

## 20. INCENTIVES FOR EFFORT - ONE-DIMENSIONAL CASES

Here we consider a class of situations where a principal (such as an owner, or an upper-tier manager, or a downstream user of a product) engages an agent (a manager, or a worker, or an upstream producer of the input in the respective cases). The principal's outcome depends on the agent's effort, and also on some other random influence. The effort is the agent's private information. It is not directly verifiable, and because of the random influence, it cannot be inferred accurately from observing the outcome. Therefore a contract between the two parties that stipulates a payment to the agent conditioned on his effort, although this may be in the ex ante interests of both parties, is not feasible. Exerting effort is costly to the agent; therefore he has an ex post temptation to shirk and blame any bad outcome on bad luck (unfavorable realization of the random component). Thus the situation is one of moral hazard.

We consider two models in some detail. These are deliberately abstracted from some aspects of reality, so as to get some basic ideas across in the simplest possible way. In subsequent handouts we will generalize some of these to more realistic situations of multiple tasks, multiple agents, and even multiple principals. We will not go into other issues such as relational contracts without external enforcement.

## 1. Linear Incentive Schemes

Denote the agent's effort by  $x$  and the principal's outcome by  $y$ , and assume

$$y = x + \epsilon, \quad (1)$$

where  $\epsilon$  is a random "observation error" or "noise" with zero expectation ( $E(\epsilon) = 0$ ) and variance  $V[\epsilon] = v$ . The zero expectation assumption is harmless, as any non-zero expectation can be separated out into the non-random part of the formula for  $y$ .

Denote the principal's payment to the agent by  $w$ ; this can be a random variable. The agent chooses  $x$  to maximize a mean-variance objective function also incorporating a cost of effort:

$$U_A = E[w] - \frac{1}{2} \alpha V[w] - \frac{1}{2} k x^2. \quad (2)$$

Denote the agent's outside opportunity utility by  $U_A^0$ . Therefore the agent's participation (or individual rationality) constraint is  $U_A \geq U_A^0$ .

The principal is assumed to be risk-neutral. This is often reasonable in the context of employment, where firms are owned by well-diversified shareholder, and even individual owners being richer are likely to be closer to risk-neutrality. But it is easy to generalize the theory to cases where the owner is risk averse and has a mean-variance objective function; I will ask you to do this in the next problem set. Here the principal's objective function is

$$U_P = E[y - w] \quad (3)$$

The principal chooses the payment scheme, namely  $w$  as a function of the observable and verifiable  $y$ , to maximize  $U_P$ , subject to the agent's participation constraint, and the knowledge that the agent is going to choose  $x$  to maximize  $U_A$ , that is, the incentive compatibility constraint. We begin by laying down a benchmark against which to compare that outcome, namely the situation without asymmetry where the effort can be directly observed and verified, and therefore a Pareto efficient or first-best contract can be implemented.

### Hypothetical Ideal or First-Best

Here the principal can choose a contract of the form  $(x, w)$ , whereby the agent promises to make effort  $x$  and the principal promises to pay the agent  $w$ , which may be a random variable. The principal will choose these to maximize

$$U_P = E[y - w] = E[x + \epsilon - w] = x - E[w],$$

subject only to the agent's participation constraint

$$U_A = E[w] - \frac{1}{2} \alpha V[w] - \frac{1}{2} k x^2 \geq U_A^0.$$

Obviously the principal will not give the agent any more than he has to, so the participation constraint holds with equality. We can then substitute out  $E[w]$  in  $U_P$  to write

$$U_P = x - \frac{1}{2} \alpha V[w] - \frac{1}{2} k x^2 - U_A^0.$$

The value of  $x$  that maximizes this satisfies the first-order condition

$$1 - \frac{1}{2} 2 k x = 0, \quad \text{therefore} \quad x = 1/k. \quad (4)$$

(The second-order condition is  $-2k \leq 0$ , which is true.) As for  $w$ , its choice should minimize  $V[w]$ , so  $w$  should be non-random. This is intuitive: since the principal is risk-neutral, it is efficient for him to bear all the risk, and since effort is directly verifiable (information is complete), there are no incentive reasons to make the agent bear any risk either. Then, using the participation constraint, we have

