribe ATM grants because pay-performance sensitivity has shallow convexity across quite wide variations in grant moneyness (refer their Figure 5), conditional on options being an add-on to existing pay packages.[9] For example, when $\rho = 2$ ATM grants substitute closely for ITM grants with a discount up to 50% and OTM grants with a premium up to 100%.[10] In general, HM argue the likelihood of an ATM grant is decreasing in risk aversion while the likelihood of an ITM grant is increasing in risk aversion:

H4A: The likelihood of an ATM grant is decreasing in risk aversion.

H4B: The likelihood of an ITM grant is increasing in risk aversion.

OTM grants are not prescribed when $\rho > 2$, so any OTM grants observed at higher levels of risk aversion are increasingly sub-optimal:

H4C: For $\rho > 2$, OTM grants are expected to exhibit a negative abnormal return at grant.

III. Sample, data and measures

[9] When grants substitute for existing compensation, optimal incentive is delivered by grants of restricted stock.

[10] Assuming add-on grants in the Hall and Murphy model, increasing risk aversion and/or lower private diversification require higher incentive (delta) *via* a lower exercise price, for a given grant size. For example, for risk aversion of 3 and 50 per cent private investment in company stock a grant discount of approximately 35 per cent to market is implied. Alternatively, for a given grant size, decreasing risk aversion and/or higher private diversification require lower incentive (delta) *via* a higher exercise price. For example, for a risk aversion value of 2 and 50 per cent private investment in company stock a grant premium of approximately 20 per cent is implied.

Testing these models requires an institutional setting in which both grant size and exercise price are free to interact. We argue this is unlikely to be the case for U.S. grants. Three strands of evidence suggest the dominance of ATM grants is largely driven by institutional rigidities. Executive stock options in the U.S. are typically fixed and non-qualifying. Since 1972, APB 25 has required fixed options with an exercise price below the stock price at issue be expensed.[11] Further, expensing a non-qualifying stock option (e.g., at market value) at grant creates an immediate tax deduction for the company but also an immediate income tax liability for the holder. Moreover, ITM options are not deductible under the Internal Revenue Code if an executive's total non-performance-based compensation exceeds $1 million a year. The sum effect is to penalize ITM grants. To complicate matters, many U.S. option grants are back-dated, where the grant date is set retrospectively at the time of grant.[12] The notional grant date invariably precedes a stock price runup (known with hindsight), so back-dating can be an *ex post* means of delivering an ITM grants which has all the appearances of an ATM grant at the grant date. Taken together, these considerations suggest that in the U.S. grant moneyness is effectively not a decision variable or is at least subject to measurement error.

On the other hand, the Australian data for our sample period, 1987-2000, are virtually free of these problems. Prior to 2000 there was no accounting requirement to disclose or expense the value of option grants[13], taxation was levied at the time of exercise on the difference between the stock price and the exercise price, and back-dating was all but eliminated by the ASX requirement to lodge notice of any change in directors' interests

[11] A fixed option is one in which the exercise price and the grant size are fixed at the time of the award, while in a variable option either or both can vary. Variable options are always expensed. Since 1995 SFAS 123 has required disclosure (but not recognition) of compensation expense (i.e., option values) relating to most fixed options in the year of grant. A good discussion of the accounting and tax issues is provided by Chance (2008).

[12] For an extended discussion of back-dating see, for example, Lie (2005) and Narayanan and Seyhun (2006).

[13] In Australia, the expensing debate was unresolved until July, 2004 when AASB 2 became effective. Prior accounting debate in Australia can be traced back to the release of the International Accounting Standards Board (IASB) in mid-2002, which stated that all share-based payments should be recognized in the financial statements of issuing companies. A summary of the Australian debate on accounting for executive stock options may be found in the March, 2002 issue of the *Australian Accounting Review*.

within 14 days of the event. Thus, if backdating exists the window of opportunity is so short to all but eliminate the problem. Grants are notified to the Australian Stock Exchange (ASX) in the *Notice of Directors' Interests* (pursuant to the then *Corporations Act*, Section 235). For the duration of our sample period this notice was to be lodged within 14 days of the grant (Section 205G).[14, 15] Any issue of securities (including options) to a director of a company must be approved by shareholders of the company prior to the issue (ASX *Listing Rule* 10.11). The grant announcement date is the date on which the ASX publishes the notification by the granting company, and is the date used for determining abnormal returns.

As in the U.S., executive stock option plans set the conditions under which subsequent grants are made.[16] The exercise price is determined either by a formula contained in the plan or on an *ad hoc* basis by the compensation committee. Many formulae imbed a permanent discount or premium[17]. Compensation committees typically have discretion as to the frequency, the size and timing of grants along with determination of the exercise price. Few plans specify grant frequency schedules: most leave this to the discretion of the compensation committee.[18] The aggregate of unexercised grants is sometimes capped at a fixed percentage of outstanding shares or, else, option grants are sometimes rationed with reference to a fixed, rolling interval.

