Employee Stock Options, Financing Constraints, and Real Investment

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March 2009

Our goals

- **Focus attention on proceeds from the exercise of stock options as a source of financing.**
  - *Options as a cost to the firm and a source of cash.*
  - *Provide significant cash inflows and tax benefits.*
- **Demonstrate that stock options help to allocate funds efficiently.**
  - *Supply of cash is synchronized with investment needs.*
  - *The optimal compensation structure can mitigate agency problem of overinvestment.*
- **Test whether constrained firms use proceeds for investment.**
  - *Measure the sensitivity of investment to the proceeds from stock options.*
  - *Regression discontinuity design.*

Importance of stock options

- Aggregate value of stock options granted by U.S. companies grew from $11 billion in 1992 to over $119 billion in 2000 (Hall and Murphy (2003)).
- In 2004, Amgen, Corp. received over $450 million from proceeds associated with stock option exercises, as well as $200 million in corresponding tax benefits.
- These cash inflows were approximately 50% of Amgen's capital expenditures for the year.
- Outstanding options average 12.7% of outstanding shares.
- Average proceeds from stock options exercise are $29M and the associated average tax benefits are $16M.

Cash inflows from option exercises

- Cash inflows associated with stock option exercises have a first order effect on firms' cash flows. How does it happen that they are ignored in the literature?
- Proceeds and tax benefits appear in the Statement of Cash Flows and enter under "Cash flows from financing activities" and "Cash flows from operating activities", respectively.
- Net increase in cash flow does not appear anywhere on the "Income statement."
- Incentive compensation growth is a relatively recent phenomenon.

Cash flow implications of stock options: at the time of the grant.

- No cash outflow at the grant date.
- Stock options replace wages and save cash for the company.
- This effect has been highlighted in Yermack (1995), Core and Guay (2001), and Hall and Murphy (2003).

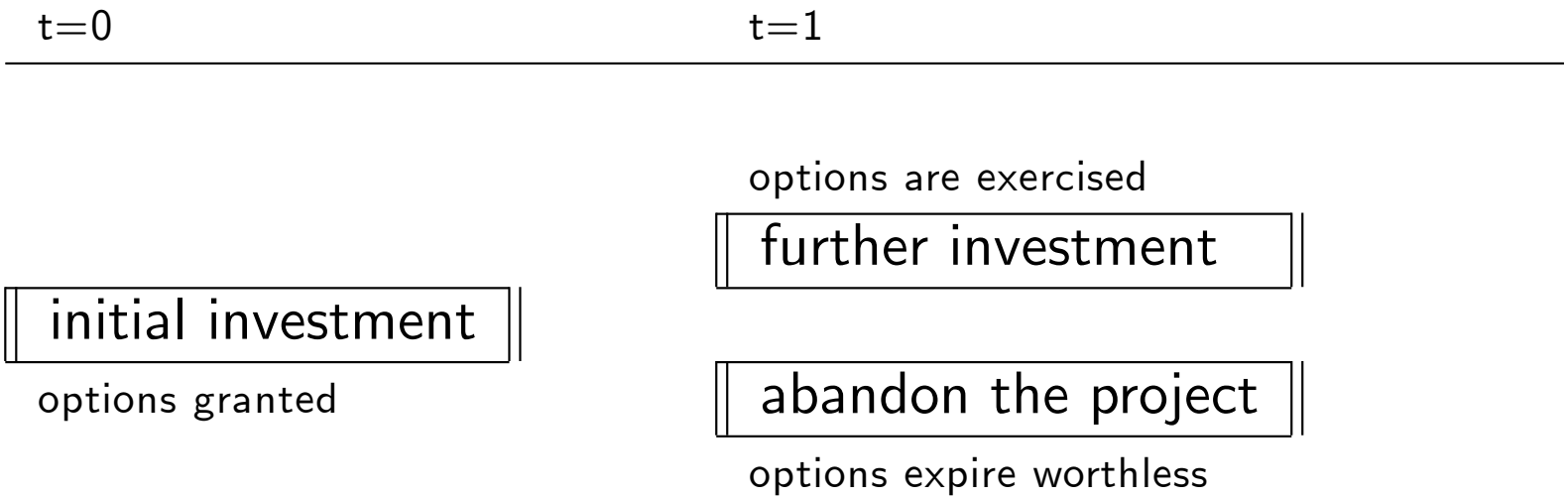
Cash flow implications of stock options: at the time of the exercise.

