AT-THE-MONEY STOCK OPTIONS, INCENTIVES, AND SHAREHOLDER WEALTH

Don Chance
Louisiana State University

Tung-Hsiao Yang
National Chung Hsing University, Taiwan

Outline

- A model of how options are awarded as incentives
- Examine whether options pay off for management when it adds value *after* receiving the options
- Conventional options fail the test and create numerous problems
- Show how to solve the problem by redesigning options
- Provide empirical estimates of the effect of this problem, which can be interpreted as the portion of an option's value that is compensation, i.e., payment for past performance, vs. incentives, i.e., payment for future performance

Model Structure

Assumptions:

- One period world (can be relaxed)
- All-equity (will be relaxed) with one share of stock
- Cash flow certainty (will be relaxed)
    - o Thus, the cost of capital is the risk-free rate, r – 1
- Uncertainty is in the form of uncertainty over whether management will be successful in investing the available cash in a positive-NPV project
- The firm has cash on hand, C_0, and a known future cash flow, C_1.

Model Structure (continued)

(no options initially)

C_0

$S_0 = C_0 + C_1 r^{-1}$ $\qquad$ C_1

0 $\qquad$ 1

- Invest C_0 in a new project -

$C_0 - C_0$

$S_0' = C_1 + \Delta C_1 r^{-1}$ $\qquad$ $C_1 + \Delta C_1$

0 $\qquad$ 1

Naturally, the traditional NPV rule holds: accept project if $\Delta C_1 r^{-1} > C_0$.

Model Structure (continued)

Award $\gamma < 1$ cash-settled options per share struck at X.

Management is charged with finding a positive-NPV project.
(Management's salary/reservation price is included in C_1.)

Payoff of the option:

$$\begin{aligned} Max(0, C_1 + \Delta C_1 - X) &= Max(0, C_1 + \Delta C_1 - S_0) \\ &= Max(0, C_1 + \Delta C_1 - (C_0 + C_1 r^{-1})) \\ &= Max(0, C_1 - C_1 r^{-1} + \Delta C_1 - C_0) \end{aligned}$$

$$C_1 - C_1 r^{-1} > 0$$

$$\Delta C_1 - C_0 > 0 \ if \ \ NPV > 0$$

PROPOSITION 1: *If management finds a positive-NPV project, the option will have value.*

That is, positive-NPV is a *sufficient* condition for the option to have value.

Model Structure (continued)

PROPOSITION 2: *The cost of the options awarded to management can exceed the value of a positive-NPV project that management finds and the firm undertakes.*

Cost (LHS) vs. NPV:

$$\gamma(C_1 + \Delta C_1 - S_0)r^{-1} > \Delta C_1 r^{-1} - C_0$$
$$\Rightarrow \gamma(C_1 + \Delta C_1 - S_0) > \Delta C_1 - C_0 r$$
$$\Rightarrow \gamma > \frac{\Delta C_1 - C_0 r}{C_1 + \Delta C_1 - S_0}$$

The RHS can be shown to be less than 1:

$$\frac{\Delta C_1 - C_0 r}{C_1 + \Delta C_1 - S_0} < 1$$
$$\Rightarrow \Delta C_1 - C_0 r < C_1 + \Delta C_1 - (C_0 + C_1 r^{-1})$$
$$\Rightarrow \Delta C_1 - C_0 r < C_1 + \Delta C_1 - C_0 - C_1 r^{-1}$$
$$\Rightarrow C_0 - C_0 r < C_1 - C_1 r^{-1}$$

Thus, the shareholders can effectively pay more for the options than they receive in incremental value.

Model Structure (continued)

PROPOSITION 3: *The option can have value even if management selects a negative-NPV project.*

The option payoff is:

$$Max(0, C_1 - C_1 r^{-1} + \Delta C_1 - C_0)$$

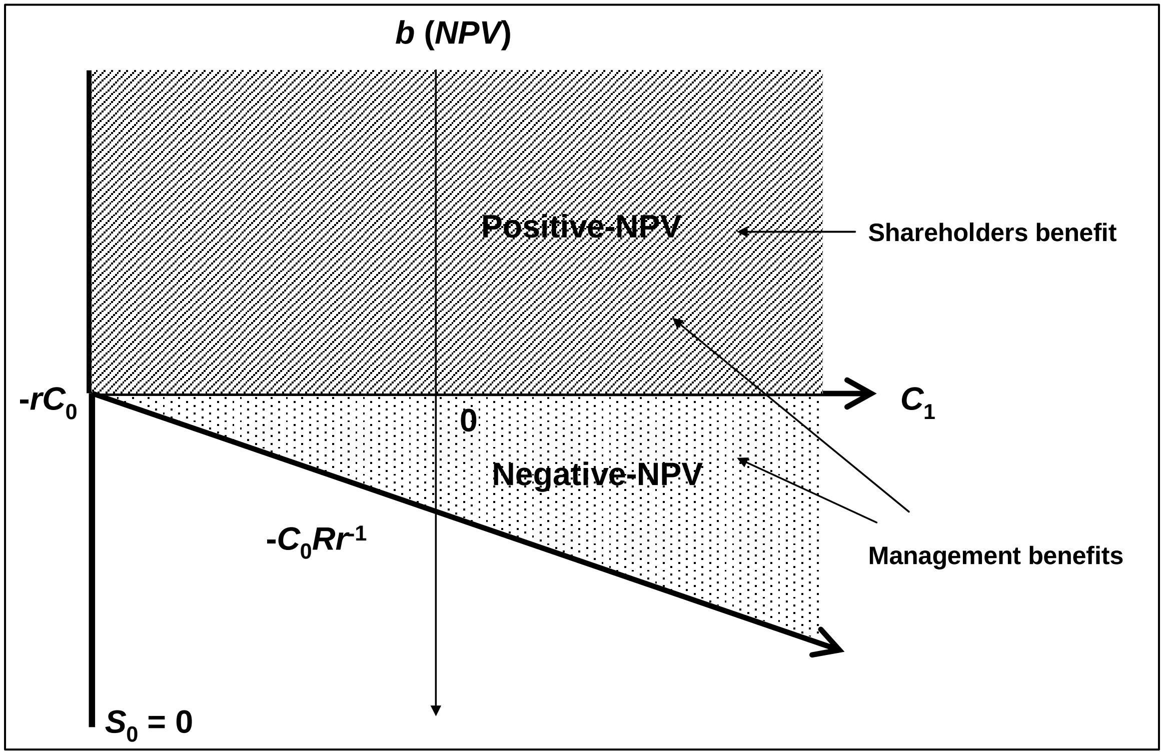
$$C_1 - C_1 r^{-1} > 0$$

Since $C_1 - C_1 r^{-1}$ is positive, $\Delta C_1 - C_0$ can be non-positive, thereby implying a negative NPV.

In fact, the option can have value even if the new project has a negative IRR.

Model Structure (continued)

Figure 1



Model Structure (continued)

PROPOSITION 4: *If managers are incentivized with traditional options, they will receive a portion of the gains from projects that the firm had in place before the options were awarded.*

The option payoff is comprised of two parts:

$$\left(C_1 - C_1 r^{-1}\right) + \left(\Delta C_1 - C_0\right)$$

That is, old cash flows + new cash flows. Thus, the old cash flows can support the new cash flows.

Model Structure (continued)

PROPOSITION 5: *If cash is not invested in new projects but is instead paid out as a dividend, the option will have value only if the dividend is smaller than the time value of the cash flow from the existing projects*.

Proof: With no capital investment, the option will have value if $C_1 > S_0 = C_1 - C_1 r^{-1}$. This is equivalent to $C_0 < C_1 - C_1 r^{-1}$. (LHS = dividend)

This is consistent with empirical studies. Stock options seem to create an aversion to dividends.

PROPOSITION 6: *If cash is not invested in new projects but is instead paid out as a dividend and the strike price of the option is adjusted downward by the amount of the dividend, the option will always have value*.

Proof: For the option to have value requires only that $C_1 - C_1 r^{-1} > 0$, which is always true.

Model Structure (continued)

PROPOSITION 7: *If firms offer at-the-money options and repurchase shares, management will always benefit from the options*.

The stock price after repurchase will be $C_0 + C_1r^{-1}$ (the same as before).

The option value will be $(C_1 /(1 – C_0/(C_0 + C_1r^{-1})) – (C_0 + C_1r^{-1}))r^{-1}$ or zero.

Rearranging, the option value is positive if $C_1 – C_1r^{-1} > C_0 – C_0r$.

This is clearly true (LHS > 0, RHS < 0).

Empirical studies show that share repurchases are more widely used by firms that use stock options and more widely used the more stock options used.

Model Structure (continued)

PROPOSITION 8: *If firms offer at-the-money options and invest in zero net-present-value projects, management will always benefit from the options.*

The option has value if $C_1 + \Delta C_1 - (C_0 + C_1 r^{-1})$ is positive.

With zero NPV, this term becomes $C_1 - C_1 r^{-1} + C_0(r - 1)$, which is clearly positive.

Henceforth, investment in a zero-NPV project will be referred to as *financial investment*.