In the absence of an Australian executive compensation database, all grant data were obtained from a keyword-search of all ASX-listed companies included in *Huntleys'*

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[14] Australian disclosures are on a par with the U.K.: see Conyon and Sadler (2001). In the U.K., Urgent Issue Task Force (UITF) Abstract 10 of the Accounting Standards Board forms the basis of executive stock options disclosure, and is similar to the Australian disclosure rules as embodied in s.205G of the *Corporations Act*

[15] More recently, disclosure rules in both the U.S. and Australia have been tightened. In the U.S., in line with Section 403 of the *Sarbanes-Oxley Act* of 2002, the SEC amended the disclosure rules for beneficiary ownership reports to be filed under Section 16(a) to be reported within two business days of receiving notification of the grant. In Australia, ASX *Listing Rule* 3.19A introduced in 2001 requires any change in directors' interests to be notified within 5 business days of the change.

[16] Australian executive stock option plans are partially surveyed in Rosser and Canil (2004) and Taylor and Coulton (2002), while U.S. executive stock option plans are partially surveyed by Hall (1999).

[17] For example, the plans of North Limited, ICI Australia Limited and Ashton Mining Limited prescribe an exercise price being the average of the stock price for the prior 5 trading days, implying an ATM grant. Energy Equity Limited specifies a permanent premium to market while Orbital Engine Limited specifies a permanent discount. Amcor Limited and BRL Hardy Limited grant full discretion to their compensation committees.

[18] Scheduled *versus* unscheduled grants in the U.S. are examined by Collins, Gong and Li (2005).

DatAnalysis service. Exercise details were obtained from the ASX *Additions to the Official List*. Of 767 cases initially identified by the keyword search, 257 cases (representing 107 companies) were deleted because the granting company failed to provide a copy of the underlying option plan. A further 98 cases for which grant dates preceded announcement dates were also deleted.[19] To avoid the problem of pre-announcement information leakage, the sample was restricted to grants occurring only on the announcement date or subsequently, thereby excluding all cases of grants made prior to announcement.[20] Application of these preliminary filters resulted in an initial selection of 412 valid grants made by 144 companies. Further deletions were made for (i) inadequate or inconsistent grant-related disclosures (186) and (ii) grants made within 3 days of other major announcements, such as earnings releases (58). The final sample comprised 168 stock option grants made by 51 companies to 65 CEOs[21]. The sample derivation is summarized thus:

Number of hits from keyword-search	767
less grants for which the option plan could not be obtained	(257)
less grants where grant date occurs prior to announcement date	(98)
Number of valid grants	412
less deletions for:	
inadequate or inconsistent grant-related disclosures	(186)
grants made within 3 days of other major announcements	(58)
Final sample	168

Of the 168 grants 74 are multiple grants, being two or more grants made on the same date to the same CEO but differentiated by expiry or the exercise price, or both.[22] These grants have the same properties as single grants in all other respects. Resource stocks make up

[19] These cases are unlikely to represent back-dating. More likely, the granting company (many of which are small) had not formally announced the grant.
[20] Announcement and grants occurred on the same day in 56.5 per cent of sampled cases, with 29.6 per cent within the following four weeks.
[21] The number of CEOs exceeds the number of companies due to CEO turnover.
[22] Spreads in exercise prices and exercise dates were intended to increase the probability that at least one of the grants would be exercised.

almost 18% of the final sample, with industrial stocks (including manufacturing, engineering, conglomerate and technology stocks) accounting for the remainder.

Compensation specialists in Australia consider that nearly all stock option grants made during the sample period were add-ons and not substitutes. This assumption is also evidenced by the proportion of (cash) salary in total compensation in our data being invariant across risk aversion: were option grants substitutes, we would have observed a negative relation. Add-on grants are also common in the U.S., as indicated by HM and Baranchuk (2006) who note simultaneous growth in option grants along with CEO salaries, bonuses and other benefits. In the pervasive absence of grant schedules, we define regular grants as grants made annually for at least three consecutive years to the same CEO and with a maximum timing variation of three months; the remainder are defined as irregular.

Grant moneyness (including the contingent CEO gain/loss at grant) is determined with reference to the stock price at the close of trade on the grant date, while shareholder returns were determined around the grant announcement date. An OTM grant is defined to occur when the stock price at grant exceeds the exercise price by at least 5%; likewise, an ITM grant occurs when the stock price falls below the exercise price by the same percentage. Notional ITM grants/OTM grants within this 5% tolerance are therefore classified as ATM awards.[23] This spread is considered wide enough to classify virtually all ATM grants correctly, i.e., Type 1 error is believed negligible. A wide spread also captures many near-ATM grants that are desirable given the non-exactitude of the Hall and Murphy (2002) predictions. The likelihood of Type 2 error (misclassifying non-ATM grants) is therefore likely higher than Type 1 error. Thus, grants classified as ITM or OTM are almost certainly not due to noise in stock prices.

[23] Narrowing this spread to ±2% does not materially affect our results.

Following Morgan and Poulsen (2001), a three-day window [-1, 1] is employed to capture grant announcements made after the close of trading on day-zero.[24] Cumulative abnormal returns are the cumulative differences between expected and raw (or observed) stock returns, where expected returns are calculated from application of the market model, with the S&P/ASX All Ordinaries Accumulation Index used to proxy market returns on the market portfolio. Beta factors for this model are estimated prior to the grant date using the excess return form of the market model (Brown and Warner, 1980). Grant CARs are equally-weighted across the sample.

