

CEO Incentives and Stock Price Dynamics: An Experimental Approach

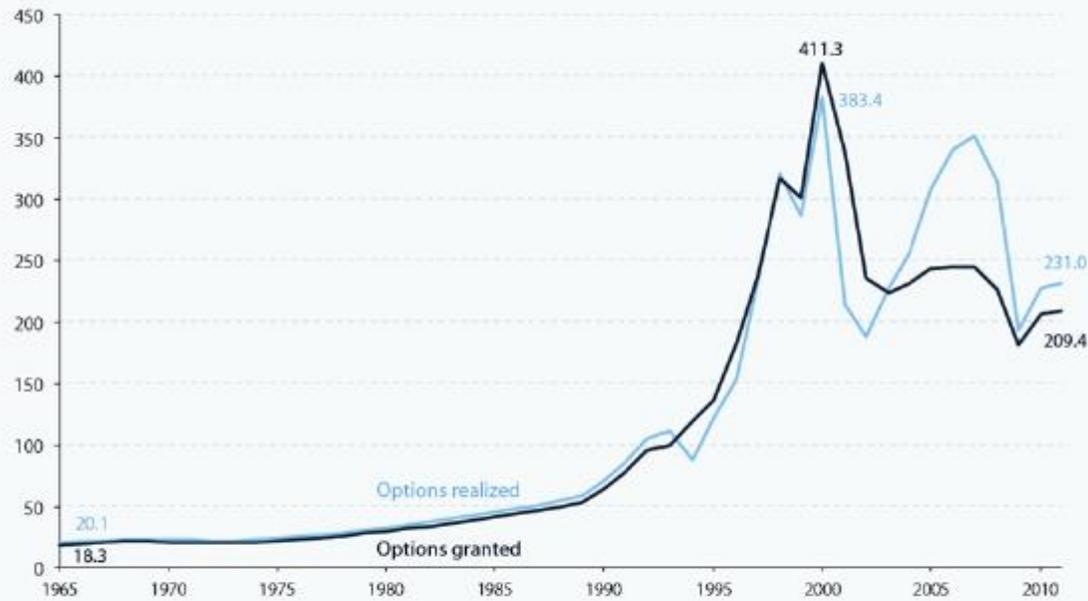
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CEO-to-worker compensation ratio, with options granted and options realized, 1965–2011



Note: "Options granted" compensation series includes salary, bonus, restricted stock grants, options granted, and long-term incentive payouts for CEOs at the top 350 firms ranked by sales. "Options exercised" compensation series includes salary, bonus, restricted stock grants, options exercised, and long-term incentive payouts for CEOs at the top 350 firms ranked by sales.

Sources: Authors' analysis of data from Compustat ExecuComp database, Bureau of Labor Statistics Current Employment Statistics program, and Bureau of Economic Analysis National Income and Product Accounts Tables



CEOs are getting more and more compared to other workers.

Agency Problem

- In firms with separation of ownership and control, agency problem may arise.
- Granting stock shares may reconcile the agency problem because it increases the interest congruence between the CEO and shareholders (Meckling (1976), Jensen and Murphy (1990a), Mehran (1995), Murphy (2003)).



Steward Theory:

Equity ownership might induce a sense of proprietorship (Wasserman, 2006; Pierce et al., 2001), leading the CEO to behave more like a “steward” of the firm (Davis et al., 1997), who maximizes the objective function of the organization.



Motivation

- It is hard to say if the effect of stock ownership comes from “feeling of ownership” or just increased income.
- It is also difficult to argue stock ownership is MORE EFFECTIVE than other incentives, e.g. cash bonus.
- Hard to address this issue with empirical data (no data on CEO effort). Controlled laboratory has advantages.

CEO Effort



Profit (FV) of the Firm



- We design an asset market experiment where the FV of the firm is endogenously determined by CEO effort.

Research Questions

- Do the CEOs invest higher effort when the same amount of payment is paid in terms of stock shares rather than cash bonus?
- How does the restriction on the CEO's ability to trade the shares of his own firm matter on his effort and price dynamics?
 - Will he work harder when he is granted this opportunity?
 - Will this lead to larger price volatility?
- Is the market able to price the CEO effort under both stock shares and cash bonus correctly by incorporating the information into share prices?

