Why Do Agency Theorists Misinterpret Market Monitoring?

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Introduction

- Separation of ownership and control is the main governance problem facing the modern corporation (Adam Smith, 1776, Berle and Means, 1932, Jensen and Meckling, 1976);
- With no one to care for passive outside investors, large and liquid companies should not exist. I hypothesize that informed speculators fulfill this role by monitoring management;
- Indeed, in the managers optimal contract, I show that pay sensitivity (inside ownership) must fall with more informative stock prices and scale, which is what one observes;
- To establish my case, I identify the reasons why the extant literature mistakenly believes that incentives move in the opposite direction.
- Jensen and Murphy (1990) show that empirically, incentives decline drastically with firm size.

Model Set-Up

- In common with Holmstrom and Tirole (1993) (HT), the model has three dates, an initial date, $t = 0$, in which the firm is founded by a risk-neutral insider, and the appointed risk-averse manager signs his contract (not subject to renegotiation).
- The manager makes effort choice according to his contractual incentives.
- Risk-neutral speculators trade on an imperfect signal of the managers effort with the stock price determined at date $t = 1$.
- At the final date, $t = 2$, the firm is liquidated with gross proceeds, $\tilde{\pi}$, used to compensate the manager
- Proceeds become:

$$\tilde{\pi} = e + \tilde{\theta}, \tag{1}$$

where e is the actual level of effort, and the intrinsic volatility in the stock price, $\tilde{\theta} \sim \mathcal{N}(0, \sigma_{\theta}^{2})$.

The Speculator's Problem, continued

- Each speculator in receipt of the same imperfect signal, $\tilde{\eta}$, and subject to a normally distributed observational error, $\tilde{\eta} \sim \mathcal{N}(0, \sigma_\eta^2)$.
- Each speculator can reduce the observational error by reducing the error variance, σ_η^2 , with a fixed informational cost $c_I = g(1/\sigma_\eta^2)$,
- The function $g(1/\sigma_\eta^2)$ is increasing in $1/\sigma_\eta^2$ and convex, for example, the quadratic function, $c_I = (1/2)c_\eta(1/\sigma_\eta^2)^2$, with a positive constant, c_η, and where the volatility, σ_η^2, is understood to fixed at its optimal value, $\bar{\sigma}_\eta^2$, with the accent no longer shown.

The Speculator's Problem

- Liquidity is provided by "noise" trader demand given by $\tilde{y} \sim \mathcal{N}(0, \sigma_y^2)$. These traders do not receive an informative signal and are not strategic.
- The market makers linear pricing rule:

$$p(\tilde{q}) = \alpha - Ap(\tilde{q}) + \lambda\tilde{q}, \tag{2}$$

- where $p(\tilde{q})$ is stock price, coefficient α intercept on the price axis,
- $\tilde{q}$ signed order flow that alters price at the rate λ, representing Kyle's lambda measure of illiquidity.
- A represents the magnitude of the managers stock appreciation right.
- Grossed-up stock price equation:

$$p\left(\tilde{q}\right) = \frac{\alpha + \lambda\tilde{q}}{(1 + A)}. \tag{3}$$

The Speculator's Problem, cont.

- Each of the n strategic traders conjectures a linear trading strategy:

$$\bar{x}_i\left(\tilde{s}_i\right) = \beta\left(\tilde{s}_i - \alpha\right), \quad \forall i = 1, ..., \ n, \tag{4}$$

  Where the accent on x_i indicates the optimum solution, and β represents the positive coefficient of trader aggressiveness.
- Only the total signed order flow is visible to the market maker, $\tilde{q} = nx_i\left(\tilde{s}_i\right) + \tilde{y} = n\beta\left(\tilde{s}_i\right) + \tilde{y}$.
- Order-flow is dependent on the sum of actions of all n strategic traders plus noise trader demand.
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$$\beta = \frac{\sigma_y}{n^{\frac{1}{2}}\left(\sigma_\theta^2 + \sigma_\eta^2\right)^{\frac{1}{2}}}. \tag{5}$$

Solution to Optimisation Problem

- HTs (p.691) stock price informativeness coefficient, μ, generalized to multiple informed traders, becomes:

$$\mu \equiv \lambda n \beta = \frac{n}{n+1} \frac{\sigma_\theta^2}{\left(\sigma_\theta^2 + \sigma_\eta^2\right)} \leqslant 1. \tag{6}$$

- The first proposition can now be stated:

Proposition

Stock price informativeness, $\mu \equiv \lambda n \beta$, is increasing in the number of informed speculators and improvements (i.e., reductions) in the speculators forecast error. As the volatility of the speculator's forecast error approaches infinity, the informativeness of the stock price approaches zero.