$$w = U_A^0 + \frac{1}{2} k x^2 = U_A^0 + \frac{1}{2k},$$

using the optimized value of  $x$ . Finally, the two parties' overall utility levels are

$$U_A = U_A^0,$$

and

$$U_P = \frac{1}{2k} - U_A^0 \quad (5)$$

The agent is on his participation constraint and gets no surplus. The principal gets all the surplus that exists in the relationship.

Of course it is possible that  $U_A^0 < 1/(2k)$ . In that case it would be optimal not to enter into this contract, and let the agent take up the outside opportunity. (The principal's outside opportunity has been implicitly assumed to be zero.)

## Second-Best Linear Incentive Schedules

Now the payment  $w$  to the agent must be conditioned on the only verifiable magnitude in the interaction, namely  $y$ . In fact we will consider a simple special case where  $w$  has to be a linear (affine, if you want to be pedantic) function of  $y$ , say

$$w = h + s y. \quad (6)$$

Here  $h$  is the basic wage and  $s$  is a performance-based bonus coefficient. So the principal's problem is reduced from one of choosing a whole function  $w(y)$  optimally to that of choosing just the two parameters  $h$  and  $s$  optimally. In later sections we will examine some simple ideas about nonlinear payment schemes.

We have

$$w = h + s(x + \epsilon) = (h + s x) + s \epsilon,$$

rearranging to separate out the non-random and random terms. Therefore

$$\mathbb{E}[w] = h + s x, \quad \mathbb{V}[w] = s^2 \mathbb{V}[\epsilon] = s^2 v,$$

Then the agent chooses  $x$  to maximize

$$U_A = h + s x - \frac{1}{2} \alpha v s^2 - \frac{1}{2} k x^2.$$

This has the first-order condition

$$s - \frac{1}{2} 2 k x = 0, \quad \text{therefore} \quad x = s/k. \quad (7)$$

(The second-order condition is  $-2k \leq 0$ , which is true.) Contrast this with the first-best effort level in (??). The effort level chosen by the agent here is only a fraction  $s$  of the first-best, reflecting the fact that the agent receives only the fraction  $s$  of the expected marginal product of his effort. For this reason, we will call the coefficient  $s$  the *power of incentive* in this scheme. We will soon obtain the principal's optimal choice of  $s$ , and later contrast it with similar expressions for the power of incentives in other situations.

Substituting for the agent's choice of  $x$  into his objective function, we get his maximized or "indirect utility" function:

$$U_A^* = h + s \frac{s}{k} - \frac{1}{2} \alpha v s^2 - \frac{1}{2} k \left( \frac{s}{k} \right)^2 = h + \frac{s^2}{2k} - \frac{1}{2} \alpha v s^2.$$

The principal's utility is then

$$U_P = \mathbb{E}[y - h - s y] = (1 - s)x - h = (1 - s) \frac{s}{k} - h.$$

The principal chooses  $h$  and  $s$  to maximize this, subject to the agent's incentive compatibility and participation constraints. The former is simply (??), and has already been incorporated into the agent's utility expression. There remains only the participation constraint  $U_A^* \geq U_A^0$ , or

$$h + \frac{s^2}{2k} - \frac{1}{2} \alpha v s^2 \geq U_A^0.$$

It is obviously not optimal for the principal to leave any slack in this constraint. Therefore we can replace the  $\geq$  by  $=$  and use this equation to substitute out for  $h$  in the principal's objective:

$$h = U_A^0 - \frac{s^2}{2k} + \frac{1}{2}\alpha v s^2. \quad (8)$$

Therefore

$$\begin{aligned} U_P &= \frac{s(1-s)}{k} + \frac{s^2}{2k} - \frac{1}{2}\alpha v s^2 - U_A^0 \\ &= \frac{s}{k} - \frac{s^2}{2k} - \frac{1}{2}\alpha v s^2 - U_A^0. \end{aligned}$$