Main Results

- The CEO effort is NOT higher when the same amount of payment is paid in terms of stock shares rather than cash bonus.
- The market is in general able to price the CEO effort into share prices. (Good market efficiency.)
- Giving CEO the possibility to trade the stock of his firm will
 - lead to higher effort.
 - but also larger price volatility.

Treatment Design

- 2 x 2 Treatment Variations

	20% of Profit as Cash Bonus	20% of Stock Shares as Endowment
CEOs are prohibited from trading	Linear Compensation (<i>L</i>)	Stock Ownership Plan (<i>S</i>)
CEOs are able to participate in trading	Linear Compensation with the Possibility of Trading (<i>LT</i>)	Stock Ownership Plan with the Possibility of Trading (<i>ST</i>)

Model

- The CEO has a production function $Y_t = f(e_t) = 1000e_t - 2000$.
- He faces a cost function $c_t(e_t) = 50e_t^2$.
- Number of shares issued by the firm $N = 200$. The CEO makes the production decision in 10 periods.
- For simplicity, we assume that the stock does not pay dividends, and the value created by the CEO will be added to the **terminal value T_t of the stock**. (Paying dividend in finite horizon leads to decreasing fundamental price.) $T_0 = 110$.

Model (CEO cannot Trade)

Effort (e_t)	Change in Terminal Value (Y_t)	Cost at t ($c(e_t)$)	Benefit at t ($a_t + 0.2 Y_t$)	Utility at t ($a_t + 0.2 Y_t - c(e_t)$)
0	-10	0	0	0
1	-5	50	200	150
2	0	200	400	200
3	5	450	600	150
4	10	800	800	0

- We assume the stock has an **initial baseline value** of **110** ECU

- $$T_t = T_{t-1} + \frac{Y_t}{N} = T_{t-1} + \frac{(1000e_t - 2000)}{200} = T_{t-1} + 5e_t - 10$$

- This means that the terminal value T_t will be unchanged if $e_t = 2$. It will increase (decrease) if e_t is greater (smaller) than 2.
- $e_t = 2$ maximizes the CEO's utility, but $e_t = 4$ maximizes the shareholders' value (wealth).

Detailed Treatment Design

- Linear Wage Compensation plan (L) treatment, we let the cash bonus be $b_t = 0.2Y_t$.
- Stock Ownership Plan (S) treatment, we give the CEOs an endowment of $s_0 = 40$ shares, 20% of the total.
- In both L and S: $U_t = a_t + 0.2Y_t - c(e_t) = [400 + (200e_t -$

When CEO can Trade

Shares Owned	Notation	Optimal Effort (e^*)
$0 \leq s'_t < 10$	Low Possession (<i>LP</i>)	$e^* = 2$
$10 < s'_t < 30$	Medium Possession (<i>MP</i>)	$e^* = 3$
$30 < s'_t \leq 200$	High Possession (<i>HP</i>)	$e^* = 4$

Total Shares Outstanding $N = 200$

- When the CEO has the possibility to trade, LT and ST, let s'_t be the stock shares held by the CEO in each period net of his initial endowment.
- Utility becomes $U_t = a_t + 0.2Y_t + s'_t * \Delta T_t - c_t(e_t) = 200e_t - 50e_t^2 + 5s'_te_t - 10s'_t$
- This increases the marginal return of effort to the CEOs.

Testable Hypotheses

- **Hypothesis 1:** *CEO always chooses $e = 2$, and the terminal value of the asset stays at 110 in treatment L and S.*
- **Hypothesis 2:** *CEO does not accumulate stock shares in treatment LT and ST, namely, $s' = 0$ in all periods, and he always chooses $e = 2$.*
- **Hypothesis 3:** *Holding other things equal, CEOs do not exert more effort when they are paid by stock ownership than cash bonus. (No difference between L and S, LT and ST)*
- **Hypothesis 4:** *Holding other things equal, CEOs do not exert more effort when they are giving the opportunity to trade their own stocks. (No difference between L and LT, S and ST)*