- Cash inflows at the time of the exercise consist of proceeds from exercise and the associated tax benefits.
- **Proceeds:** employees are required to pay the strike price at the time of the exercise, even for so-called cashless exercise.
- **Tax benefits:** the firm receives an associated tax deduction on the difference between the stock price at exercise and the strike price. See Graham, et al (2004).

The use of stock options

- Provision of incentives (Hall and Liebman (1998), Murphy (1999)).
- Not likely to be a first order consideration for lower level employees.
  - Oyer and Schaefer (2005) reject an incentives-based explanation for broad-based option plans.
  - Suggest sorting (optimistic employees) or retention (Oyer (2004)) are more consistent with the data.
- When employees' outside opportunities are correlated with firm performance, the use of stock options can minimize renegotiation costs in labor markets (Oyer (2004)).
- Our work adds to this literature by relating the cash inflows from stock option exercises to investment.

Cash implications of stock options: the big picture



Related literature

- Stein (1992)
  — Issuing convertible bonds allows firms to signal quality to the market and issue equity through the backdoor.
- Mayers (1998)
  — Convertible bonds control overinvestment incentives and allow for staged financing by injecting equity into the capital structure and increasing debt capacity at conversion.
  — Convertible bonds do not directly provide cash flow at conversion.

Related literature

- Stock options are essentially warrants issued to employees.
- Sahlman (1990) and Schultz (1993) discuss how VC's and warrants mitigate overinvestment by providing for staged financing.

Model: Overview

- Financially constrained firm that invests at two dates and faces uncertainty.
- The firm can borrow a limited amount using investment as collateral.
- Investment opportunities are correlated with cash flows and stock prices.
- We consider the possibility of overinvestment when investment opportunities are poor.

Stock options and financing constraints

- Granting of stock options can substitute for cash wages at the time of the grant.
- Yermack (1995), Core and Guay (2001), and Kato, Lemmon, Luo, and Schallheim (2005).
- Not clear, however, that employees are the most efficient providers of capital to the firm.
  - Employee stock options are non-transferable.
  - Human capital risk.
- Will require a higher return to hold options compared to better diversified investors.

Stock options and financing constraints

- Employees may be efficient providers of capital when either:
  - Information asymmetries between employees and the firm are smaller than those between the firm and outside investors (Huddart and Lang (2003)).
  - When employees are more optimistic than alternative investors and strictly prefer the claim offered by the firm to traded equity (Bergman and Jenter (2007)).

Stock options and financing constraints

- We do not attempt to provide a complete theory of why firms grant options or why options might dominate other securities.
- We assume that the firm is constrained in its ability to access external finance, but that it can issue stock options at a cost.
  — Employee optimism.
  — Reduced informational frictions.
  — Other unmodeled benefits of stock options (e.g., Oyer (2004)).

Model I: Setup

t=0

c_0

borrow qI_0

save C

t=1

c_1

borrow qI_1

use C

pay back qI_0 and qI_1

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invest I_0

n *options* $+ w$

prob p

price S^H

invest I_1^H

payoff

$H(I_1^H) + F(I_0)$

prob $1 - p$

invest I_1^L

price S^L

payoff

$L(I_1^L) + F(I_0)$

Model II: Additional assumptions

- Functions F, H and L are increasing and concave.
- Limited collateral $B_0 \leq qI_0$.
- $H'(I) > L'(I)$ -investment opportunities are correlated with demand.
- Participation constraint $w + zn(S^H - K) \geq W$.
- Assume that salary is paid at the time of the grant.
- Risk aversion means $z < p$.