The only remaining choice variable is  $s$ . The first-order condition is

$$\frac{1}{k} - \frac{s}{k} - \frac{1}{2}\alpha v (2s) = 0;$$

the second-order condition is obviously met. Solving the first-order condition, therefore the optimum is

$$s = \frac{1}{1 + \alpha v k}. \quad (9)$$

This formula yields some very nice and simple intuitive interpretations:

[1] In general,  $0 < s < 1$ . We saw in the first-best that if it were not for the information asymmetry, it would be efficient for the risk-neutral principal to absorb all the risk, leaving the agent with a non-random income. Then  $s$  would equal zero. On the other hand, if there is information asymmetry, the only way to induce the agent to exert a level of effort equal to the first best ( $1/k$ ) is to have  $s = 1$ , thereby giving the agent the full *marginal* expected return to his effort. (The total payment to the agent can be adjusted by choosing the fixed component of the payment, namely  $h$ , appropriately.) In general, the optimal  $s$  strikes a balance between the risk-bearing and the incentive purposes.

[2] The higher is  $\alpha$ , the lower is  $s$ . The intuition is as follows. A high  $s$  makes the agent's income more random (risky). The principal must then offer the agent a higher fixed payment  $h$  to continue fulfilling the participation constraint. This gets more and more costly ( $h$  increases with  $s^2$ ), and the effect is more pronounced when  $\alpha$  is higher, as (??) shows. Therefore a higher  $\alpha$  entails a lower  $s$ .

[3] The higher is  $v$ , the lower is  $s$ . A high  $v$  means that the error or noise term  $\epsilon$  in the outcome  $y$  is likely to be bigger. Then paying the agent for a higher  $y$  may too often be rewarding him for good luck, or punishing him for bad luck. The agent does not like this risk, and again the principal must raise the fixed payment to meet the participation constraint. It is better for the principal to lower the  $s$  to some extent.

[4] Substituting the formula (??) back into the principal's objective, we find its maximized value:

$$U_P = \frac{1}{2k(1 + \alpha v k)} - U_A^0. \quad (10)$$

Comparing this with the corresponding expression (??) in the full information, first best case, we see the loss caused by the information asymmetry. The principal bears this loss;

the agent remains on his participation constraint so  $U_A = U_A^0$  as before. It is in fact possible that

$$\frac{1}{2k(1 + \alpha v k)} < U_A^0 < \frac{1}{2k},$$

in which case the transaction should be undertaken if there is full information but not if the agent's effort is unverifiable. (In this situation, if the agent's effort is observable to the two parties without being externally verifiable, it may be possible to achieve an equilibrium that is Pareto better than the outside opportunities, if the relationship is repeated and the parties are sufficiently patient to allow credible self-enforcing cooperation in their repeated game.)

[5] What is the rough order of magnitude of the numbers involved? John Garen (*Journal of Political Economy* December 1994) offers the following numbers. Large U.S. corporations during 1970-1988 time had median market value approximately \$2 billion  $2 \times 10^9$ , and median variance  $v \approx 2 \times 10^{17}$ . Their CEOs had a median income of about \$1 million ( $1 \times 10^6$ ). If we take their coefficient of relative risk aversion to be about 2, their coefficient of absolute risk aversion would be  $\alpha = 2 \times 10^{-6}$ . We want

$$E[y] = x = s/k = 2 \times 10^9$$

and we have

$$s = 1/(1 + \alpha v k) = 1/(1 + 4 \times 10^{11} k).$$

Eliminating  $k$  between the two equations,

$$s = 1/(1 + 200 s), \quad \text{or} \quad 200 s^2 + s - 1 = 0.$$

The positive root of this is about 0.0683. The actual values are much smaller, averaging 0.0142. (Garen claims that his numbers justify the low optimal values of  $s$ , and that implausible  $k$ ,  $\alpha$  are needed to make much difference to the calculation, but does not give explicit calculations based on this formula.) Conversely, the fixed component  $h$  is probably too large, and participation constraints are probably overfulfilled. (For more on the general problem of CEO overcompensation, see Graef Crystal, *In Search of Excess*, and related literature.)