		CEO							
Treatment:		<i>L</i>		<i>LT</i>		<i>S</i>		<i>ST</i>	
Type of Account:		Saving	Liquid	Saving	Liquid	Saving	Liquid	Saving	Liquid
Initial Cash		4000	0	0	4000	4000	0	0	4000
Free Gift		4400	0	4400	0	0	0	0	0
Total Initial Cash		8400	0	4400	4000	4000	0	0	4000
Initial Share		0		0		40		40	
Initial Ownership Value		0		0		4400		4400	
Total Initial Endowment Value		8400		8400		8400		8400	
C/A for CEO		-		-		91%		91%	

		Investors (Non-CEO Traders)							
Treatment:		<i>L</i>		<i>LT</i>		<i>S</i>		<i>ST</i>	
Type of Account:		Liquid		Liquid		Liquid		Liquid	
Total Initial Cash		4000		4000		4000		4000	
Initial Share		40		40		40		40	
Initial Ownership Value		4400		4400		4400		4400	
Total Initial Endowment Value		8400		8400		8400		8400	
C/A for Trader		91%		91%		91%		91%	

Experimental Parameterizations

Period: 1 Round: 1 Remaining Time (sec): 7

Cash: 3982 Shares: 40

Table of Bids (Buying Orders)
Select the chosen order before clicking "buy" or "withdraw"

Price	Volume
81	1
80	2

Execution Quantity:

E

Table of Asks (Selling Orders)
Select the chosen order before clicking "sell" or "withdraw"

Price	Volume
97	5
90	4
100	2
100	5

Execution Quantity:

 F

Current Price :
H 81

D Price:
Volume:

G **Transaction(s) History**

Price	Volume	Status of Transaction(s)
90	1	You accept other player's ask
81	1	You accept other player's bid

I **History of Withdrawn/Invalidated Order(s)**

Order Price	Order Volume	Type	Withdrawn Order	Invalidated Order
80	2	Bid	1	0
90	1	Ask	0	1

Screenshot (Trading)

Period	Terminal Value	CEO's Effort	Avg Price
1	115	3	140.0

D1		A1	
Effort CEO has put in for this period	3		
CEO's Shares at the end of this period	41		
Terminal Value	115		
Cash at the beginning of this period	4000		
Cash at the end of this period	3860		
		B1	
Shares at the beginning of this period	40		
Shares at the end of this period	41		
Initial Wealth at the beginning of this period	0		
Wealth at the end of this period	8525		
			C1

Screenshot (Information Feedback)

Table 7. The Average Effort of CEOs

Treatment	Average Effort				Signed Rank p -value (H_0 : Mean Effort = 2)	n
	mean	s.d.	Min	Max		
<i>L</i>	2.22	0.41	1.2	3.1	0.014	24
<i>LT</i>	2.53	0.54	1.5	3.7	0.0002	24
<i>S</i>	2.16	0.4	1.1	2.9	0.076	22
<i>ST</i>	2.39	0.77	0.9	3.8	0.003	22

Result 1: CEO's effort in treatments L and S are close to 2. But it is NOT higher in S compared to L, or ST compared to LT.

CEO Trading

Shares Owned	Notation	Optimal Effort (e^*)
$0 \leq s'_t < 10$	Low Possession (<i>LP</i>)	$e^* = 2$
$10 < s'_t < 30$	Medium Possession (<i>MP</i>)	$e^* = 3$
$30 < s'_t \leq 200$	High Possession (<i>HP</i>)	$e^* = 4$
Total Shares Outstanding $N = 200$		