Summary of Uses

Table 1. Managerial and Shareholder Benefits from Alternative Uses of Cash

	To Management	To Shareholders
Capital investment	$\gamma(C_1 - C_1 r^{-1} - C_0 + \Delta C_1)$	$(1-\gamma)C_1 + \gamma C_1 r^{-1} + \gamma C_0 + (1-\gamma)\Delta C_1$
Dividend	$\gamma(C_1 - C_1 r^{-1} - C_0)$	$(1-\gamma)C_1 + \gamma C_1 r^{-1} + C_0 r + \gamma C_0$
Strike-adjusted dividend	$\gamma(C_1 - C_1 r^{-1})$	$(1-\gamma)C_1 + \gamma C_1 r^{-1} + C_0 r$
Share repurchase	$\gamma(C_1 - C_1 r^{-1} - C_0 + C_0 r)$	$(1-\gamma)C_1 + \gamma C_1 r^{-1} + \gamma C_0 + (1-\gamma)C_0 r$
Financial investment	$\gamma(C_1 - C_1 r^{-1} - C_0 + C_0 r)$	$(1-\gamma)C_1 + \gamma C_1 r^{-1} + \gamma C_0 + (1-\gamma)C_0 r$

Summary of Uses (continued)

Table 2. Order of Preference of Management and Shareholders for Each Use of Funds When Stock Options are Awarded

Condition	Order of Preference for Management	Order of Preference for Shareholders
A. $C_0 < \Delta C_1 r^{-1}$	CI $\succ$ FI $\sim$ SR $\succ$ DSA $\succ$ D	
(i) $(1 - \gamma)\Delta C_1 > C_0 r$		CI $\succ$ D $\succ$ DSA $\succ$SR $\sim$ FI
(ii) $C_0 r - \gamma C_0 < (1 - \gamma)\Delta C_1 < C_0 r$		D $\succ$ CI $\succ$ DSA $\succ$ SR $\sim$ FI
(iii) $C_0 r - \gamma C_0 > (1 - \gamma)\Delta C_1$		D $\succ$ DSA $\succ$ CI $\succ$ SR $\sim$ FI
B. $C_0 > \Delta C_1$	FI $\sim$ SR $\succ$ DSA $\succ$ CI $\succ$ D	D $\succ$ DSA $\succ$ SR $\sim$ FI $\succ$ CI
C. $C_0 = \Delta C_1$	FI $\sim$ SR $\succ$ DSA $\sim$ CI $\succ$ D	D $\succ$ DSA $\succ$ SR $\sim$ FI $\succ$ CI
D. $\Delta C_1 r^{-1} < C_0 < \Delta C_1$	FI $\sim$ SR $\succ$ CI $\succ$ DSA $\succ$ D	D $\succ$ DSA $\succ$ SR $\sim$ FI $\succ$ CI
E. $C_0 = \Delta C_1 \mathrm{r}^{-1}$	FI $\sim$ SR $\sim$ CI $\succ$ DSA $\succ$ D	D $\succ$ DSA $\succ$ SR $\sim$ FI $\sim$CI
F. $\Delta C_1 = 0$	FI $\sim$ SR $\succ$ DSA $\succ$ D $\sim$ CI	D $\succ$ DSA $\succ$ SR $\sim$ FI $\succ$ CI
G. $\Delta C_1 < 0$	FI $\sim$ SR $\succ$ DSA $\succ$ D $\succ$ CI	D $\succ$ DSA $\succ$ SR $\sim$ FI $\succ$ CI

Points of agreement:

A: Positive NPV with value exceeding cost

F & G: Zero or negative incremental cash flow

Management is indifferent between FI and SR.

Other Cases Examined

Results are unchanged when (see proofs in Appendix)

- The firm has insufficient cash to undertake the capital investment and
  - Issues debt
  - Issues equity
- The firm has more than enough cash to undertake the capital investment

A Principal-Agent World

Can we justify this model in a principal-agent model framework?

We require only that $\gamma < 1$. Assume that manager either finds positive-NPV project or undertakes financial investment.

Assume the probability of finding a positive-NPV project is $p(\gamma)$ and that

$$p'(\gamma) > 0$$
$$p''(\gamma) < 0.$$

The value of the firm is

$$V_0 = \begin{pmatrix} p(\gamma)[(1-\gamma)C_1 + \gamma C_1 r^{-1} + \gamma C_0 + (1-\gamma)\Delta C_1] \\ +(1-p(\gamma))[(1-\gamma)C_1 + \gamma C_1 r^{-1} + \gamma C_0 + (1-\gamma)C_0 r]. \end{pmatrix} r^{-1}$$

Objective function of the board:

$$\max_{\gamma} V_0(\gamma).$$

First- and second-order conditions demonstrate that $\gamma < 1$.