HM measure pay-performance sensitivity by $\delta V_e(n)/\delta S$, where $V_e(n)$ is the executive's valuation, *S* is the stock price and *n* is the number of granted options. Executive value is determined after taking into account risk aversion and diversification but not early exercise, which is treated as a separate adjustment.[25] Since for add-on grants Hall and Murphy (2002, p. 25) show that $\delta V_e(n)/\delta C_{BS}(n)$ is not sensitive across a wide range of grant discounts/premiums, we measure pay-performance sensitivity by the partial derivative of the Black-Scholes call value with respect to the stock price, $\delta C_{BS}(n)/\delta S$ or $N(d_1).n$, adjusted for dividends. CEO risk aversion and private diversification are proxied because these variables cannot be directly observed. Our primary measure of (absolute) risk aversion is $\rho' = MRP/3.33\sigma^2$, where *MRP* is the market risk premium (set at 5%), σ is the standard deviation of stock returns for a given company and 3.33 is a constant that delivers a sample-average aversion level of $\rho = 2$ which is pivotal in the HM model.[26] A further reason for selecting $\rho = 2$ is that the firms in our sample exhibit higher beta risk than average, implying lower executive risk aversion than an often assumed investor value of around 3.[27] The degree of *Private diversification* is proxied by the index

[24] Daily abnormal returns for a week either side of this window are not statistically significant.
[25] Ingersoll (2006) presents an algorithm for adjusting the Black-Scholes call value for all three factors.
[26] This is the standard approach used in portfolio theory; see Bodie, Kane and Marcus (2005), ch.7.
[27] The choice is not critical because our results are closely similar for sample-average aversion values of 3 and 4.

$\ln\left[\left(\frac{(100 - Equity\ ownership)}{Equity\ ownership}\right).TA\right]$, where *TA* is pre-grant total assets. The intuition underlying this measure is that CEOs are likely less diversified as their direct equity ownership increases but more diversified as firm size increases. For example, in a small firm it is to be expected that an owner-manager has most of her wealth tied up in the business, while in a large corporation a CEO having a similar stake is likely also to be wealthy (i.e., privately diversified) in her own right.

IV. Analysis

Descriptive statistics are presented in Table 1. Firm financial characteristics are consistent with the economic conditions of the 1990s, but the sample exhibits higher than average beta risk. This is not surprising because options are more valuable and hence carry stronger incentive effect as stock volatility (which is usually positively related to beta) increases. Individual option grants tend below 0.5% of outstanding shares. Across the whole sample, the contingent gain at grant (based on the spread between the stock price and the exercise price) is significantly positive (mean $p = 0.072$, median $p = 0.063$), implying an average discount of about 1.5%. An early indication of problems for the HM model is given by the absence of a positive relation between the number of options granted and the exercise price ($r = -.081$, $p = 0.297$). Grant and CEO characteristics are differentiated by (i) firm size and (ii) grant moneyness in Table 2 using probit analysis. Small firms (with book total assets below AUD500m) make larger grants (relative to outstanding ordinary shares) but exhibit lower CEO equity ownership and lower CEO risk aversion and private diversification than large firms. Grant and CEO characteristics do not differ between ATM and OTM grants, but CEO tenure is lower and private diversification is higher for ATM-grant firms relative to

ITM-grant firms. Notably, neither grant size nor CEO risk aversion differ according to grant moneyness, which is inconsistent with HM. Separate univariate analysis (results not reported) shows that ATM-grant firms make larger grants and exhibit higher CEO risk aversion and private diversification than non-ATM-grant firms but have lower CEO equity ownership.

Prior to testing the HM propositions we show that our measure of risk aversion possesses desirable properties. These are (i) a positive relation with the degree of corporate diversification[28], (ii) a positive relation with cash flow/total assets and (iii) an inverse relation with growth opportunities, commonly proxied by market-to-book of assets[29]. Aversion is expected increasing in corporate diversification because more diversified firms are less risky which suits more risk-averse executives. Likewise, firms with a higher proportion of cash flow to total assets are likely to exhibit lower stock return volatility that also suits more risk-averse executives. On the other hand, higher growth opportunities imply higher risk that suits less risk-averse executives. As a robustness check, we introduce an alternative risk aversion measure that is tested in the same way. The alternative aversion measure assumes that CEOs enter their new job with a level of risk aversion equal to the sample average (ρ = 2.011), but as their tenure lengthens risk aversion converges to that implied by the standard portfolio theory measure (ρ'). For example, an executive joining a firm whose stock volatility implies lower (higher) risk aversion than the sample average is conjectured to adjust her aversion downwards (upwards) linearly as she assimilates with the

[28] See Amihud and Lev (1981), May (1995) and Tufano (1996).

[29] These are not the only benchmarks for developing a risk aversion measure. Guay (1999) further argues that more risk-averse executives prefer a higher proportion of cash in their total compensation, while Berger, Ofek and Yermack (1997) argue that executives become more risk averse as their tenure is longer. Our aversion measure does not load on either of these variables, but we do not consider this a threat because both alternatives involve circular reasoning. In the former case, option grants will naturally lower the observed proportion of cash in total compensation. In the latter case competition in the executive labor market should lower the incidence of incumbencies that are detrimental to shareholders; if executives are entrenched they will be unlikely to accept incentive options in the first place.

firm ‘culture’. This process is further conjectured to evolve fully by the tenth year. Thus, the alternative risk aversion measure ρ'' is:

$$\left\{\rho_s + \frac{t}{T}(\rho' - \rho_s)\middle|\rho' \geq \rho_s\right\}; else\ \rho_s - \frac{t}{T}(\rho_s - \rho')$$

where $\rho_s = 2.011$, t is the number of years of tenure and T = 10. We choose the measure which is most strongly associated with variables previously identified as having a fixed directional relationship with risk aversion. Specifically, a negative relation with growth opportunities is expected because higher growth requires lower risk aversion. For the same reason, we also expect to observe a positive relation with corporate diversification because diversified firms are less risky than the returns risk of the same segments operated as independent entities. Likewise, high-cash flow firms have a higher proportion of assets-in-place than low-cash flow firms and are therefore more attractive to risk-averse executives. Consistency tests for both aversion measures are presented in Table 3, which shows that the primary measure for risk aversion (ρ') is clearly preferred.