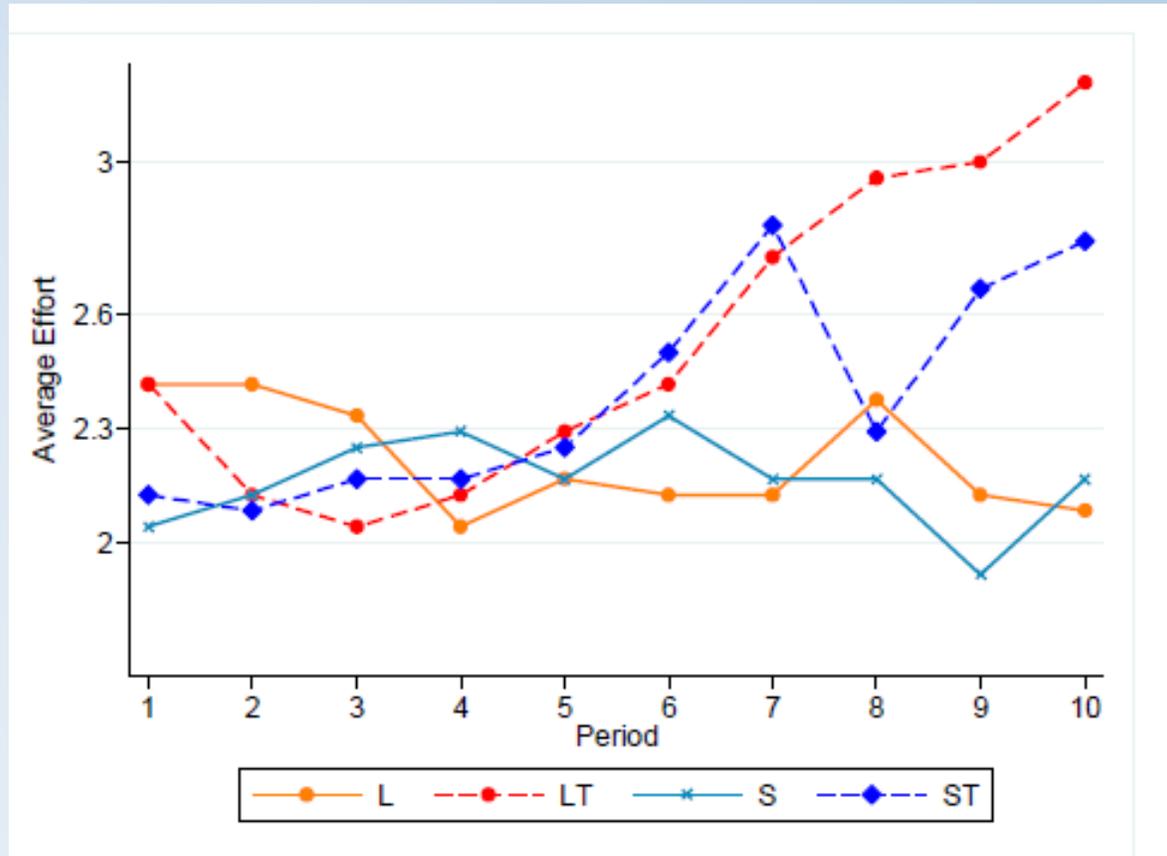
Table 10. CEOs' Asset Holdings

Treatment	CEO's Final s'_t		Signed Rank p -value (H_0 : Final $S'_t = 0$)	N
	Mean	Sd		
<i>LT</i>	18.46	17.52	< 0.0001	24
<i>ST</i>	18	12.53	< 0.0001	22
Mann-Whitney p -value				
$H_0: LT = ST$	0.7495			

Table 11. Average Effort Deviation

Treatment	Average of $e_t - e^*(s'_t)$				Signed Rank p -value (H_0 : Deviation = 0)	n
	mean	sd	min	max		
<i>L</i>	0.22	0.41	-0.8	1.1	0.01	24
<i>LT</i>	0.08	0.74	-1.5	1.7	0.49	24
<i>S</i>	0.17	0.41	-0.9	0.9	0.07	22
<i>ST</i>	-0.09	0.61	-1.3	1.4	0.44	22

- **Result 2:** we reject Hypothesis 2. The average holding of additional stock shares by the CEO is significantly greater than zero. The average CEO's effort is also substantially higher than 2. The higher CEO's effort leads to positive profit to the non-CEO traders. However, given the optimal CEO effort is higher when CEO holds more stocks, the CEOs in treatment *ST* actually under-invest their effort compared to the optimal level.