[6] I simply assumed that the incentive payment scheme was linear. It may be possible to do better by using nonlinear schemes. These get mathematically difficult and we must leave most of that analysis to more advanced treatments. But a few simple ideas and cases are useful and simple enough.

## 2. Nonlinear Incentive Schedules

### Some General Theory

Once again, the agent chooses effort  $x$  at utility cost  $K(x)$ , and that is his private information. The principal's outcome is denoted by  $y$ , and this is verifiable but random, capable of taking on values  $y_i$  with probabilities  $\pi_i(x)$ , for  $i = 1, 2, \dots, n$ . If the agent makes more effort, this probability distribution will shift to the right in the sense of first order stochastic dominance.

But we assume that the support (the set of  $i$  for which the probabilities are positive) remains unchanged. Otherwise, if for example the probability of some very low outcome falls to zero for a level of effort the principal might wish to sustain in the first best but remains positive if the agent puts in a lower level of effort, then the principal can achieve the first best by choosing a contract that imposes extremely harsh penalties on the agent if this low outcome is realized. That penalty is simply a deterrent threat; it need never be imposed in equilibrium so long as the agent is making the desired effort level, and therefore its harshness does not interfere with the agent's participation constraint. The same idea can be generalized somewhat, to situations where the principal is able to achieve an outcome very close to the first best. I will leave the details of this to more advanced treatments.

Here we can allow both the principal and the agent to be risk-averse, with respective utility-of-consequences functions  $u_p$  and  $u_a$ . The principal's informationally feasible contract takes the form: "Work for me, and I will pay you  $w_i$  if the outcome is  $y_i$ ." This gives the agent the expected utility

$$EU_A = \sum_{i=1}^n \pi_i(x) u_a(w_i) - K(x), \quad (11)$$

and the principal has

$$EU_P = \sum_{i=1}^n \pi_i(x) u_p(y_i - w_i). \quad (12)$$

Before considering the moral hazard problem, let us find the hypothetical ideal first best where the effort  $x$  is observable and verifiable and can be made a part of the contract, which can then take the form "Work for me and put in effort  $x$ , and I will pay you  $w_i$  if the outcome is  $y_i$ ." The principal can choose the  $x$  and all the  $w_i$ , and need consider only the agent's participation constraint  $EU_A \geq U_A^0$ . The Lagrangian is

$$\mathcal{L} = \sum_{i=1}^n \pi_i(x) u_p(y_i - w_i) + \lambda \left\{ \sum_{i=1}^n \pi_i(x) u_a(w_i) - K(x) - U_A^0 \right\}.$$

The first-order conditions with respect to the payments  $w_j$ 's are

$$\frac{\partial \mathcal{L}}{\partial w_j} = \pi_j(x) \left[ -u'_p(y_j - w_j) + \lambda u'_a(w_j) \right],$$

or

$$\frac{u'_p(y_j - w_j)}{u'_a(w_j)} = \lambda \quad \text{for all } j. \quad (13)$$

These are the familiar conditions for first-best risk sharing that we met in the general Arrow-Debreu theory of efficient risk-sharing in complete markets; see the analysis across pp. 6-7 of Handout 13, and the resulting equation (1) there. Thus, in the absence of moral hazard, the issue of efficient risk-bearing is conceptually separated from the issue of finding the first-best optimal level of effort, which is given by the first-order condition

$$\frac{\partial \mathcal{L}}{\partial x} = \sum_{i=1}^n \pi'_i(x) [u_p(y_i - w_i) + \lambda u_a(w_i)] - \lambda K'(x) = 0. \quad (14)$$

The summation can be thought of as the marginal product of effort on a “social expected utility,” summing up the utilities-of-consequences of the principal and the agent with weights 1 and  $\lambda$  respectively.