Derivation of Kyle's Lambda and Stock Price

- Kyles lambda measure of illiquidity becomes:

$$\lambda = \frac{n\beta\sigma_\theta^2}{(n\beta)^2\left(\sigma_\theta^2+\sigma_\eta^2\right)+\sigma_y^2}. \tag{7}$$

- Evaluating the grossed-up linear pricing rule incorporating the managers stock appreciation right allocation, Ap , yields:

$$p(\tilde{q}) = \mathbb{E}\left[\frac{\alpha+\lambda\tilde{q}\,|\tilde{q}=q}{1+A}\right]$$

Stock Price

- Hence:

$$p(\tilde{q}) = \frac{1}{1+A}\left\{\mathbb{E}(\alpha+\lambda\tilde{q}) + \frac{Cov(\alpha+\lambda\tilde{q},\tilde{q})}{Var(\tilde{q})}\left[\tilde{q}-\mathbb{E}(\tilde{q})\right]\right\}. \tag{8}$$

- Hence, on simplification:

$$p(\tilde{q}) = \frac{1}{1+A}\left[\bar{e} + \frac{n\beta\sigma_\theta^2}{n^2\beta^2\left(\sigma_\theta^2+\sigma_\eta^2\right)+\sigma_y^2}(\tilde{q})\right], \tag{9}$$

where, once again, $\bar{e} = \alpha$ represents the managers equilibrium action.

Derivation of Price

- On solving equations (5) and (9) for β by eliminating λ, I obtain the representative partially-informed traders demand:

$$x = \beta \left(e + \tilde{\theta} + \tilde{\eta} - \bar{e} \right) \equiv \frac{\sigma_y}{n^{\frac{1}{2}} \left(\sigma_\theta^2 + \sigma_\eta^2 \right)^{\frac{1}{2}}} \left(e + \tilde{\theta} + \tilde{\eta} - \bar{e} \right). \tag{10}$$

- Kyles lambda, specified by equation (7), becomes,

$$\lambda = \frac{\sigma_\theta^2 n^{\frac{1}{2}}}{\sigma_y \left(n + 1 \right) \left(\sigma_\theta^2 + \sigma_\eta^2 \right)^{\frac{1}{2}}}, \tag{11}$$

The Model: Theory of Managerial Incentives

- The manager faces a standard linear incentive contract with income,
$$I = W + Ap, \tag{12}$$
- Fixed wage W, plus stock appreciation rights Ap, where p is the stock price and A is the incentive weight;
- There are $n \geqslant 1$ partially informed homogenous strategic traders (speculators);
- These subject to a normally distributed observational error, $\tilde{\eta} \sim \mathcal{N}(0, \sigma_\eta^2)$
- The firm is naturally risky: $\tilde{\theta} \sim \mathcal{N}(0, \sigma_\theta^2)$ and λ , represents Kyle's lambda measure of illiquidity
- Stock price informativeness, μ, is:

$$\mu \equiv \lambda n \beta = \frac{n}{n+1} \frac{\sigma_\theta^2}{\left(\sigma_\theta^2 + \sigma_\eta^2\right)} \leqslant 1; \tag{13}$$

- Stock price informativeness is represented by the product of n, informed trader aggressiveness, β, and Kyle's Lambda, λ:
- Stock price is increasing in director effort, e , at the rate $\frac{\mu}{1+A} < 1$, i.e., with:

$$p = \frac{1}{(1+A)} \left[(1-\mu)\,\bar{e} + \mu \left(e + \tilde{\theta} + \tilde{\eta} \right) + \lambda \tilde{y} \right]. \qquad (14)$$