Solving the Problems

Unsuccessful attempts:

- o Redefine NPV as NPV minus cost of options (helps but does not solve the problem)
- o Award options only on incremental value (impractical)

Adjust the strike by the cost of capital

$X = S_0 r$

$$Max(0, C_1 + \Delta C_1 - X) = Max(0, C_1 + \Delta C_1 - S_0 r)$$
$$= Max(0, C_1 + \Delta C_1 - (C_0 r + C_1))$$
$$= Max(0, C_1 - C_1 + \Delta C_1 - C_0 r)$$
$$= Max(0, \Delta C_1 - C_0 r)$$
$$\Delta C_1 > C_0 r \text{ as } \Delta C_1 r^{-1} > C_0 \ (NPV > 0)$$

The option then has value if and only if there is positive NPV.

Solving the Problems (continued)

The cost of the options cannot exceed the NPV:

$$\gamma(C_1 + \Delta C_1 - S_0 r)r^{-1} < \Delta C_1 r^{-1} - C_0$$
$$\gamma < \frac{\Delta C_1 r^{-1} - C_0}{C_1 r^{-1} + \Delta C_1 r^{-1} - S_0}$$
$$\gamma < \frac{\Delta C_1 r^{-1} - C_0}{C_1 r^{-1} + \Delta C_1 r^{-1} - (C_1 r^{-1} + C_0)}$$
$$\gamma < 1.$$

Thus, management does not benefit from cash flows that were in place before the options were awarded. Option value is strictly driven by the new project NPV.

With dividends, the value of the option at time 1 is determined by whether $C_1 - (C_0 r + C_1)$ exceeds zero, which it does not. A similar result obtains for share repurchase.

With financial investment, NPV is clearly zero, so the option expires worthless.

Note: If shares are used instead of options, the propositions and their problems all continue to hold. Moreover, with shares having effectively a zero strike price, there is no way to adjust the strike price.

Solving the Problems (continued)

Cost-of-Capital Indexed Options

Mentioned in:

Graham (*The Intelligent Investor*, 1949)

Stewart (*Harvard Business Review*, 1990)

Jensen (Harvard Research Paper, 2001)

Bogle (*The Battle for the Soul of Capitalism*, 2005)

But there has been no thorough study in the academic literature.

Solving the Problems (continued)

Introducing Uncertainty

C_0, $E(C_1)$ — C_1

$-C_0$, $E(\Delta C_1)$ — ΔC_1

0 — 1

Current value is $S_0 = C_0 + E(C_1)/k$ where k -1 is the cost-of-capital.

Initially assume the new project has the same risk as the old.

Adjusted strike will be

$$X = kS_0 = k(C_0 + E(C_1) / k) = C_0 k + E(C_1).$$

Solving the Problems (continued)

The option payoff will be

$$
\begin{aligned}
Max(0, C_1 + \Delta C_1 - X) &= Max(0, C_1 + \Delta C_1 - (C_0 k + E(C_1))) \\
&= Max(0, C_1 - E(C_1) + \Delta C_1 - C_0 k).
\end{aligned}
$$

Thus, even with the strike adjustment, the option payoff is a function of the unexpected performance of the existing and new projects.

This shows that value can be created by not only taking on new projects but by managing existing projects so that expectations are exceeded.

Thus, even if the firm had no cash and no investment opportunities, the manager could create value by making existing projects exceed expectations. The manager should be rewarded for that and will be.

In fact, management can even shift resources from projects if the gain on one project more than exceeds the loss on the other.

But if the strike is not adjusted in this manner, the manager does not have to beat expectations. He need only have $C_1 > E(C_1)/k$ (for the case of zero initial cash).

Solving the Problems (continued)

Other problems addressed:

- Uncertainty and early exercise
- Separating luck and skill

For the latter, we assume that the stock price at time 1 consists of the expected stock price plus the unexpected performance associated with the market and the unexpected performance attributed to the executive:

$$S_1 = E(S_1) + \omega(M) + \omega(E)$$

Assuming a CAPM world, the strike should be adjusted in this manner:

$$\begin{aligned} X &= S_0(k + (r_m - \mu_m)\beta) \\ &= S_0(r + (\mu_m - r)\beta + (r_m - \mu_m)\beta) \\ &= S_0(r + (r_m - r)\beta) \end{aligned}$$

Solving the Problems (continued)