Time Series of CEO Effort

Table 13. OLS Estimation of (Absolute) Deviation from Optimal Effort

	(1)	(2)
Variables	Effort Deviation	
SOP Dummy	-0.111 (0.116)	-0.120 (0.117)
CEO Trading Dummy	-0.198* (0.117)	-0.221* (0.119)
CEO's Risk Preference		-0.00193 (0.0320)
CEO's Gender		-0.158 (0.118)
Constant	0.249*** (0.0821)	0.362 (0.227)
Observations	92	92
R ²	0.041	0.060
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Deviation of CEO from the Optimal Level

Result CEO Trading on Effort

- **Result 3:** *we do not reject Hypothesis 3. To the opposite, we find the average effort by the CEO is insignificantly lower in treatments where they are paid by stock ownership program than cash bonus. In addition, CEOs are significantly less likely to invest more than optimal level of effort in treatments with stock ownership program.*
- **Result 4:** *we reject Hypothesis 4. CEOs on average exert more effort in absolute terms in treatments with possibility to trade. But they are also more likely to under-invest their effort in relative terms.*

Market Efficiency

Treatment	<i>RAD</i>		<i>RD</i>		Price Amplitude	
	mean	Signrank <i>p</i> -value (H0:0)	mean	H0:0	mean	H0:0
<i>L</i>	0.09	< 0.0001	-0.01	0.7533	0.26	< 0.0001
<i>LT</i>	0.12	< 0.0001	0.04	0.0072	0.37	< 0.0001
<i>S</i>	0.04	< 0.0001	-0.0018	0.6682	0.14	< 0.0001
<i>ST</i>	0.11	< 0.0001	0.06	0.2087	0.21	< 0.0001
	<i>p</i> -value	n	<i>p</i> -value	n	<i>p</i> -value	n
<i>H0: L=LT</i>	0.016	48	0.020	48	0.004	48
<i>H0: S=ST</i>	0.003	48	0.410	48	0.005	48
<i>H0: L=S</i>	0.020	48	0.695	48	0.023	48
<i>H0: LT=ST</i>	0.070	48	0.216	48	0.002	48

- RAD and RD (Stockl et al. 2010) are measures of deviation from the fundamental price normalized by the scale of the fundamental price. They are very small in this experiment.