Model III: Maximization problem

Maximize the sum of dividends:

$$\max_{n,w,C,I,B} \{d_0 + p(d_1^H - nS^H + d_2^H) + (1-p)\left(d_1^L + d_2^L\right)\}$$

$$s.t.\ d_0 = c_0 + B_0 - C - I_0 - w(1-T) \geq 0$$
$$d_1^H = c_1^H + C + B_1^H - I_1^H + nK + n(S_H - K)T \geq 0$$
$$d_1^L = c_1^L - I_1^L + C + B_1^L \geq 0$$
$$d_2^H = F(I_0) + H(I_1^H) - B_0 - B_1^H$$
$$d_2^L = F(I_0) + L(I_1^L) - B_0 - B_1^L.$$

Model IV: Unconstrained firm

Investment of unconstrained firm is not sensitive to the compensation mix.

Justification: Since constraints do not bind, the unconstrained firm makes first best investment, i.e.,

$$H'(I_1^{H*}) = 1, F'(I_0^*) = 1, L'(I_1^{L*}) = 1.$$

Investment is not sensitive to changes in compensation structure, i.e.

$$\frac{\partial I_1^{H*}}{\partial n} = \frac{\partial I_1^{L*}}{\partial n} = \frac{\partial I_0^*}{\partial n} = 0.$$

Model V: Investment by a constrained firm

Maximize the sum of the dividends, using the participation constraint and budget constraints

$$\max_{w,C,I}\{F(I_0) - I_0 - w(1-\frac{p}{z})(1-T) \\ +p(H(I_1^H) - I_1^H) + (1-p)\left(L(I_1^L) - I_1^L\right)\}.$$

the optimal investment levels are determined by:

$$I_0^* = \frac{c_0 - C - w}{1-q}, \qquad L'(I_1^{L*}) = 1$$

$$I_1^{H*} = \frac{1}{1-q}\left(c_1^H + C + nK + n(S^H - K)T\right).$$

Model VI: Savings

The first order condition with respect to savings C (no tax, for simplicity)

$$F'(I_0) = (1-p)1 + pH'(I_1^H).$$

Intuition: Optimal savings sets the marginal profitability of current investment equal to the expected marginal profitability of future investment at $t = 0$.
Totally differentiating this condition with respect to the number of options n yields:

$$\begin{aligned} \frac{\partial C^*}{\partial n} &= -\frac{F''(I_0)\frac{\partial w}{\partial n} + pH''\left(I_1^H\right)K}{F''(I_0) + pH''(I_1^H)}. \\ &< 0 \text{ if K is sufficiently high} \end{aligned}$$

Model VII: Investment sensitivity to compensation

In contrast to investment of an unconstrained firm, investment of constrained firm increases with inflow of funds from stock options.

$$\frac{\partial I_0^*}{\partial n} = \frac{-1}{1-q}\frac{\partial w}{\partial n} - \frac{1}{1-q}\frac{\partial C^*}{\partial n} > 0$$

$$\frac{\partial I_1^{H*}}{\partial n} = \frac{1}{1-q}\left(\frac{\partial C^*}{\partial n} + K\right) > 0$$

Model VIII: Optimal compensation structure

Consider the first order condition with respect to n:

$$\left(F'(I_0) - 1\right) \frac{\partial I_0}{\partial n} + \left(H'(I_1^H) - 1\right) p \frac{\partial I_1^H}{\partial n} - \left(1 - \frac{p}{z}\right) \frac{\partial w}{\partial n} = 0.$$

- First two terms capture the effect of stock options on budget constraints.
- The last term is due to risk aversion. Risk-neutrality means $z = p$.
- Corner and interior solutions are possible.

Model IX: Agency problem

Holding compensation policy fixed, with a more severe overinvestment problem (smaller L'), the firm carries lower optimal savings. The first order condition with respect to C is

$$F'(I_0) = (1-p)L'(I_1^L) + pH'(I_1^H).$$

- We show that (under mild conditions) the overinvestment problem generally increases the incentives to pay employees with stock options.

The sample

- Stock option exercises, grants, and outstanding options during 2000-2005.
- Source: IRRC (aproximately S&P 1500). Hand-collected sample for NASDAQ 100 firms.
- Final sample contains 7,116 firm-year observations from 1,416 firms.
- We calculate proceeds, tax benefits, and the Black-Scholes value of the granted options from this data.
- Computing tax benefits is difficult (Hanlon and Shevlin (2001)).

