EXAMPLE (Ch.9, Sec.4, pp.277-80) – MANAGERIAL BONUSES

Value of successful project = $600K
Success Probability = 0.8 if high effort
0.4 if low effort (was 0.6 in book)

Manager's outside opportunity = $100K
$-equivalent of his cost of making high effort = $50K

Owner's Surplus or profit
= 0.8 * 600 - 100 - 50 = 330 if high effort
0.4 * 600 - 100 = 140 if low effort
So high effort is better

HYPOTHETICAL IDEAL (called “First-Best” in economics)

No Info asymmetry – Effort directly observable
Owner offers manager a contract
“Make high effort and I will pay you $150K (plus a little)”

But if not directly observable and contractible,
    must use scheme based on some observable indicator
This should be statistically correlated with effort
General idea: Contract to manager has base salary plus
    a bonus if the observable indicator of success is favorable
Will consider various cases of varying difficulty
    incentive schemes may not attain first-best
    payoff lower than would be with full information
CASE 1 – Success itself is observable

Basic salary = s  Bonus for success = b
Manager’s expected payoff
  if high effort:   s + 0.8 * b - 50
  if low effort:    s + 0.4 * b
So to induce high effort, need  s + 0.8 * b - 50 > s + 0.4 * b
This is called the Incentive compatibility condition / constraint (IC)
  (0.8-0.4) * b > 50    or    b > 125
Also need the individual rationality (IR) or
  participation condition / constraint (PC):
  s + 0.8 * b - 50 > 100 or s + 0.8 * b > 150

When these conditions are met (manager is making high effort),
  owner’s expected payoff     = 0.8 * 600 - s - 0.8 * b
To max this, he wants to keep s and b as small as possible
Solution: b = 125, and then s = 150 - 0.8 * 125 = 150 - 100 = 50
Then owner’s expected payoff = 480 - 50 - 100 = 330
First-best is attained

In the book, low effort gave probability of success 0.6
High effort made less difference (only 0.8 - 0.6 = 0.2)
  to probability of getting bonus
So needed larger size of bonus to motivate high effort
  (0.8-0.6) * b > 50    or    b > 250
Then the IR/PC constraint gave s = 150 - 0.8 * 250 = - 50
Negative salary can be interpreted as:
  (1) manager puts up capital (equity stake or partnership)
  (2) manager is fined on failure
But these may be infeasible or illegal
Then had to keep s = 0, over-fulfilling IR/PC, and
  owner’s expected payoff = 480 - 0 - 0.8 * 250 = 280 < 330
If owner’ outside opportunity between 280 and 330, he may
  not implement worthwhile project: first-best was not achieved
This was the cost of the information asymmetry

Now go back to probabilities 0.8, 0.4 of success
Case 2 – Success not directly or immediately observable
Must use some other observable indicator
statistically related to actual success but with errors
(eventually what matters is statistical relation to effort)

<table>
<thead>
<tr>
<th></th>
<th>Indicator of success</th>
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<tbody>
<tr>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>Actual success</td>
<td></td>
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<tr>
<td>Yes</td>
<td>0.75</td>
</tr>
<tr>
<td>No</td>
<td>0.30</td>
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</tbody>
</table>

Bonus b paid if indicator is good. Probabilities of this:
with low effort: \(0.4 \times 0.75 + 0.6 \times 0.3 = 0.30 + 0.18 = 0.48\)
with high effort: \(0.8 \times 0.75 + 0.2 \times 0.3 = 0.60 + 0.06 = 0.66\)
The IC is \((0.66 - 0.48) \times b \geq 50\) or \(b \geq 50/0.18 = 278\)
(Both types of errors reduce the probability difference,
so need bigger bonus to motivate high effort)
and IR/PC is \(s + 0.66 \times b \geq 150\)

Even if the owner keeps b at its smallest value, \(b = 278\),
to keep the manager’s total expected payment down to 150
requires \(s = 150 - 0.66 \times 278 = -33\)
If this is infeasible, letting \(s = 0\) and over-fulfilling IR/PC
reduces the owner’s expected payoff to
\(0.8 \times 600 - 0.66 \times 278 = 480 - 183 = 297 < 330\)
It is in the owner’s interest to find indicators of success
that are as accurate as possible

Case 3 – Simultaneous projects (multi-tasking)

Two projects. Each if successful yields 600 to owner
Probabilities of success of each are 0.4 if low effort, 0.8 if high
Success of the two is statistically independent of each other
Same manager works on both
Manager’s outside opportunity is now 200
Manager's extra cost of making high effort on only one is 50
and that for high effort on both is \(50 + 50 + k = 100 + k\)
k > 0 – especially difficult to put high effort on both: substitutes
k < 0 – synergies in effort on the two; they are complements