Return to the case of unverifiable effort and the consequent moral hazard. Now given the principal’s contract  $(w_i)$ , the agent chooses effort  $x$  to maximize  $EU_A$ . The first-order condition for this is

$$\frac{\partial EU_A}{\partial x} = \sum_{i=1}^n \pi'_i(x) u_a(w_i) - K'(x) = 0. \quad (15)$$

Contrasting this with the first-best (??), we already see that at unchanged  $(w_i)$ , moral hazard will lead to too little effort, because the agent will not internalizing the effect on the principal’s utility. Of course the principal adjusts the  $(w_i)$  to cope with this as best he can; he now chooses the contract to maximize his own payoff subject to the agent’s incentive compatibility constraint (??) as well as the participation constraint  $EU_A \geq U_A^0$ .

We saw in course of the analysis of moral hazard in insurance that the agent’s preferences as well as the feasible choice set (budget constraint in that context) can have non-convexities, and therefore the first-order condition may not suffice to pin down the global optimum. Here we ignore the problem and proceed.

The Lagrangian is

$$\begin{aligned} \mathcal{L} = & \sum_{i=1}^n \pi_i(x) u_p(y_i - w_i) + \lambda \left\{ \sum_{i=1}^n \pi_i(x) u_a(w_i) - K(x) - U_A^0 \right\} \\ & + \mu \left\{ \sum_{i=1}^n \pi'_i(x) u_a(w_i) - K'(x) \right\}. \end{aligned}$$

Therefore the first-order conditions for the payments  $w_j$  are

$$\frac{\partial \mathcal{L}}{\partial w_j} = \pi_j(x) \left[ -u'_p(y_j - w_j) + \lambda u'_a(w_j) \right] + \mu \pi'_j(x) u'_a(w_j) = 0,$$

or

$$\frac{u'_p(y_j - w_j)}{u'_a(w_j)} = \lambda + \mu \frac{\pi'_j(x)}{\pi_j(x)} \quad \text{for all } j. \quad (16)$$

The effect of moral hazard and unobservability of effort can be seen by comparing this with the first-best risk-sharing condition (??). First of all, it can be proved that  $\mu > 0$ . This may seem trivial because one is always used to thinking of Lagrange multipliers as positive, but the first-order condition for which  $\mu$  is the multiplier is an exact equation so the matter is not that simple. However, the proof is technical and I omit it. So take it for granted and ask: How will the ratio of marginal utilities  $u'_p(y_j - w_j) / u'_a(w_j)$  depart from the equality across states? The answer: It will be high for those states for which  $\pi'_j(x) / \pi_j(x)$  is high, and low for those states for which this is low. Now  $u'_p(y_j - w_j) / u'_a(w_j)$  being high means  $(y_j - w_j)$  being low and/or  $w_j$  being high. So, roughly speaking, the moral hazard entails giving the agent a higher payment than the first best in those states where  $\pi'_j(x) / \pi_j(x)$  is high.

What is the intuition for this? Note that

$$\frac{\pi'_j(x)}{\pi_j(x)} = \frac{d \ln [\pi_j(x)]}{dx}.$$

This is the responsiveness of the log-likelihood of state  $j$  to the agent's effort. So it is a measure of the informativeness of state  $j$  about a marginal change in effort: if the agent slacks a little, it will be revealed most importantly by a fall in the probability of states with high  $\pi'_j(x)/\pi_j(x)$ . Therefore, to deter the agent from such slacking, the principal should set the payments to the agent high in such states. In other words, the principal is rewarding the agent more in the more informative states than he would do in the first best where such inferences about effort from state are not an issue. Of course the derivative is evaluated at the  $x$  that the principal wants to implement in this second-best situation. The first-order condition for that is complicated and uninformative, so I omit it. Also, the resulting optimal payment scheme ( $w_i$ ) (or a nonlinear function  $w(y)$  if outcomes  $y$  are allowed to be a continuum) gets quite complicated.