Investment measures

- 1) Capital Expenditures 2) Research & Development 3) Total Investment
- All variables are normalized by lagged book assets.
- Why incorporate R&D?
  - Investment in R&D accounts for 1/3 of Total Investment, on average.
  - Investment in R&D may be more sensitive to internally generated funds because of low collateral and high asymetric information.
  - It is inappropriate to view the firm as having separate sources of funds for R&D and CAPEX.
- Since R&D is expensed on income statement we add it back to the cash flow.

Sample

Variable	Mean	Std. Dev.	25%	50%	75%
CAPEX/Asst	0.066	0.063	0.026	0.047	0.083
R&D/Asst	0.036	0.063	0	0	0.049
Total Investment/Asst	0.104	0.091	0.043	0.076	0.133
Stock Rep./Asst	0.027	0.050	0	0.002	0.031
Option Proceeds/Asst	0.013	0.020	0.001	0.005	0.015
Fraction of Non-exec.	0.842	0.249	0.799	0.958	1
Tax Benefits/Asst	0.007	0.021	0.000	0.001	0.004
Option Grants/Asst	0.055	0.102	0.008	0.020	0.056
SEO Proceeds/Asst	0.016	0.081	0	0	0
Option Proceeds ($M)	29.12	66.79	1.49	6.13	23.03
Tax Benefits ($M)	16.40	116.17	0.07	0.77	5.22
Option Grants ($M)	135.68	598.71	8.30	25.00	78.29
Option Use	0.127	0.397	0.063	0.099	0.149

Use of options across firms

High and Low Users of Stock Options				
	High Users		*Low Users*	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
CAPEX/Assets	0.059	0.056	0.065	0.050
R&D/Assets	0.050	0.069	0.018	0.038
Total Investment/Assets	0.110	0.092	0.084	0.063
Stock Repurchases/Assets	0.037	0.060	0.028	0.052
Option Proceeds/Assets	0.019	0.026	0.008	0.013
Tax Benefits/Assets	0.020	0.065	0.004	0.019
Option Grants/Assets	0.092	0.168	0.025	0.050

Estimating investment sensitivity to option proceeds and tax benefits.

$$\frac{I_{it}}{A_{i,t-1}} = \alpha_i + \alpha_t + \beta_1 \frac{\textit{Non-Option CF}_{it}}{A_{i,t-1}} + \beta_2 Q_{i,t-1} + \beta_3 \frac{\textit{Option Proceeds}_{it}}{A_{i,t-1}} + \beta_4 \frac{\textit{Tax Benefits}_{it}}{A_{i,t-1}} + \varepsilon_{it}$$

- Regressions also include firm and year fixed effects.
- Standard errors are clustered at the firm level.

Estimating investment sensitivity to option proceeds and tax benefits.

- Tobin's Q is likely measured with substantial error (e.g., Erickson and Whited (2000))
- Rely on Regression Discontinuity Design (RDD) widely used in labor economics (e.g., Angrist and Lavy (1999), Van der Klaauw (1996)). See also Rauh (2006) paper on mandatory pension contributions.
- The identifying assumption is that the relationship between the moneyness of stock options and the exercise proceeds is discontinuous at the point where options are out of the money.