Using this preferred measure, we now proceed to the tests of the HM model. Tests of hypotheses H1 through H4B are presented in Table 4. For H1, *Private diversification* is correctly signed (negative) but *Exercise price/Stock price* is not. Given the likelihood that our risk aversion measure is reliable, failure to establish a positive relation with the exercise price poses a major threat to the HM model. Recall that pay-performance sensitivity is defined by HM as the product of delta and the number of options granted. Since delta is exogenous, the source of the failure is attributable to the number of options granted. The test of H2 shows that *Risk aversion* is inversely related to *Exercise price/Stock price* as hypothesized, but the positive coefficient on *Number of options* is unexpected. However, given the outcome of testing H1, it is apparent that the number of options granted is again problematic for HM, who argue that more risk-averse CEOs require smaller grants, and *vice versa*. Thus, our results indicate exactly the reverse. The test of H3 is inconclusive. To this point, the evidence suggests the number of options granted does not behave as predicted by HM, whereas behavior of the exercise price conforms to their model. The test outcome of H4A is adverse: ATM grants are found to occur more, and not less, frequently as CEO risk aversion increases. In other words, risk aversion is decreasing in non-ATM grants. To the extent that our risk aversion measure is credible, it appears that ATM grants are over-prescribed by HM. H4B fares no better, suggesting in turn that ITM grants are under-prescribed. However, H4C receives strong support (mean CAR = -0.013, p = 0.000, n = 12), which suggests that OTM grants are correctly prescribed (i.e., reserved principally for low risk aversion cases). Given the hypothesized inverse relation between risk aversion and the exercise price (refer the test of H2), it appears many ITM grants should have been ATM grants.

Our results so far suggest two factors prevent the HM model from receiving unqualified empirical support: first, the number of options granted does not increase with the exercise price and, second, the HM model 'works' for high CEO risk aversion but not low aversion. Both outcomes could be attributable to violation of the HM assumption of constant CEO productivity across firm size. When CEOs have low productivity, reducing the exercise price may provide the incentive increment that is required, which would explain why there more ITMs than prescribed by HM. If CEOs are more productive in large firms relative to small firms, then smaller grants may suffice to deliver a given incentive, resulting in a negative (and not positive) relation between the number of options granted and incentive.

We explore these possibilities by employing the model of Baker and Hall (2004) whose effort-based model incorporates the essential arguments of HM but also recognizes the impact of CEO marginal productivity (γ) on pay-performance sensitivity (b). The HM assumption of a constant γ across firm size is a special case in their model. When γ is constant, an increase in the number of options granted (*n*) unambiguously increases CEO incentive irrespective of firm size. However, when γ varies with firm size, larger grants do not necessarily add to incentive. Baker and Hall (2004) empirically estimate $\gamma \cong 0.4$. To determine whether γ affects the prescriptions of the HM model, we initially assume $\gamma = 0$ so that observed b's are also assumed to be optimal, as suggested by Baker and Hall (2004). Thus, $b^* = \Delta.\frac{n}{N}$, which is the original pay-performance sensitivity measure of Jensen and Murphy (1990). Setting $b = b^*$ allows γ to be obtained from equation (3) of Baker and Hall (2004): $\gamma = \sqrt{\frac{2b^*\rho'\sigma 2}{1-b^*}}$ [30]. Total CEO incentive (or 'incentive strength') is then measured by γb^*.

Baker and Hall (2004) conjecture that $b^*$and γ are impacted oppositely by firm size. In their model, b^*falls very quickly as firm size rises, which means that large firm CEOs have trivial incentive relative to small firm CEOs. 2SLS regression (1) of Table 5 confirms, after controlling for CEO risk aversion and stock return volatility, that b^* is inversely related to firm size in our sample. *Cet. par*., large-firm CEOs therefore have lower incentive than small-firm CEOs which, according to Baker and Hall (2004), would be consistent with large-firm CEOs being more productive than small-firm CEOs. However, regression (2) of Table 5 shows that γ is inversely related to firm size after controlling for private diversification and stock return volatility. In other words, large-firm CEOs are in fact relatively less productive despite having less incentive. Regression (3) shows the inverse relation persists when the dependent variable is incentive strength (γb^*). However, the results documented in Table 5 remain subject to the assumption of fixed CEO productivity, thereby allowing incentive to be measured by $b^* = \Delta.\frac{n}{N}$. However, since in our sample

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[30] Solving this expression with our data yields a γ value of 0.394 which is remarkably close to the Baker and Hall (2004) estimate for *Execucomp* data.

$\gamma \neq 0$, CEO productivity cannot be assumed fixed across firm size, so we substitute $b = \frac{\gamma^2}{\gamma^2 + 2\rho'\sigma^2}$ which requires an exogenously-determined γ.