- Risk-shifting

If the new project has different risk from the existing projects, the strike should be adjusted further. Let k' be the cost-of-capital of the new project ($k' \neq k$). Then the adjusted cost-of-capital should be

$$k^* = \left(\frac{1}{S_0}\right)\left(E(C_1) + C_0 k'\right).$$

The option payoff will then be

$$\begin{aligned} Max(0, C_1 + \Delta C_1 - X) &= Max(0, C_1 + \Delta C_1 - S_0 k^*) \\ &= Max(0, C_1 + \Delta C_1 - S_0(1/S_0)(E(C_1) + C_0 k')) \\ &= Max(0, C_1 + \Delta C_1 - (E(C_1) + C_0 k')) \\ &= Max(0, C_1 - E(C_1) + \Delta C_1 - C_0 k'). \end{aligned}$$

So the proper cost-of-capital is then applied in determining the option's payoff. For a standard option, risk-shifting can be an even greater problem.

Empirical Estimates

The objective is to estimate how the values of options would differ if they were issued with cost-of-capital adjustments.

In addition, the model tells us that

- The more cash on hand, the more valuable is this feature of the option to managers.
- Managers may also be prone to overinvestment (unprofitable investment) because they can engage in empire-building and still benefit from their options.

This will also enable us to identify the portion of option value that is compensation relative to the portion that is incentives.

- Data:
    - All non-financial firms in Compustat, CRSP, and ExecuComp
    - 1992-2005
    - 4,553 firm-years

Empirical Estimates (continued)

Basic Procedure

- Estimate the cost-of-capital for each firm
- Revalue the options of the top five executives as though they were adjusted by the cost of capital
- Determine the difference in option value and express this value relative to various measures
- Determine if this option value difference is related to free cash flow and overinvestment

Empirical Estimates (continued)

Estimating the Cost of Capital

We follow a procedure by Vassalou and Xing (*Journal of Finance*, 2004), which is based on the Black-Scholes-Merton model of equity as an option.

Five variables:

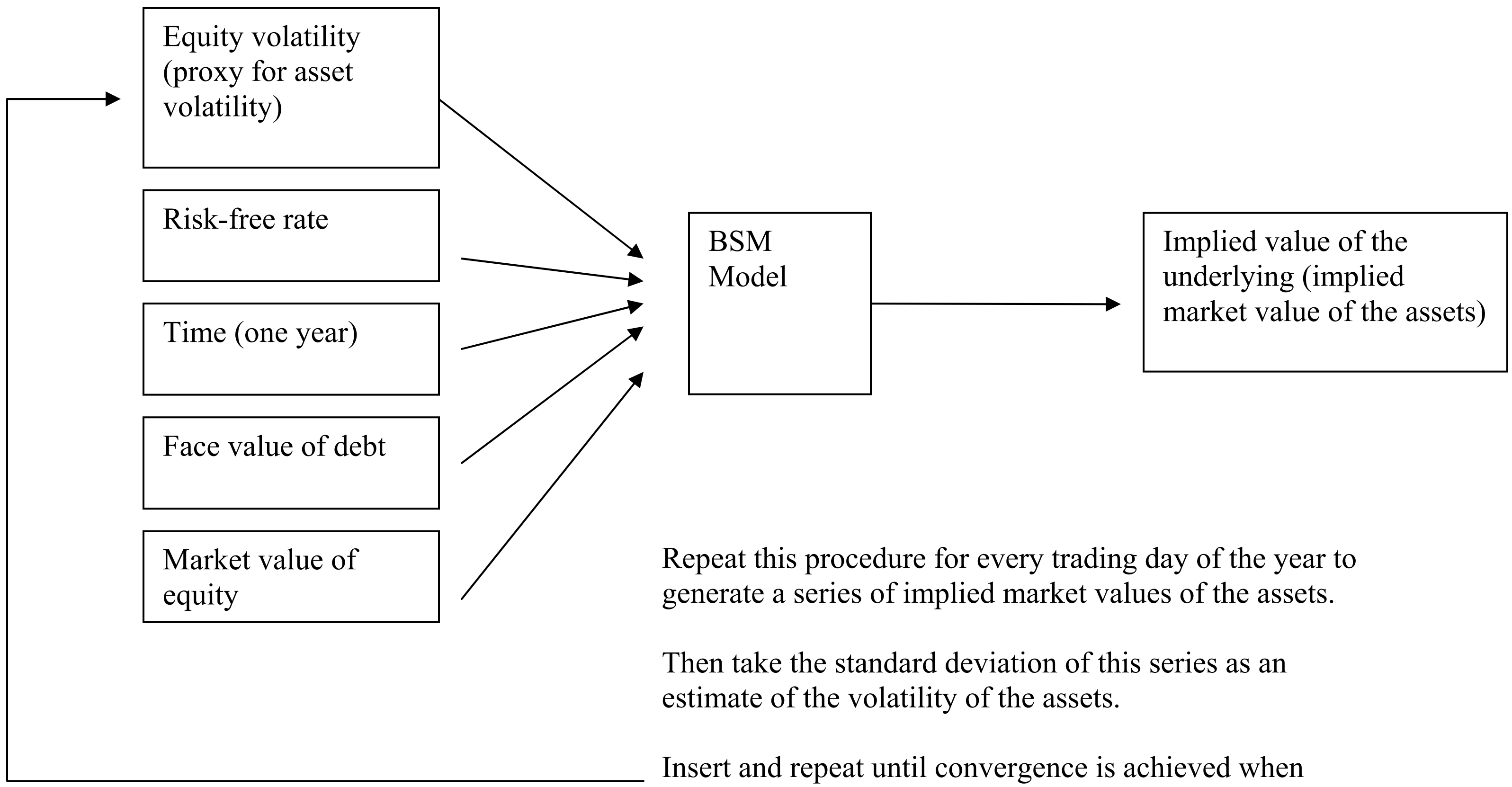
- Market value of assets
- Face value of zero coupon debt
- Risk-free rate
- Time to maturity of debt
- Volatility of assets
- These inputs combine to produce the market value of the equity from the BSM model.