Proceeds/assets versus moneyness

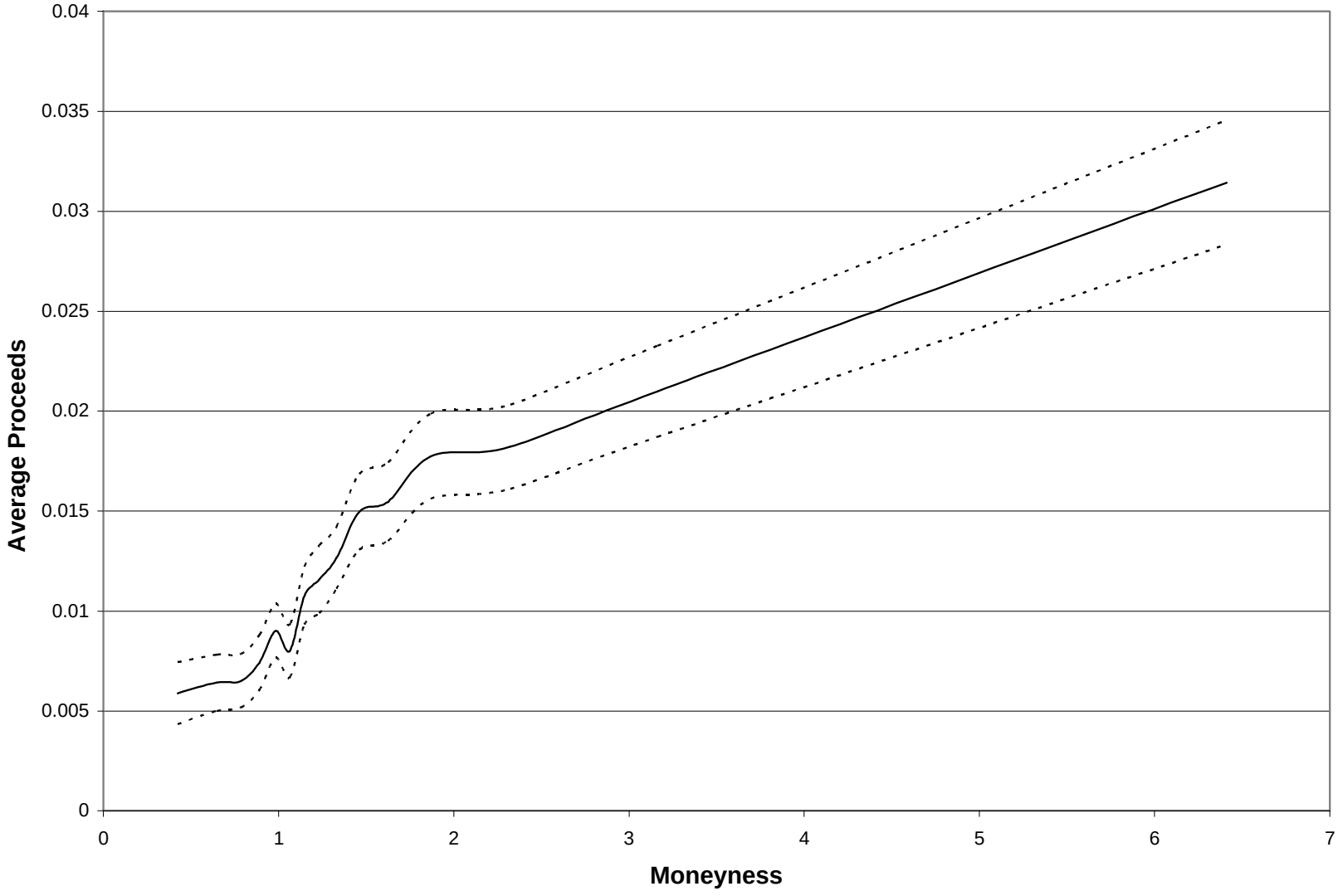

Figure 1. **Stock Option Exercise Proceeds and Moneyness.**

Investment/assets versus moneyness

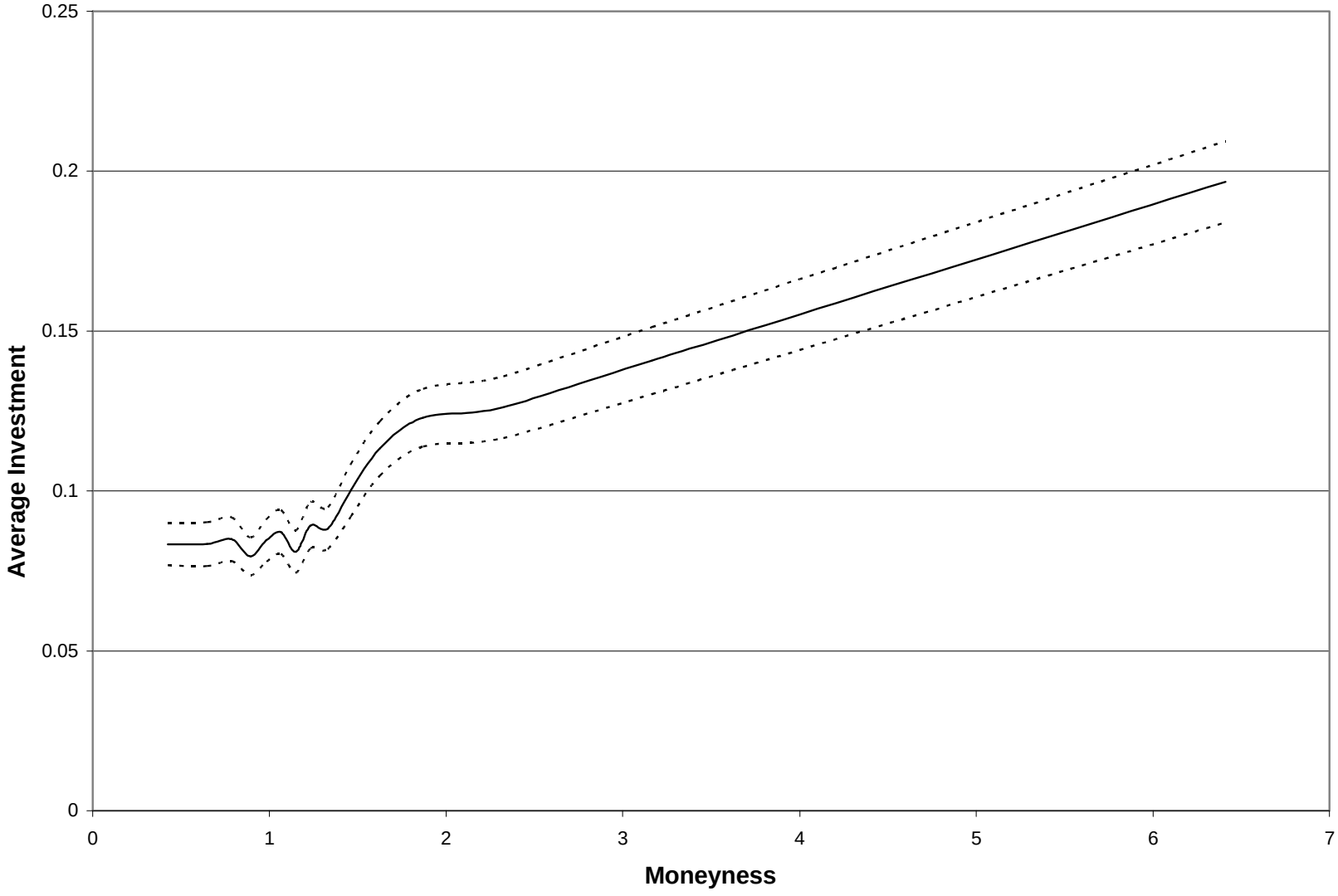

Figure 2. **Real Investment and Moneyness.**

Results of the sensitivity regression I

Panel A	Dependent variables						
	Total Invest.	CAPEX	R&D	Stock Rep.	Total Invest.	Total Invest.	Total Invest.
Cash Flow	0.188***	0.103***	0.082***	0.010	0.174***	0.188***	0.179***
	(10.47)	(8.58)	(8.48)	(0.85)	(8.81)	(10.32)	(9.88)
Q	0.009***	0.006***	0.003***	0.003***	0.009***	0.009***	0.005***
	(8.48)	(7.63)	(4.21)	(3.08)	(7.20)	(7.97)	(3.48)
Option Proceeds	**0.360*** **	**0.094***	**0.266*** **	**0.001**	**0.293*** **		**0.233*** **
	(4.40)	**(1.66)**	**(5.47)**	**(0.02)**	**(2.78)**		**(2.84)**
Tax Benefits					**0.225*** **		
					(2.71)		
Proceeds (Non-exec.)						**0.334*** **	
						(3.47)	
Proceeds (Executives)						**0.609*** **	
						(3.44)	
Expected Proceeds							**0.061*** **
							(4.98)
Adj.-R^2	0.777	0.713	0.896	0.477	0.793	0.773	0.782
Observations	7,106	7,106	7,106	6,586	5,517	6,855	6,724