We determine γ by estimating a Cobb-Douglas production function in order to obtain productivity estimates on three factors: capital, executive and labor inputs. Capital input (*K*) is measured by the depreciated value of PPE, executive input (*E*) by the capitalized value of current-period CEO salary (excluding bonuses) and labor input (*L*) by total assets *less* PPE (which follows from the balance-sheet identity). Inferring factor inputs from capitalised costs is appropriate as long as these markets are competitive, which is reasonably assumed to be the case. Output is value-added (*V*), which is *ln*(Market-to-book of assets $\times$ Total assets) - 1. The full specification for estimation therefore is:

$$ln(V) = ln(\alpha) + \beta_1 ln(K) + \beta_2 ln(E) + \beta_3 ln(L) + \varepsilon$$

where marginal productivities are given by the β coefficients attaching to each factor input. The model is estimated separately for three sectors: (i) Manufacturing, (ii) Mining & Energy, and (iii) Services, Financial & Retailing. Sector boundaries were arrived at after some experimentation: Mining & Energy are characterized by exposure to commodity price risk, while the third sector is service-centered. The least-squares results are reported in Table 6. The regression parameters for the three sectors are satisfactory. The marginal productivity of executive input varies considerably between the three sectors, ranging from 0.564 in Services, Financial & Retailing to -0.360 in Mining & Energy. The high productivity in Services, Financial & Retailing is not surprising given the emphasis on human capital. In contrast, in Mining & Energy CEO input can be argued secondary to variation in commodity prices: for example, the risk of falling commodity prices may induce negative value-added irrespective of the efficiency of executive input. The productivity coefficients thus obtained become the γ values in $b = \frac{\gamma^2}{\gamma^2 + 2\rho'\sigma^2}$.[31] This approach results in a lower sample estimate of γ, namely 0.242. After applying the same controls as in Table 5, the 2SLS regressions of Table 7 confirm the presence of a firm size effect, albeit less pronounced, across alternative specifications of γ. Using the exogenously-determined γ (and hence no longer assuming that CEO productivity is fixed), a 2SLS regression of the number of granted options on CEO productivity and incentive is reported in Table 8. The number of granted options is shown to be negatively related to CEO productivity but unrelated to incentive, even after controlling for private diversification, risk aversion and firm size. Thus, when CEO productivity is accounted for, a positive relationship between the number of options granted and incentive no longer holds. However, despite relaxing the assumption of constant CEO productivity, large-firm CEOs are shown to remain less productive than small-firm CEOs, but the solution is not larger option grants. Perhaps it is a lower exercise price because prior analysis (notably the test of H2) indicates that exercise prices are set in accord with HM.[32]

Table 9 reports probit regressions of grant moneyness on exogenously-determined *CEO Productivity* and *Incentive*. ITM grants are positively related to CEO productivity but inversely related to incentive, suggesting the incentive lost through a grant discount is recovered through higher CEO productivity. OTM grants exhibit the opposite tendency: grant premiums are employed to generate incentive but without sacrificing CEO productivity. This interpretation is confirmed by an absence of a relationship with *Incentive strength* except for OTM grants, which exhibits a positive sign (results not reported). Since ITM grants are not independent of CEO productivity, we conclude that the HM model correctly prescribes OTM grants but is potentially deficient with respect to ITM grants.

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[31] Baker and Hall (2004), equation (2) with the company/period subscripts removed.

[32] Replication of the 2SLS regression reported in Table 9 with exercise price substituted as the dependent variable shows that exercise prices are unrelated to CEO productivity.

When CEO productivity is lower, the HM model is likely to prescribe an ATM grant when an ITM grant is likely optimal. However, when CEO productivity is higher, the HM model is likely to give a close approximation. To support this inference, recall that in our sample large-firm CEOs are less productive than small-firm CEOs, so we expect to observe positive CARs for ITM grants made to large-firm CEOs, and non-positive CARs for grants to small-firm CEOs. The evidence is supportive: ITM grants to large-firm CEOs exhibit a mean grant CAR of 0.010 (p = 0.031), while grant CARs for ITM grants to small-firm CEOs are insignificantly different from zero (p = 0.672).

V. Conclusions

We report the first tests of the key incentive-related propositions contained in the widely-cited optimal incentive model of HM. Our use of Australian data confers dual benefits not present in U.S. data: freely-adjusting exercise prices while minimizing the impact of expensing requirements and tax considerations. In the HM model, the level of executive risk aversion and the degree of private diversification jointly determine pay-performance sensitivity simultaneously with the exercise price, but executive productivity is not endogenized. The posited positive relation between pay-performance sensitivity and the exercise price is not found in our data. The observed inverse relation is attributable to the positive (and not negative) relation between CEO risk aversion and absolute grant size. Their model further assumes that larger grants create more incentive. However, when the incentive consequences of varying CEO marginal productivity are recognized (following Baker and Hall, 2004), we show that larger grants do not necessarily generate stronger incentive. Hence, granting more options to less productive large-firm CEOs is dysfunctional. Empirically, ITM grants are found associated with higher CEO productivity.