Assumptions

- One-year maturity
- Face value of debt is
  - Debt due in one year, plus
  - One-half of long-term debt

Empirical Estimates (continued)

Estimating the Cost of Capital (continued)



Repeat this procedure for every trading day of the year to generate a series of implied market values of the assets.

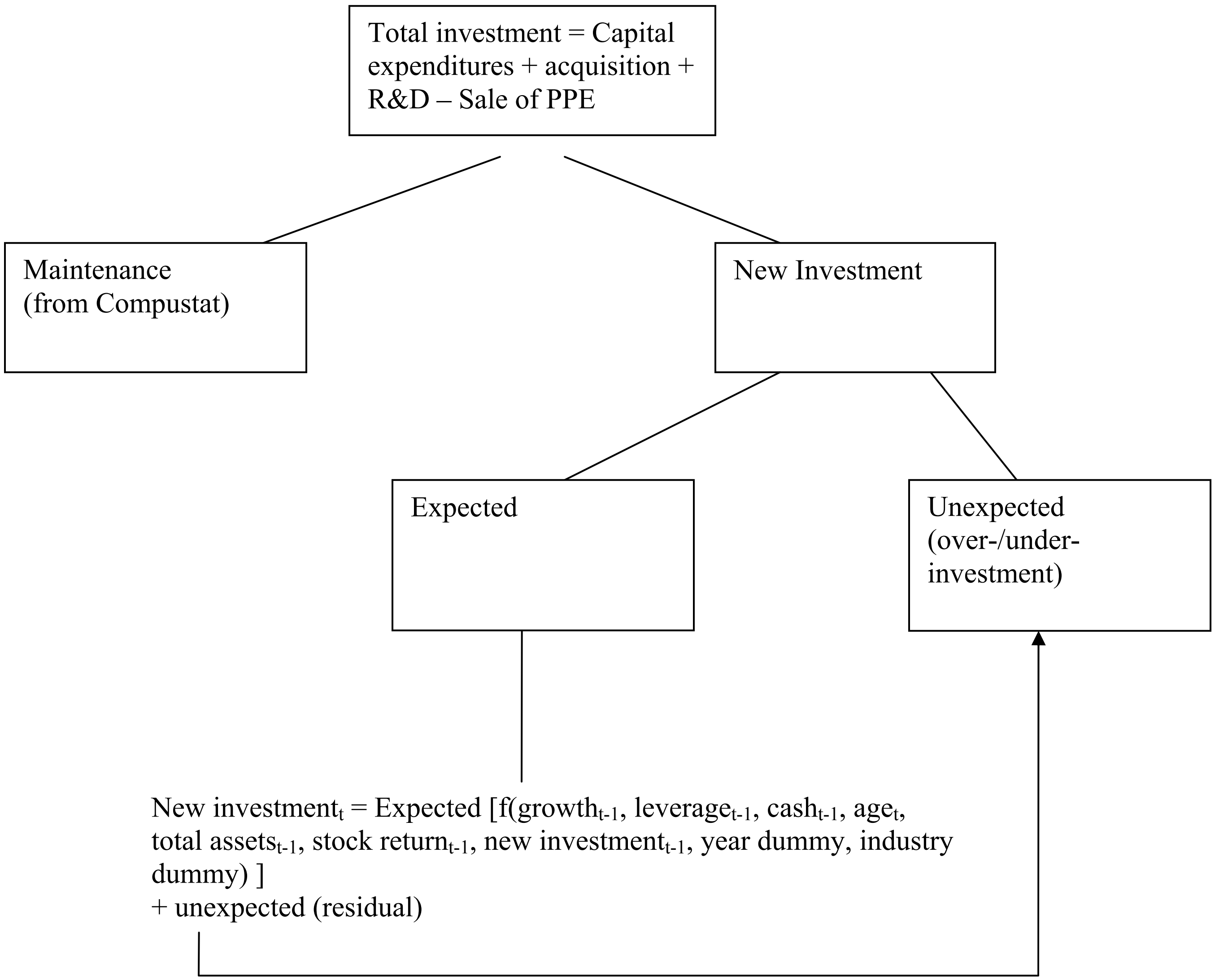
Then take the standard deviation of this series as an estimate of the volatility of the assets.