- Inside shareholder maximizes the expected liquidation value of the firm, $\mathbb{E}[\tilde{\pi}] = \bar{e} = \frac{A}{1+A}\frac{\mu}{c}$

$$\underset{\frac{A}{1+A}}{Max}\, \frac{A}{1+A}\frac{\mu}{c} - \mathbb{E}[I]. \qquad (15)$$

- Contractual weight given by:

$$\bar{A} = \frac{1}{\mu - 1 + \gamma c \sigma_\theta^2}, \tag{16}$$

  with the incentive weight, $\bar{A}$, unambiguously falling in informativeness, μ;
- This is because the optimal contract must minimize product of volatility coming from informative signal and from noise;

- Proposition

  The manager/director's pay sensitivity with respect to stock price, $\bar{A}$, always falls with increased stock price informativeness, μ. Additionally, a higher CARA risk coefficient, γ , greater productivity uncertainty for given stock price informativeness, θ , and higher effort cost, c , all reduce managerial pay-for-performance sensitivity, $\bar{A}$.

  - The solution to the model, is illustrated in Figure 1. The figure shows the lowering of the equilibrium values of the directors pay for performance sensitivity as stock price informativeness increases.

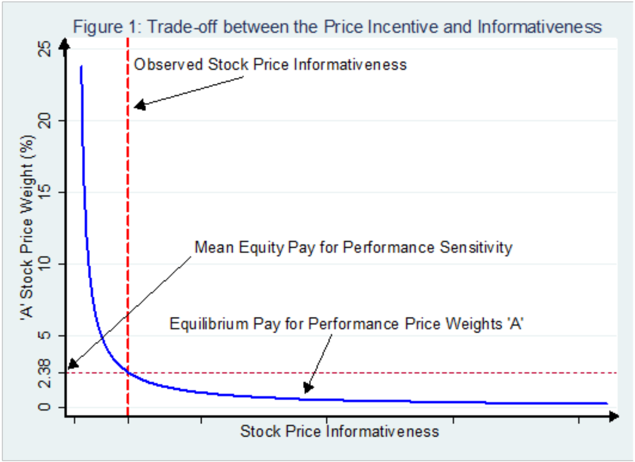
Figure 1: Trade-off between the Price Incentive and Informativeness
Observed Stock Price Informativeness
Mean Equity Pay for Performance Sensitivity
Equilibrium Pay for Performance Price Weights 'A'
'A' Stock Price Weight (%)
25
20
15
10
5
2.38
0
Stock Price Informativeness

- Since equilibrium effort is:

$$\bar{e} = \frac{\bar{A}}{1+\bar{A}}\frac{\mu}{c} = \frac{1}{\mu + \gamma c \sigma_\theta^2}\left(\frac{\mu}{c}\right), \tag{17}$$

  a rise in informativeness increases effort despite the fall in incentives.
- The directors expected pay is equal in value to half the value of the effort put in:

$$\mathbb{E}\left[I\right] = \frac{1}{2}\left(\frac{\bar{A}}{1+\bar{A}}\right)^2 \frac{\mu}{c}\left(\mu + \gamma c \sigma_\theta^2\right) = \frac{1}{2}\bar{e}, \tag{18}$$

  Hence expected pay is increasing in informativeness, μ as compensation for additional effort.
- Equilibrium stock price is:

$$\bar{p} = \frac{\bar{A}}{\left(1+\bar{A}\right)^2}\frac{\mu}{c} \equiv \bar{e}\frac{\mu - 1 + \gamma c \sigma_\theta^2}{\mu + \gamma c \sigma_\theta^2}. \tag{19}$$

  Hence stock price is also increasing in the degree of informativeness.

Where did Holmstrom and Tirole (1993) (HT) go wrong?

