

if $c = 1$ and w_2 if $c = 2$. The manager's utility is $\log(w)$ if he does not investigate and $(\log(w) - \alpha)$ if he does, or the reservation utility of $\log(\bar{w})$ if he quits.

If the shareholders want the manager to investigate, the contract must satisfy the self-selection constraint

$$U(\text{not investigate}) \leq U(\text{investigate}). \quad (8.3)$$

If the manager investigates, he still fails to find a low-cost technique with probability $(1-\theta)^2$, so inequality (8.3) is equivalent to

$$\theta \log(w_1) + (1-\theta) \log(w_2) \leq [1 - (1-\theta)^2] \log(w_1) + (1-\theta)^2 \log(w_2) - \alpha. \quad (8.4)$$

The self-selection constraint is binding, since the shareholders want to keep the manager's compensation to a minimum. Turning inequality (8.4) into an equality and simplifying yields

$$\theta(1-\theta) \log\left(\frac{w_1}{w_2}\right) = \alpha. \quad (8.5)$$

The participation constraint, which is also binding, is $U(\bar{w}) = U(\text{investigate})$, or

$$\log(\bar{w}) = [1 - (1-\theta)^2] \log(w_1) + (1-\theta)^2 \log(w_2) - \alpha. \quad (8.6)$$

Solving equations (8.5) and (8.6) together for w_1 and w_2 yields

$$\begin{aligned} w_1 &= \bar{w} e^{\alpha/\theta}, \\ w_2 &= \bar{w} e^{-\alpha/(1-\theta)}, \end{aligned} \quad (8.7)$$

where e does not here denote effort, but the constant $e \approx 2.72$ in natural logarithms. The expected cost to the firm is

$$[1 - (1-\theta)^2] \bar{w} e^{\alpha/\theta} + (1-\theta)^2 \bar{w} e^{-\alpha/(1-\theta)}. \quad (8.8)$$

If the parameters are $\theta = 0.1$, $\alpha = 1$, and $\bar{w} = 1$, the rounded values are $w_1 = 22,026$ and $w_2 = 0.33$, and the expected cost is 4,185. Quite possibly, the shareholders decide it is not worth making the manager investigate.

But suppose that Apex has a competitor, Brydox, in the same situation. The shareholders of Apex can threaten to boil their manager in oil if Brydox adopts a low-cost technology and Apex does not. If Brydox does the same, the two managers are in a Prisoner's Dilemma, both wishing not to investigate, but each investigating from fear of the other. Apex's forcing contract specifies $w_1 = w_2$ to fully insure the manager, and boiling-in-oil if Brydox has lower costs than Apex. The contract need satisfy only the participation constraint that ~~$\log(w - \alpha) = \log(\bar{w})$~~ , so $w = 2.72$ and Apex's cost of extracting the manager's information is only 2.72, not 4,185. Competition raises efficiency, not through the threat of firms going bankrupt but through the threat of managers being fired.

$\log(w) - \alpha$

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to Warren Manners