Here are some references for the brave:

Mirrlees, J. A. Notes on welfare economics, information and uncertainty. In M. Balch, D. McFadden and S. Wu (eds.), *Essays in Equilibrium Behavior Under Uncertainty*, Amsterdam: North-Holland, 1974.

Holmström, B. Moral hazard and observability. *Bell Journal of Economics*, 10, 74–92, 1979.

Grossman, S. J. and Hart, O. D. An analysis of the principal-agent problem. *Econometrica*, 51, 7–45, 1983.

## A Common Special Case – Quotas

Incentive payment schemes in practice are often step functions: there is a threshold level of the verifiable outcome, say  $y = y^*$ , such that the agent receives a discrete jump up in his compensation if the outcome passes this threshold:

$$w(y) = \begin{cases} w_L & \text{if } y < y^*, \\ w_H & \text{if } y \geq y^*, \end{cases}$$

where  $w_L > w_H$ . When is this useful?

Suppose the principal would like the agent to choose effort  $x^*$ . So he would like the incentive scheme to be such that the agent will lose a lot by shirking. That is, for  $x$  even slightly below  $x^*$ , the probability  $\text{Prob}\{y \geq y^* \mid x\}$  should be much less than the probability  $\text{Prob}\{y \geq y^* \mid x^*\}$ . Figure 1 illustrates this.

However, the principal must have sufficiently precise information about the underlying functions to judge the  $y^*$  and the  $w_L, w_H$  correctly. Otherwise, complicated nonlinear schemes are open to strategic manipulation by the agent, especially when time is involved. Here are some examples: [1] A salesman who has fulfilled his quota for the year may conspire with his customers to postdate any further orders to the following year to make sure of fulfilling the quota for that year. [2] If a salesman is lucky to have filled his quota early



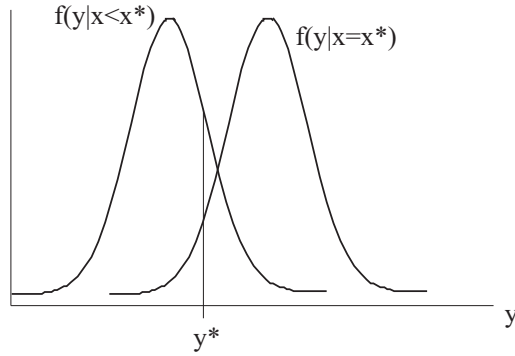


Figure 1: Case when Step-Function Incentive Scheme Works Well

in the year may shirk for the rest of the year, and one who is unlucky and at some point late in the year sees no prospect of meeting the quota for the year may give up for the rest of the year.

For these reasons, and for simplicity too, linear schemes are often used. Sometimes, step-function schemes and linear schemes are combined to try to achieve some of the advantages of each; for example, a salesman may have a percentage commission (linear) and a bonus for meeting a sales target (step-function).

### 3. Some Further Considerations

The models above are the simplest “first-generation” models of the theory of incentive payments under moral hazard. The subsequent literature is huge and considers many additional issues. In the next two topics we will take up some of these – mainly to do with multidimensionality – in detail; here is a very brief account of the rest.

#### a. Carrots Versus Sticks

There are two key aspects of any outcome-based incentive contract: the average payment to the agent, and the spread of payments in good versus bad outcomes. For a given spread (power of incentive), if average is low, this is a “stick” type incentive; if average is high, it is a “carrot” type incentive. The latter is more costly to the principal. The average is determined by the agents outside opportunity (participation constraint). Therefore the principal may deliberately seek agents with poor alternatives, but they may have low skill. In some cases principal may successfully lower the agents alternatives; Stalin tried this.

#### b. Other Performance Indicators

Often the owners outcome  $Y$  is also unobservable or unverifiable. Instead, some other verifiable indicator  $Z$  must be used. But when incentives are offered for  $Z$ , agents will focus

efforts on what helps  $Z$  and this may work to the detriment of  $Y$  which the principal really cares about. So such indicators  $Z$  must be chosen with care. How good such an indicator is depends on how well the marginal products of effort  $X$  on the true  $Y$  and the usable  $Z$  are correlated with each other. This is especially important when there are multiple dimensions of effort.