If effort directly observable and contractible, owner can get effort
both low: \(0.4 \times 600 + 0.4 \times 600 - 200 = 280\)
1 high / 1 low: \(0.8 \times 600 + 0.4 \times 400 - 200 - 50 = 470\)
both high: \(0.8 \times 600 + 0.8 \times 600 - 200 - 100 - k = 660 - k\)
So high effort on both is best so long as \(k < 660 - 470 = 190\)

Successes directly observable; bonuses \(b_1\), \(b_2\) for the two tasks
ICs for inducing high effort on both must now
deter the manager from slacking on either or both projects:
\[
\begin{align*}
    s + 0.8 \times b_1 + 0.8 \times b_2 - 100 - k & \geq s + 0.4 \times b_1 + 0.8 \times b_2 - 50 \\
    s + 0.8 \times b_1 + 0.8 \times b_2 - 100 - k & \geq s + 0.8 \times b_1 + 0.4 \times b_2 - 50 \\
    s + 0.8 \times b_1 + 0.8 \times b_2 - 100 - k & \geq s + 0.4 \times b_1 + 0.4 \times b_2 \\
\end{align*}
\]
or
\[
\begin{align*}
    0.4 \times b_1 & \geq 50 + k \\
    0.4 \times b_2 & \geq 50 + k \\
    0.4 \times (b_1 + b_2) & \geq 100 + k
\end{align*}
\]

If \(k > 0\), then satisfying the first two guarantees the third
So owner will keep \(b_1 = b_2 = 125 + 2.5 \times k\)
And the IR/PC will give
\[
\begin{align*}
    s + 0.8 \times (250 + 5 \times k) - 100 - k = 200 \quad \text{or} \quad s = 100 - 3 \times k
\end{align*}
\]
This is worse than if the agent’s choice was “both or neither”:
The third IC above gives \(b_1 + b_2 \geq 250 + 2.5 \times k\); then IR/PC is
\[
\begin{align*}
    s + 0.8 \times (250 + 2.5 \times k) - 100 - k = 200 \quad \text{or} \quad s = 100 - k
\end{align*}
\]
So now the possibility of \(s < 0\) is higher

General result - Implementing good incentives in multi-task contexts
is harder if the tasks are substitutes
Conversely, it can be easier if they are complements
Example - teaching vs. research in universities, subst’s or compl’s?
This has implications for design of institutions –
try to group together complementary tasks
SUMMARY OF INCENTIVE SCHEMES

1. General situation – an “agent” performs action, a less-informed “principal” devises incentive scheme
   Typically consists of salary + outcome-dependent bonus
   Optimal design presents tradeoff
   Higher bonus motivates better effort by agent,
   but involves extra cost to principal
   - in our examples, over-fulfilling IR/PC to keep salary ≥ 0
   - in others, higher salary to compensate agent for risk

2. Total payment determined by participation condition
   i.e. by the manager or worker’s outside opportunity
   Strength of incentive (spread between payment for good vs bad observation of indicator of success)
   determined by incentive compatibility condition

OTHER REMARKS ON MORAL HAZARD

1. Agent’s risk-aversion
   Need spread between payments for good and bad outcomes to achieve incentive-compatibility
   But this creates risk for agent, so must offer higher average for participation
   Trade-off between risk and incentives

2. Multiple tiers of agency – Collusion at lower tiers
   Middle manager should be given incentive to enforce scheme designed for lowest level
   May imply need for weaker incentives to lowest level

3. Multiple owners (principals) 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
   Result – weak incentives in the aggregate
   Especially important in politics and public sector
OTHER WAYS TO COPE WITH MORAL HAZARD

1. Repeated relationships
   (1) If luck at different times is independent, then average output is accurate measure of average effort
   (2) Career concerns – use promotion or raises to achieve more early effort

2. Comparison with others
   if luck component is correlated across people then the ranking of your outcome is accurate indication of the ranking of your effort so prizes for best performances good incentives

3. The cost of coping with moral hazard depends on the agent’s outside opportunity
   (1) Hire “motivated agent” who gets direct payoff from better outcome This may be easier in public sector, non-profits than in commercial firms
   (2) A given strength of incentive is consistent with different total expected payment to agent; can use “Carrot” – especially high reward for good outcome “Stick” – severe punishment for bad outcome Which to use depends on agent’s outside opportunity So principal try deliberately to get agent who has poor alternative opportunity but such an agent may have low productivity Or take steps to worsen alternatives of prospective workers Stalinist policies!