Results of the sensitivity regression II: Total Investment

Panel B	Dependent variable is Total Investment			
	Full Sample	Full Sample	0.5<M<2.0	0.75<M<1.75
Cash Flow	0.175***	0.177***	0.154***	0.166***
	(9.49)	(9.44)	(8.23)	(6.69)
Q	0.008***	0.009***	0.011***	0.012***
	(7.25)	(7.25)	(7.06)	(5.13)
Option Proceeds	**0.269*** **	**0.286*** **	**0.262*** **	**0.264** **
	(3.27)	**(3.43)**	**(2.44)**	**(1.98)**
Moneyness	0.004***			
	(3.59)			
Moneyness^2	-0.000***			
	(-3.39)			
Past Return 1 year		0.002		
		(1.51)		
Past Return 3 years		0.001		
		(1.45)		
Adj.-R^2	0.782	0.778	0.763	0.778
Observations	6,724	7,062	5,006	4,007

Degree of Financing Constraints

Financing Constraints	Dependent variable is Total Investment				
	CF	Q	Opt. Proceeds	Obs.	Adj.-R^2
1. *Firm Size*					
Small Firms	0.176***	0.010***	**0.342*** **	3,283	0.782
	(6.84)	(5.99)	**(3.65)**		
Large Firms	0.219***	0.007***	**0.164**	3,466	0.765
	(10.12)	(4.46)	**(1.50)**		
2. *Dividend Payout*					
Zero Dividends	0.188***	0.008***	**0.408*** **	3,391	0.762
	(7.90)	(6.43)	**(3.87)**		
Positive Dividends	0.184***	0.009***	**0.116**	3,358	0.745
	(6.87)	(3.78)	**(1.23)**		
3. *Bond Ratings*					
Below Inv. Grade	0.186***	0.009***	**0.389*** **	4,326	0.766
	(8.26)	(6.97)	**(4.02)**		
Inv. Grade and Above	0.216***	0.006***	**0.197**	2,423	0.768
	(6.83)	(2.60)	**(1.55)**		
4. CP Ratings					
Unrated Firms	0.191***	0.009***	**0.374*** **	5,206	0.772
	(9.17)	(7.33)	**(4.11)**		
Rated Firms	0.201***	0.007***	**0.218**	1,543	0.755
	(4.32)	(2.21)	**(1.11)**		

Alternative Hypothesis

Financing Constraints	Dependent Variable is Stock Repurchases				
	CF	Q	Opt. Proceeds	Obs.	Adj.-R^2
1. Firm Size					
Small Firms	-0.006	0.003**	**-0.083**	2,985	0.447
	(-0.42)	(2.44)	**(-1.06)**		
Large Firms	0.049**	0.005**	**0.386****	3,273	0.547
	(2.18)	(2.12)	**(2.28)**		
2. Dividend Payout					
Zero Dividends	0.015	0.002**	**-0.079**	3,020	0.430
	(0.97)	(2.12)	**(-0.95)**		
Positive Dividends	0.009	0.007***	**0.349****	3,238	0.532
	(0.63)	(2.91)	**(2.50)**		
3. Bond Ratings					
Below Inv. Grade	0.003	0.002*	**-0.035**	3,930	0.461
	(0.23)	(1.90)	**(-0.45)**		
Inv. Grade and Above	0.011	0.008***	**0.275***	2,328	0.532
	(0.54)	(2.58)	**(1.71)**		
4. CP Ratings					
Unrated Firms	0.003	0.003**	**-0.023**	4,766	0.472
	(0.15)	(2.19)	**(-0.31)**		
Rated Firms	0.044*	0.006**	**0.213**	1,492	0.513
	(1.73)	(2.20)	**(0.95)**		

Conclusion

- We show that stock options relax the financing constraints at the time of the grant and also provide significant inflows of cash at the time of exercise.
- Stock options allow firms to increase investment precisely in those states where the demand for investment is high.
- Test whether financially constrained firms with larger stock option programs raise less external funds in financing their new investment than similar firms without such programs.
- Test whether firms in which investment demand is more correlated with stock price grant more stock options to employees.
- Illustrates an additional benefit of broad-based option plans that has not previously been studied.