The over- (under-) prescription of ATM (ITM) grants is at least partly attributable to the omission of CEO productivity from the HM model. ITM grants issued to less-productive CEOs exhibit positive abnormal returns at grant. We conclude that lowering the exercise price rather than increasing the grant size is the preferred mechanism for incentivizing less-productive CEOs, who in our sample reside in large firms. Replication of these results on U.S. data where less-productive CEOs reside in small firms would serve to confirm our conclusions.

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TABLE 1. Descriptive Statistics.

Variable	Mean	Median	Standard deviation	25th Percentile	75th Percentile
Firm characteristics:					
Firm size (log)	5.92	5.92	1.85	4.84	7.64
Stock return volatility (%)	41.2	32.0	25.2	23.2	51.4
Beta risk	1.31	1.12	0.92	0.80	1.83
Market-to-book of assets	1.32	1.04	1.41	0.08	1.30
Financial leverage (%)	19.0	17.6	13.5	8.4	28.9
CEO characteristics:					
Tenure (years)	4.06	4.00	2.40	4.56	5.00
Equity ownership (%)	1.53	0.03	4.53	0.01	0.46
Grant characteristics:					
Grant size (%)	0.34	0.15	0.68	0.05	0.36
Contingent gain at grant	0.015	0.013	0.189	-0.047	0.101
Grant expiry (years)	4.60	5.00	0.82	2.00	6.00
N=168					

Note: *Stock return volatility* is measured by the annualized standard deviation of pre-grant monthly stock returns (in percentage terms) over a minimum 3 years prior to grant. *Firm size* is measured by pre-grant ln(total assets). *Market-to-book of assets* is the sum of the sum of the market value of equity and the book value of debt divided by book total assets, all pre-grant. *Financial leverage* is the ratio of total debt to total assets, all pre-grant. *Tenure* is the number of years since appointment. *Equity ownership* is the number of ordinary shares beneficially-owned pre-grant and divided by the number of ordinary shares outstanding. *Grant size* is the number of granted options divided by the number of outstanding ordinary shares prior to grant, expressed as a percentage. *Contingent gain at grant* is the stock price at grant minus the exercise price, divided by the stock price at grant: a gain (loss) implies a discount (premium). *Grant expiry* is the contracted term to expiry.

TABLE 2. Probit regressions: Differentiation of Grant and CEO Characteristics by (i) Firm Size and (ii) Grant Moneyness

Dependent variable:	Small Firm =1	ATM=1 (ATM vs OTM)	ATM=1 (ATM vs ITM)
Contingent CEO gain	0.012	n.a.	n.a.
	(0.015)		
Grant size (%)	2.626**	-0.764	-0.670
	(2.538)	(-1.563)	(-1.382)
Grant expiry (years)	-0.250	0.303	0.254
	(-1.424)	(1.474)	(1.347)
Tenure (years)	0.056	-0.010	-0.094*
	(0.961)	(-0.164)	(-1.687)
CEO equity ownership (%)	-0.120***	-0.004	0.050
	(-4.345)	(-0.112)	(1.489)
CEO risk aversion (absolute)	-0.314***	0.102	0.068
	(-2.871)	(1.270)	(0.378)
CEO private diversification (index)	-0.211***	0.016	0.116**
	(-5.754)	(0.338)	(2.389)
Intercept	3.514	-1.485	-2.060**
	(4.351)	(-1.519)	(-2.029)
McFadden R^2	0.457	0.111	0.163
Number of observations = 1	*95*	*55*	*55*
Number of observations = 0	*73*	*48*	*65*

Note: A *small firm* has Total Assets < AUD500m. An ATM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is ≤ ±5%. An ITM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is > 5%. An OTM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is < 5%. *Contingent gain at grant* is the stock price at grant minus the exercise price, divided by the stock price at grant: a gain (loss) implies a discount (premium). *Grant size* is the number of granted options divided by the number of outstanding ordinary shares prior to grant, expressed as a percentage. *Grant expiry* is the contracted term to expiry. *Tenure* is the number of years since appointment. *CEO equity ownership* is the number of ordinary shares beneficially-owned pre-grant and divided by the number of ordinary shares outstanding. *CEO risk aversion* is proxied in absolute terms by $MRP/3.33\sigma^2$ where the market risk premium (*MRP*) is set at 5 per cent and σ is the annualized standard deviation of stock returns estimated over a minimum 3 years months prior to grant. *CEO private diversification* is proxied by the index $\ln\left[\left(\frac{(100-Equityownership)}{Equityownership}\right).TA\right]$, where *TA* is pre-grant total assets. All regressions are on panel data and are White- corrected for heteroscedasticity.

***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

TABLE 3. Consistency Tests of Risk Aversion (ρ) Measures

Dependent variable:	ρ'	ρ''
N=168		
Growth opportunities	-0.083*	-0.044
	(-1.76)	(-1.52)
Corporate diversification (=1)	1.068***	0.458***
	(3.57)	(3.08)
Cash flow/Total assets	1.415***	0.380
	(2.80)	(1.33)
Intercept	1.126	1.700
Adjusted R^2	0.123	0.066

Note: All independent variables are measured pre-grant. *Growth opportunities* are measured by market-to-book of assets, which is the sum of the market value of equity and the book value of debt divided by book total assets. *Corporate diversification* is a binary variable where two or more reported operating segments classify a firm as diversified. *Cash flow* is net cash flow from operations. All regressions are on panel data and are White-corrected for heteroscedasticity.