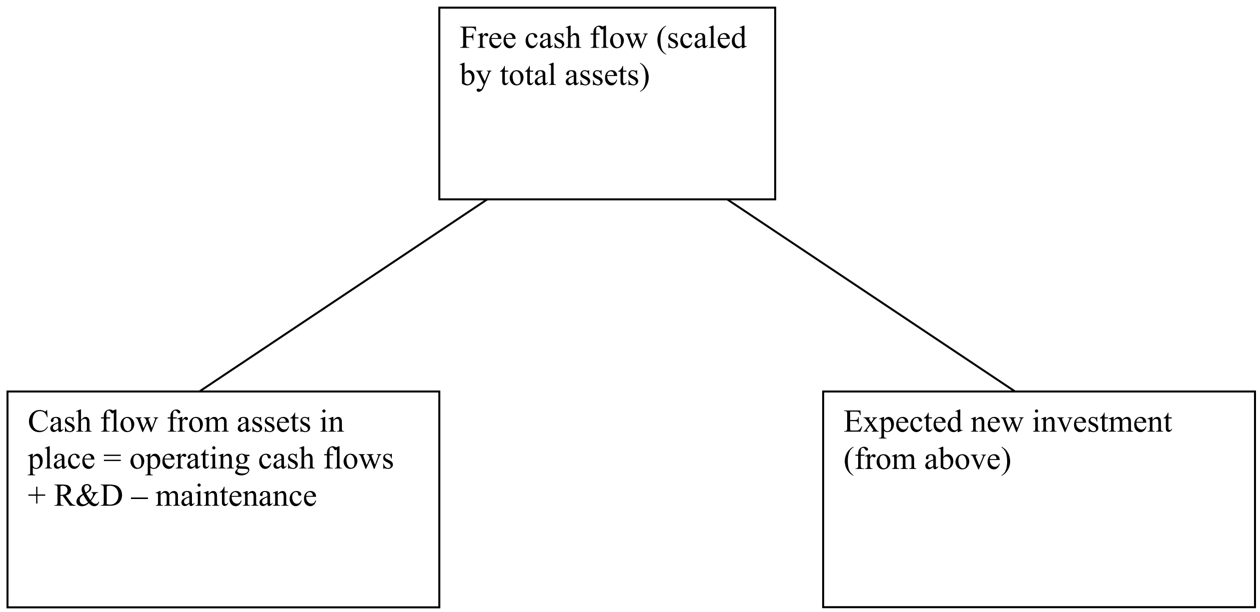
Insert and repeat until convergence is achieved when successive errors are less than 0.0001.

Empirical Estimates (continued)

Estimating Overinvestment and Free Cash Flow

Follows Richardson (*Review of Accounting Studies*, 2006)


Total investment = Capital expenditures + acquisition + R&D – Sale of PPE
Maintenance (from Compustat)
New Investment
Expected
Unexpected (over-/under-investment)
New investment$_t$ = Expected [f(growth$_{t-1}$, leverage$_{t-1}$, cash$_{t-1}$, age$_t$, total assets$_{t-1}$, stock return$_{t-1}$, new investment$_{t-1}$, year dummy, industry dummy)]
+ unexpected (residual)


Free cash flow (scaled by total assets)
Cash flow from assets in place = operating cash flows + R&D – maintenance
Expected new investment (from above)

Empirical Estimates (continued)

Estimating Overinvestment and Free Cash Flow

Summary statistics are in Table 3.

We replicate Richardson's results, testing various versions of the model. Results do not differ widely with R^2's ranging from 32 to 34 percent.