- HT make identical assumptions to mine but reach opposite conclusion-incentives must always rise, not fall, with information;
- HT begin by mistakenly attempting to base a contact on stock price when the manager's effort is already at its optimum level;
- They then mistook the incentive weight in their "normalized" contract for actual incentive contract weight that they began with;
- They chose a new incentive weight because their aim was to maximize the signal-to-noise ratio based on an idealized "normalized" stock price free of the contaminating effect of the equilibrium contract weight itself;

Where did Holmstrom and Tirole (1993) (HT) go wrong? Continued

- HT began with a false belief that agency theory is about maximizing the signal to noise ratio (Holmstrom (1979);
- By increasing the incentive weight when signal stronger, they give more weight to the signal when it is stronger;
- HT begin by correctly deriving the actual stock price volatility, but fail to notice it is the product of volatility due to information in the stock price and volatility due to noise;
- Aim of the inside shareholder (principal) is to minimize the product of these two sources of volatility as manager has to be compensated for volatility;
- HT's incentive weight turns out to move in precisely the opposite direction, up not down, in response to information in stock price.

Does HT's error matter in 2018?

- Yes. A generation of economists have been taught false doctrine that information in stock price implies large liquid stocks must have high inside ownership but actually mostly have negligible ownership;
- Means that existence of the modern corporation remains a mystery;
- Obvious: once error corrected the existence of the modern corporation must be due to market monitoring;
- Private equity has nearly all the features of public equity but much smaller because there is no stock price and hence no market monitoring.

HT's Approach

- HT devote much of their analysis to a *normalized* performance measure, z,

$$z \equiv \frac{(1+A)\,p - (1-\mu)\,e}{\mu}, \tag{20}$$

with $z = e + \tilde{\theta} + \tilde{\eta} + \frac{1}{n\beta}\tilde{y}$,

- Variance of z is given by:

$$var\,(z) = \frac{(1+n)}{n}\left(\sigma_\theta^2 + \sigma_\eta^2\right) \equiv \frac{\sigma_\theta^2}{\mu}, \tag{21}$$

with $\frac{(1+n)}{n} = 2$ when $n = 1$. $\frac{\sigma_\theta^2}{\mu}$ represents the noise-to-signal ratio in the normalized price by construction, equation (**??**) shows, volatility is given by the product of noise, σ_θ^2, and information, μ.

- The manager's income becomes:

$$I = Ap + W = s\mu\,\mathbb{E}(z) + d, \tag{22}$$

  where the fixed wage, $W = d - s\mu\bar{e}\frac{(1-\mu)}{\mu}$, and expected normalized price equals equilibrium effort, $\mathbb{E}(z) = \bar{e}$.

- Variance of managerial income:

$$var(I) = b^2 var(z) = \frac{b^2\sigma_\theta^2}{\mu} = (s\mu)^2\frac{\sigma_\theta^2}{\mu} = s^2\mu\sigma_\theta^2, \tag{23}$$

  where HT (p.692, equation (20)) denote incentive weight for normalized contract by $b \equiv s\mu$

- The manager maximizes his expected income net of his (quadratic) effort cost:

$$\underset{e \in [0,\infty)}{Max} \ \mathbb{E}[I] - \frac{1}{2}ce^2 = d + s\mu e - \frac{1}{2}ce^2, \tag{24}$$

same solution $\bar{e} = \frac{s\mu}{c}$.

$$\underset{s}{Max} \frac{s\mu}{c} - \mathbb{E}[I] = \frac{s\mu}{c} - \frac{s^2\mu}{2c}\left[\left(\mu + \rho c \sigma_\theta^2\right)\right], \tag{25}$$

- HT's equilibrium effort:

$$\bar{e} = \frac{b}{c}, \tag{26}$$

Informativeness appears to have no effect on the equilibrium level of effort;

- Equation(25), yields:

$$\bar{b} \equiv \bar{s}\mu = \frac{\mu}{\mu + \rho c \sigma_\theta^2}, \tag{27}$$

- HT's incentive weight, $\frac{d\bar{b}}{d\mu} > 0$. HT (p.693, equations (22a) to (22c)) justify their program and focus on their assumed incentive weight, b, on the grounds that it minimizes the noise-to-signal ratio, $\frac{b^2\sigma_\theta^2}{\mu}$, given in equation (23) above. At its face value and contrary to my Proposition **??**, HT (pp. 693-694 and equation (24)) conclude that the manager's actual incentive weight (which they mistakenly treat as their *normalized* incentive sensitivity parameter, $\bar{b}$), is always increasing, not diminishing, in stock price informativeness.