***Significant at the 1% level.
*Significant at the 10% level.

TABLE 4. HM Tests

Hypothesis #:	H1	H2	H3	H4A	H4B
Dependent variable:	*Pay-performance sensitivity/ Risk aversion*	*Risk aversion*	*Private diversif-ication/ Risk aversion*	ATM *grant* (=1)	ITM *grant* (=1)
Estimation method:	Least squares	Least squares	Least squares	Maximum likelihood	Maximum likelihood
N=168					
Exercise price/stock price	-0.176 (-1.02)	-0.311** (-2.54)	-0.920 (-0.32)		
Number of options (millions)		0.341** (2.03)	-2.215 (-1.45)		
Risk aversion				0.180*** (2.976)	-0.113** (-1.99)
Private diversification	-0.041** (-2.32)				
Intercept	1.110*** (4.16)	2.161*** (8.82)	15.297*** (4.25)	-0.826*** (-5.071)	-0.067 (-0.44)
Adjusted R^2	0.026	0.042	0.017		
McFadden R^2				0.042	0.015
Number of observations = 1				*55*	*65*
Number of observations = 0				*113*	*103*

Note: *Pay-performance sensitivity* is the option delta multiplied by the number of granted options. *Risk aversion* is proxied in absolute terms by $MRP/3.33\sigma^2$ where the market risk premium (*MRP*) is set at 5 per cent and σ is the annualized standard deviation of stock returns estimated not less than 36 months prior to the grant date. *Private diversification* is proxied by the index $\ln\left[\left(\frac{(100-Equityownership)}{Equityownership}\right).TA\right]$, where *TA* is pre-grant total assets. For the OLS regressions, *t* statistics are shown in parentheses, while for the logit regression the parenthesized numbers are Wald statistics. An ATM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is ≤ ±5%. An ITM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is > 5%. All regressions are on panel data with the White correction for heteroscedasticity applied to the least squares regressions.

***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

TABLE 5. 2SLS regressions of Incentive, CEO Productivity and Incentive Strength on Firm Size.

Dependent variable:	(1) *Incentive* b^*	(2) *CEO productivity* γ	(3) *Incentive strength* $b^*\gamma$
N=168			
Firm size	-0.070***	-0.240***	-0.212**
	(-4.81)	(-3.59)	(-2.22)
Intercept	0.613***	1.817***	1.481**
	(6.63)	(4.09)	(2.438)
Adjusted R^2	0.274	0.136	0.036

Note: *Incentive* (b^*) is delta multiplied by the number of granted options and divided by the number of outstanding shares. *CEO productivity* is given by $\sqrt{\frac{2b^*\rho'\sigma^2}{1-b^*}}$, where ρ' is measured CEO risk aversion and σ is the standard deviation of stock returns for not less than 3 years prior to grant. CEO risk aversion is $MRP/3.33\sigma^2$ where the market risk premium (*MRP*) is set at 5%. The following pairs of simultaneous equations are estimated (only the second is reported):

Regression (1):

(a) $Firm\ size = \beta_0 + \beta_1\ CEO\ risk aversion + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $Incentive = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$

Regression (2):

(a) $Firm\ size = \beta_0 + \beta_1\ \text{Private diversification} + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $CEO\ productivity = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$

Regression (3):

(a) $Firm\ size = \beta_0 + \beta_1\ CEO\ risk aversion + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $Incentive strength = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$,

where *Firm size* is measured by pre-grant ln(total assets) and *Private diversification* is proxied by $ln(1 + (1/\text{Percentage of stock owned beneficially by the CEO}))$. *t* statistics are shown in parentheses. All regressions are on panel data incorporating the White correction for heteroscedasticity.

***Significant at the 1% level.
**Significant at the 5% level.

TABLE 6. Estimation of CEO productivity using Cobb-Douglas Specification.

Industry classification:	Manufacturing	Mining & energy	Services, financial & retailing
Number of observations	*95*	*32*	*41*
Capital input	0.109*	0.059	0.281***
	(1.83)	(1.37)	(2.94)
CEO input	0.055**	-0.360*	0.564***
	(2.04)	(-1.85)	(3.95)
Labor input	0.750***	0.981***	0.418***
	(6.29)	(4.80)	(2.99)
Intercept	0.940	2.044	-1.397**
	(1.03)	(1.32)	(-1.96)
Adjusted R^2	0.877	0.902	0.914

Note: *Output* is measured by Value-added which is *ln*(Market-to-book of assets $\times$ Total assets)-1. *Capital input* is measured by *ln*(Property, Plant & Equipment). *CEO input* is CEO salary excluding bonuses capitalized at the firm's weighted average cost of capital. *Labor input* is measured by *ln*(Total Assets *less* Property, Plant & Equipment) minus *Executive input*. All variables are pre-grant. *t* statistics are shown in parentheses. All regressions are on panel data incorporating the White correction for heteroscedasticity.

***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

TABLE 7. 2SLS Regressions of Incentive, CEO Productivity and Incentive Strength on Firm Size.