Empirical Estimates (continued)

Results

Table 4. Difference in Value between At-the-Money Options and Cost-of-Capital Options

Variables	Mean	Median	Std. Dev.	P(10th)	P(90th)
OPVALDIFF/MV	0.00269	0.00067	0.00833	0.00007	0.00605
OPVALDIFF /TA	0.00334	0.00074	0.00953	0.00008	0.00773
OPVALDIFF/SAL	1.27801	0.44903	4.60768	0.06051	2.68217
OPVALDIFF/SPB	0.73910	0.27872	2.15346	0.04233	1.58037
OPVALDIFF/TOTC	0.17857	0.11194	0.18057	0.01796	0.43737
OPVALDIFF/OPTV	0.42089	0.32646	0.34493	0.04259	0.93737

Results:

- 0.27% (0.07%) relative to market value of equity
- 127.8% (44.9%) relative to salary
- 17.9% (11.1%) relative to total compensation
- 42.1% (32.6%) relative to option value

Empirical Estimates (continued)

Results

Table 5. Regression of Free Cash Flow on Option Value Difference

Variable	Model I	Model II	Model III FCF>0	Model IV FCF>0
OPTVALDIFF/MV	0.448	0.495	0.670	0.637
	(1.77)*	(1.98)**	(2.71)***	(2.70)***
V/P_{t-1}	0.005	0.017	-0.019	-0.016
	(0.73)	(2.35)**	(-5.54)***	(-4.29)***
LEV_{t-1}	-0.076	-0.078	0.015	0.010
	(-4.39)***	(-4.29)***	(0.94)	(0.57)
$CASH_{t-1}$	-0.076	-0.114	0.051	0.031
	(-6.43)***	(-9.07)***	(4.30)***	(2.25)**
AGE_{t-1}	0.004	0.003	0.001	0.0001
	(1.88)*	(1.25)	(0.46)	(0.09)
$SIZE_{t-1}$	0.010	0.009	-0.003	-0.002
	(7.10)***	(6.61)***	(-2.89)***	(-2.34)**
SR_{t-1}	0.009	0.013	0.002	0.005
	(1.98)**	(2.91)***	(0.86)	(1.68)*
$INV_{New,t-1}$	-1.154	-0.178	0.084	0.070
	(-7.16)***	(-8.12)***	(4.35)***	(3.37)***
Constant	-0.037	-0.034	0.074	0.067
	(-3.26)***	(-2.29)**	(10.85)***	(7.34)***
Year dummies	No	Yes	No	Yes
Industry dummies	No	Yes	No	Yes
Adjusted R^2	0.109	0.163	0.079	0.094

Results:

OPTVALDIFF positively related to FCF; stronger when FCF > 0

Empirical Estimates (continued)

Results

Table 6. Regression of Unexpected Investment on Option Value Difference

Variable	Model I	Model II	Model III (Overinvestment)	Model IV (Overinvestment)
OPTVALDIFF/MV	0.168	0.156	0.926	0.925
	(0.83)	(1.76)	(2.09)**	(2.03)**
FCF>0	0.245	0.255	0.225	0.179
	(5.26)***	(5.24)***	(3.64)***	(2.82)***
FCF<0	0.085	0.090	-0.213	-0.178
	(1.83)*	(1.85)*	(-4.20)***	(-3.64)***
Constant	-0.006	-0.007	0.049	0.027
	(-2.22)**	(-1.23)	(14.45)***	(3.30)***
Year dummies	No	Yes	No	Yes
Industry dummies	No	Yes	No	Yes
Adjusted R^2	0.040	0.042	0.061	0.088

Note: growth, size, etc. are not included here because they have effectively already been accounted for in a prior regression; FCF > 0 & < 0 allows examination of asymmetric response.

Results:

FCF positively related to overinvestment as expected.

OPTVALDIFF not related except when firms have positive overinvestment.

Conclusions

- Conventional (at-the-money) options reward management for results achieved before the options are granted.
- The cost of conventional options can exceed incremental value achieved from new investment.
- Management can benefit even if it undertakes projects that destroy shareholder wealth.
- Because of this result,
    - Management will be averse to dividends, unless the strike is adjusted.
    - Management will find financial investment and share repurchase equally desirable and preferred over dividends even if the strike is adjusted.
- Indexing the exercise price to the cost of capital solves these problems.
- This problem amounts to about
    - One-quarter percent of equity value
    - 42 percent of option value
    - 18 percent of compensation
- One could conclude that these figures represent the amount by which options reward management for past achievements, or hence, be viewed as the compensation component of options.