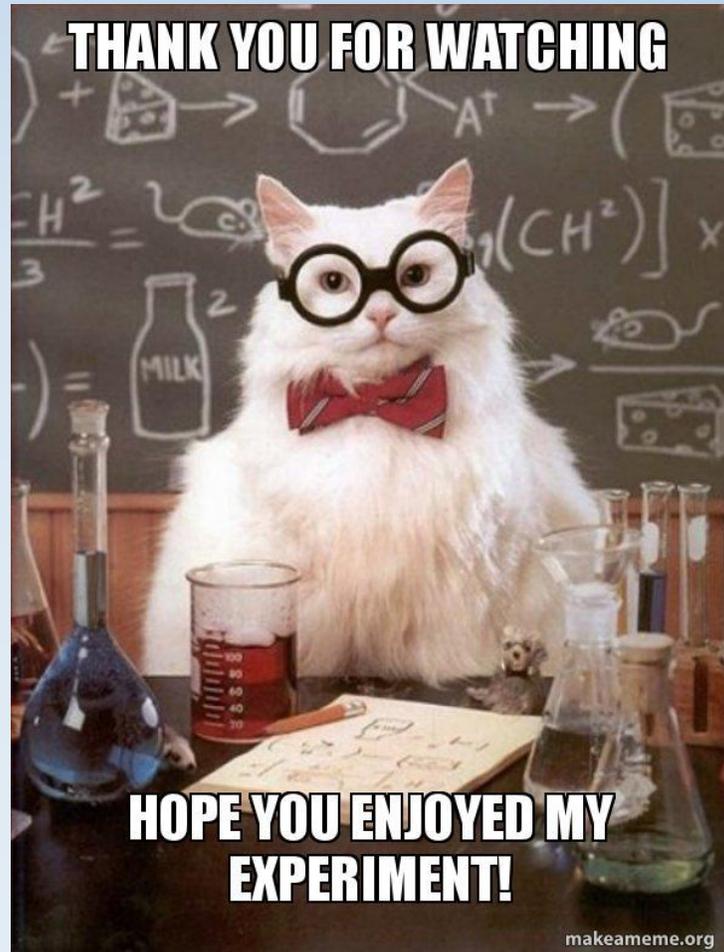
Market Efficiency and Treatment Effect

Variables	<i>RAD</i>		<i>RD</i>		Price Amplitude	
SOP dummy	-0.0273 (0.0223)	-0.0250 (0.0219)	0.0177 (0.0261)	0.0198 (0.0260)	-0.139*** (0.0417)	-0.135*** (0.0401)
CEO Trading Dummy	0.0477** (0.0223)	0.0290 (0.0195)	0.0605** (0.0261)	0.0425* (0.0241)	0.0883** (0.0417)	0.0554 (0.0416)
s.d. of CEO's Effort		0.0695*** (0.0224)		0.0669** (0.0274)		0.122*** (0.0365)
Constant	0.0806*** (0.0195)	0.0425* (0.0251)	-0.0171 (0.0225)	-0.0537* (0.0297)	0.271*** (0.0461)	0.204*** (0.0461)
Observations	96	96	96	96	96	96
R-squared	0.061	0.137	0.059	0.110	0.144	0.205

- Trading possibility for CEO results in larger deviation.

Conclusion

- The paper studies CEO effort and asset bubbles in a double auction market with different executive compensation schemes and CEO trading rules.
- We find
 1. High **market efficiency** (little bubble), maybe because the DGP of the FV is easier to understand and more similar to that in a real stock market.
 2. CEO effort is insignificantly **lower** when the payment is made **in stock shares** compared to cash, holding the total payment value constant.
 3. Allowing CEOs to trade lead to **higher effort in absolute terms**, but also more “shirking” compared to the optimal level, and **more price deviation**.



Thank you!

CEO Strategic Effort

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>LT</i>				<i>ST</i>			
	Shirking		Excessive Effort		Shirking		Excessive Effort	
$(S'_t \text{ at } t+1) - (S'_t \text{ at } t)$	0.0236*** (0.00460)	0.0243*** (0.00413)	-0.0131*** (0.00462)	-0.0134*** (0.00433)	0.0144** (0.00556)	0.0159*** (0.00566)	-0.000846 (0.00509)	-0.00300 (0.00492)
Medium Possession Dummy		0.229*** (0.0674)		-0.237*** (0.0691)		0.261*** (0.0690)		-0.194*** (0.0635)
High Possession Dummy		0.303*** (0.107)				0.0532 (0.100)		
Period		-0.0288*** (0.00917)		0.00632 (0.0136)		-0.0118 (0.0127)		0.00399 (0.0135)
Constant	0.167*** (0.0269)	0.229*** (0.0558)	0.376*** (0.0369)	0.406*** (0.0732)	0.302*** (0.0325)	0.259*** (0.0717)	0.250*** (0.0328)	0.313*** (0.0728)
Observations	216	216	196	196	216	216	193	193
R-squared	0.118	0.197	0.024	0.067	0.033	0.095	0.000	0.045

- It seems CEO takes lower effort when they want to accumulate stocks.

	L	LT	S	ST
The number of active traders	5 (5 non-CEO traders)	6 (5 non-CEO traders and 1 CEO trader)	4 (4 non-CEO traders)	5 (4 non-CEO traders and 1 CEO trader)
Number of Observations (CEOs)	24	24	24	24

Instruction	Quiz	Trials	Effort Elicitation	Summary Page for CEO	Trading	Summary Page for All	Risk Elicitation
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- Traders' degree of *risk preferences*, using incentivised test introduced by Holt and Laury (2002).

of Observations and Timeline

Treatment	Session	Group	Incentive Payment (20% of Profit)	Is CEO allowed to Trade?	In one market:			In one session:		
					No of Manager	No of Investors	No of Active Traders	Total No of Managers	Total No of Investors	Total No of Subjects
<i>L</i>	1	1 - 9	Cash Bonus	No	1	5	5	9	15	24
<i>L</i>	2	10 - 18	Cash Bonus	No	1	5	5	9	15	24
<i>L</i>	3	19 - 24	Cash Bonus	No	1	5	5	6	15	16
<i>LT</i>	4	25 - 33	Cash Bonus	Yes	1	5	6	9	15	24
<i>LT</i>	5	34 - 42	Cash Bonus	Yes	1	5	6	9	15	24
<i>LT</i>	6	43 - 48	Cash Bonus	Yes	1	5	6	6	15	16
<i>S</i>	7	49 - 57	Stock Shares	No	1	4	4	9	12	21
<i>S</i>	8	58 - 66	Stock Shares	No	1	4	4	9	12	21
<i>S</i>	9	67 - 72	Stock Shares	No	1	4	4 ^[a]	6	12	14
<i>ST</i>	10	73 - 81	Stock Shares	Yes	1	4	5	9	12	21
<i>ST</i>	11	82 - 90	Stock Shares	Yes	1	4	5	9	12	21
<i>ST</i>	12	91 - 96	Stock Shares	Yes	1	4	5 ^[b]	6	12	14
Total								96	162	240