Dependent variable:	(1) *Incentive* b	(2) *CEO productivity* γ	(3) *Incentive strength* γb
N=168			
Firm size	-0.027*	-0.074***	-0.040***
	(-1.77)	(-4.51)	(-3.50)
Intercept	0.336***	0.682***	0.329***
	(3.72)	(6.44)	(4.50)
Adjusted R^2	0.015	0.071	0.008

Note: *Incentive* (b) is given by $\frac{\gamma^2}{\gamma^2+2\rho'\sigma^2}$, where γ is CEO productivity. *CEO productivity* is given by $\sqrt{\frac{2b^*\rho'\sigma^2}{1-b^*}}$, where ρ' is measured CEO risk aversion and σ is the standard deviation of stock returns for not less than 3 years prior to grant. CEO risk aversion is $MRP/3.33\sigma^2$ where the market risk premium (*MRP*) is set at 5%. The following pairs of simultaneous equations are estimated (only the second is reported):

Regression (1):

(a) $Firm\ size = \beta_0 + \beta_1\ CEO\ risk aversion + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $Incentive = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$

Regression (2):

(a) $Firm\ size = \beta_0 + \beta_1\ \text{Private diversification} + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $CEO\ productivity = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$

Regression (3):

(a) $Firm\ size = \beta_0 + \beta_1\ CEO\ risk aversion + \beta_2 Stock\ return\ volatility + \varepsilon$

(b) $Incentive strength = \alpha_0 + \alpha_1 Firm\ size + \varepsilon$,

where *Firm size* is measured by pre-grant *ln*(total assets) and *Private diversification* is proxied by $ln(1+(1/\text{Percentage of stock owned beneficially by the CEO}))$. *t* statistics are shown in parentheses. All regressions are on panel data incorporating the White correction for heteroscedasticity.

***Significant at the 1% level.
*Significant at the 10% level.

TABLE 8. 2SLS regression of number of options granted on CEO productivity and incentive in a Baker and Hall (2004) context.

Dependent variable:	*Number of options granted*
N=168	
Incentive	1.404
	(0.68)
CEO productivity	-1.894**
	(-2.01)
Intercept	0.740**
	(2.14)
Adjusted R^2	0.094

Note: *Incentive* (b) is given by $\frac{\gamma^2}{\gamma^2+2\rho'\sigma^2}$, where γ is CEO productivity. *CEO productivity* is given by $\sqrt{\frac{2b^*\rho'\sigma^2}{1-b^*}}$, where ρ' is measured CEO risk aversion and σ is the standard deviation of stock returns for not less than 3 years prior to grant. CEO risk aversion is *MRP*/$3.33\sigma^2$ where the market risk premium (*MRP*) is set at 5%. The following pair of simultaneous equations is estimated (only the second is reported):

(a) $CEO\ productivity = \beta_0 + \beta_1\ CEO\ risk aversion + \beta_2\ \mathrm{P}rivate\ diversification + \beta_3 Firm size + \varepsilon$

(b) $Number of\ options granted = \alpha_0 + \alpha_1 CEO productivity + \alpha_2 Incentive + \varepsilon$

where *Firm size* is measured by pre-grant *ln*(total assets) and *Private diversification* is proxied by $ln(1+(1/\text{Percentage of stock owned beneficially by the CEO}))$. *t* statistics are shown in parentheses. The regression is on panel data incorporating the White correction for heteroscedasticity.

**Significant at the 5% level.

TABLE 9. Probit regressions of Grant Moneyness on exogenously-determined CEO Productivity and Incentive.

	(1)	(2)	(3)	(4)
Dependent variable:	ITM *grant* (=1)	OTM *grant* (=1)	ATM *grant* (=1)	ITM *grant* (=1)
Estimation method:	Probit	Probit	2SLS	2SLS
CEO productivity	2.150**	-0.711		
	(2.08)	(-0.80		
Incentive	-3.538***	2.502**		
	(-2.59)	(2.25)		
CEO risk aversion			0.104	0.078
			(1.54)	(1.02)
Intercept	-0.196	-0.873***	0.118	0.229
	(-1.45)	(-5.84)	(0.84)	(1.44)
McFadden R^2	0.044	0.062		
Adjusted R^2			0.029	0.153
Number of observations = 1	*65*	*48*	*55*	*65*
Number of observations = 0	*103*	*120*	*113*	*103*

Note: An ITM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is > 5%. An OTM grant occurs when the stock price at grant *minus* the exercise price, divided by the stock price at grant, is < 5%. *CEO productivity* is given by $\sqrt{\frac{2b^{*}\rho'\sigma^2}{1-b^{*}}}$, where ρ' is measured CEO risk aversion and σ is the standard deviation of stock returns for not less than 3 years prior to grant. *CEO risk aversion* is *MRP*/3.33σ^2 where the market risk premium (*MRP*) is set at 5%. *Incentive* (b) is given by $\frac{\gamma^2}{\gamma^2+2\rho'\sigma^2}$, where γ is CEO productivity. z statistics are shown in parentheses for the probit regressions; t statistics are shown for the 2SLS regressions. The following pairs of simultaneous equations are estimated (only the second is reported):

Regression (3):

(a) $CEO\ risk aversion = \beta_0 + \beta_1\ CEO\ productivity + \varepsilon$

(b) $ATM\ grant = \alpha_0 + \alpha_1 CEO\ risk aversion + \varepsilon$

Regression (4):

(a) $CEO\ risk aversion = \beta_0 + \beta_1\ CEO\ productivity + \varepsilon$

(b) $ITM\ grant = \alpha_0 + \alpha_1 CEO\ risk aversion + \varepsilon$

All regressions are on panel data incorporating the White correction for heteroscedasticity.

***Significant at the 1% level.
**Significant at the 5% level.