### **c. Multiple Tasks**

The same agent often performs multiple tasks for the principal. Outcomes from some of them may be observable with less error (lower variance of  $\epsilon$ ), and this may seem to justify higher-powered incentives for those (higher  $s$ ). But that will cause the agents to focus on these tasks and ignore the others. So the principal has to accept weaker incentives all round. The problem can sometimes be mitigated by grouping together the tasks appropriately - one agent should perform a set of tasks where his efforts are complements, not substitutes, so focusing on one task does not hurt the outcomes of the others.

### **d. Multiple Agents**

If the same principal employs many agents performing similar tasks, and if noise or error component is highly positively correlated across people, then the observation that one agent's outcome is less than that of another agent constitutes an accurate indication of his effort relative to that of the other. So payments based on relative performance, e.g. prizes, can be good incentives schemes.

### **e. Repeated Relationships**

If the same agent takes similar actions repeatedly for a principal, and if the noise or error components at different times are uncorrelated, then the average output is a more accurate measure of average effort, and can allow the principal to construct more powerful incentive schemes.

The principal can also use incentive schemes that span time, e.g. a better outcome may be rewarded not by an immediate monetary reward, but by a deferred reward such as promotion. This idea of "career concerns" is an important part of incentive theory.

### **f. Efficiency Wage**

Here the interaction is repeated, and the agent's action may become observable with some delay. Then the principal may usefully offer an incentive scheme whereby the agent is paid more than outside opportunity, but is fired if he is ever caught shirking. Consider a simple illustrative case where the effort is a binary variable, good versus bad. Let the wage prevailing in the outside market for jobs not involving moral hazard be  $W_0$ . Suppose the agent is paid  $W$  so long as he is not detected shirking. Let the agent's extra cost of making good effort be  $C$ , and the probability of being caught making bad effort,  $P$ . Let the discount factor be

$\delta$ . If caught, the agent will lose  $(W - W_0)$  in all subsequent periods. Therefore the expected cost of shirking is

$$P (W - W_0) (\delta + \delta^2 + \delta^3 + \dots) = P (W - W_0) \delta / (1 - \delta).$$

If this is greater than  $C$ , the agent will shirk. So the condition, expressed in terms of the excess the agent must be paid, or the “efficiency wage,” is

$$W - W_0 \geq \frac{1 - \delta}{\delta} \frac{C}{P}.$$

The dependence of this on the various parameters on the right hand side fits the intuition quite well. (Exercise – Think this through.) An example of such a scheme is where you accept the fact that your regular auto mechanic overcharges you a little all the time, because this deters him from trying to get away with cheating you in a big way.

### **g. Motivated Agents**

Such agents care directly about principals outcome, so they may need less material incentives. This may be especially relevant in charities, public sector agencies, health, education, etc. Psychologists find that in such situations, the agents’ “intrinsic” incentives can actually decrease if large “extrinsic” monetary ones are offered.

Any principal would like to hire motivated agents because they need less monetary compensation, but identifying them may itself pose information problems (adverse selection).

### **h. Hierarchical Agencies**

Most firms or bureaucracies have multiple tiers of agency. For example, in a company there is a hierarchy of shareholders (who are theoretically the top-level principals), board of directors, top management, middle management, foremen, workers. Any higher-level principal must recognize danger of collusion at lower tiers. If lower level workers have high-powered incentives, then their supervisors may collude with them and get kickbacks for falsely certifying they have earned the bonuses. So the top principal may have to accept weaker incentives at the lowest levels to ensure that the schemes are “collusion-proof.”

### **i. Multiple Principals**

Some agencies have multiple principals (owners or stakeholders) with imperfectly aligned or conflicting objectives. Then the agent’s incentives (sticks or carrots) coming from any one principal can be offset by those offered by other principals. The result is weak incentives in the aggregate. This is especially important in politics and the public sector bureaucracies.