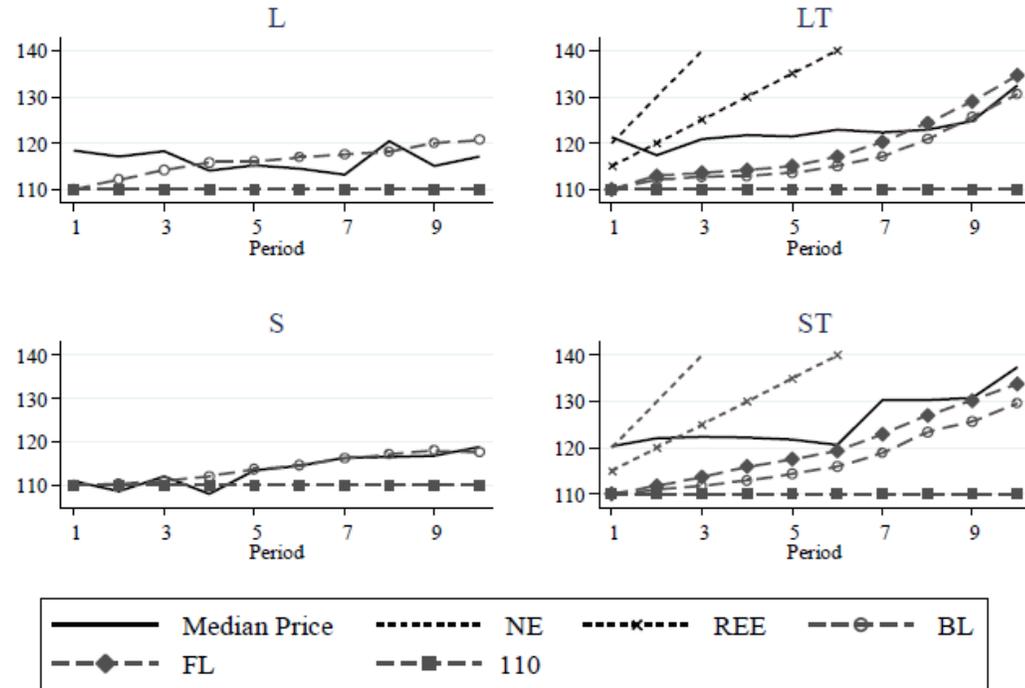
[a] The only exceptions are group 68 and 71. There are five (three) investors, and thus five (three) active traders in group 68 (71).

[b] The only exceptions are group 92 and 95. There are five (three) investors, and thus six (four) active traders in group 92 (95).

- NE: if CEO uses all his cash to buy stock shares at 110 in period 1. $\widetilde{FV}_t = \{110, 120, 130, \dots, 210\}$ for $t \in \{1, 2, 3, \dots, 10\}$
- RE: if CEO uses all his cash to buy stocks in period 1 and other traders know his effort is going to increase in later periods. $\widetilde{FV}_t = \{110, 120, 130, \dots, 210\}$ for $t \in \{1, 2, 3, \dots, 10\}$
- Backward looking model (BL): $\widetilde{FV}_t = V_{t-1}$
- Forward looking model (FL): $\widetilde{FV}_t = V_{t-1} + dV^*(s'_{t-1})$.
- NE and RE are predetermined, while BL and FL are extrapolative

Alternative Definitions of FV

Median Price and (estimated) Fundamentals



Fitness of different FV models: extrapolative models fit better.