Incentives for Innovation

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FTG Summer School - August 2015

Economic Literature on Innovation

- Patent race and endogenous growth literatures
- Simplified representation of R&D activity:
  - Reduced-form model of the innovation process.
  - Aggregate agent playing simultaneously the roles of *financier, creator, owner,* and (often) *user* of the innovation.
- How to provide incentives in innovative tasks?

Agency Problems

- Berle and Means (1932): Separation of ownership and control. Why?
  - Cash constraints
  - Expertise/specialization
  - Risk sharing
- Principal-agent problems (e.g. Harris and Raviv, 1978, Holmstrom, 1979).

Standard Theory of Incentives: Pay–for–Performance Enhances Productivity

- windshield installers (Lazear, 2000).
- Canadian tree planters (Paarsch and Shearer, 1999).
- Philippine agricultural workers (Foster and Rosenzweig, 1994).
- professional golf players (Ehrenberg and Bonnano, 1990).

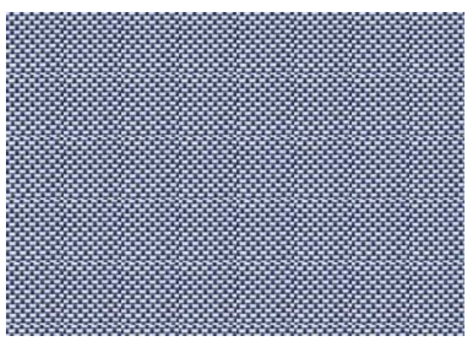
The Positive Effects of Pay-for-Performance Are Not a Consensus in Psychology

Laboratory and Field Experiments: McGraw (1978), Kohn (1993) and Amabile (1996).

In flexible open-ended tasks, pay-for-performance may undermine performance.

- reduces intrinsic motivation.
- inhibits creative responses.

The Negative Effects of Rewards - Glucksberg (1962)



3M's Basic Principle of Management

Mistakes will be made. But if a person is essentially right, the mistakes he or she makes are not as serious in the long run as the mistakes management will make if it undertakes to tell those in authority exactly how they must do their jobs. Management that is destructively critical when mistakes are made kills initiative. And it's essential that we have many people with initiative if we are to continue to grow.

William L. McKnight, former 3M CEO.

Other Examples of Incentive Schemes that Protect or Reward the Agent When Failure Occurs

- the institution of tenure.
- golden parachutes.
- managerial entrenchment.
- debtor–friendly bankruptcy laws.

Outline of the Talk

Part I: Measurement Issues
- Holmstrom (1989)
- Aghion and Tirole (1994)

Part II: Innovation as Experimentation
- Manso (2011)

Outline of Part I: Measurements Issues

1. Noisy Measures/Risky Activity
2. Incomplete Contracts

Holmstrom (1989) - “Agency Costs and Innovation”

- Single innovation project with payoff:

$$y = e + \tilde{\epsilon},$$

where e represents the agent's effort and $\tilde{\epsilon}$ is a normal random variable with mean μ and variance σ^2.

- Principal is risk-neutral. Agent is risk averse with utility over income $u(x) = -\exp\{-rx\}$, private cost of effort $c(e) = ke^2/2$, and zero reservation utility.
- Principal offers the agent a linear contract (why linear?):

$$s(y) = a + by.$$

The Principal's Problem: First-Best

The principal's problem is then:

$$\sup_{\{a,b,e\}} (\mu + e) - (a + b(\mu + e)),$$

subject to:

$$a + b(\mu + e) - (1/2)rb^2\sigma^2 - ke^2/2 \geq 0 \qquad \text{(IR)}$$

The Principal's Problem: First-Best

Because the (IR) constraint binds (why?), we can rewrite the problem as:

$$\sup_{\{b,e\}} (\mu + e) - ((1/2)rb^2\sigma^2 + ke^2/2),$$

The solution is $b = 0$ and $e_{FB} = 1/k$.

The Principal's Problem: Second-Best

The principal's problem is:

$$\sup_{\{a,b,e\}} \ (\mu + e) - (a + b(\mu + e)),$$

subject to:

$$e \in \arg\max\{a + b(\mu + e) - (1/2)rb^2\sigma^2 - ke^2/2\} \qquad \text{(IC)}$$

and

$$a + b(\mu + e) - (1/2)rb^2\sigma^2 - ke^2/2 \geq 0 \qquad \text{(IR)}$$

The Principal's Problem: Second-Best

Because the (IR) constraint binds, we can rewrite the problem as:

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subject to:

$$e \in \arg\max\{b(\mu + e) - (1/2)rb^2\sigma^2 - ke^2/2\}. \qquad \text{(IC)}$$

The Principal's Problem: Second-Best

Using the first-order condition, we know that:

$$e \in \arg\max\{b(\mu + e) - (1/2)rb^2\sigma^2 - ke^2/2\}. \qquad \text{(IC)}$$

implies $e_{SB} = b/k$.

Therefore, the principal's problem can be rewritten:

$$\sup_{b} (\mu + b/k) - \left((1/2)rb^2\sigma^2 + k(b/k)^2/2\right),$$

Solving for b yields:

$$b = (1 + rk\sigma^2)^{-1}$$

Low-Powered Incentives for Noisier/Riskier Tasks

Pay-for-performance sensitivity $b = (1 + rk\sigma^2)^{-1}$ is higher:

- the lower is the cost k of effort
- the lower is the agent's risk-aversion r
- the lower is the variance σ^2 of the performance measure

Trade-off Between Risk Sharing and Incentives

- For optimal effort, $b = 1$
- For optimal risk sharing, $b = 0$
- Optimal contract: $0 < b = (1 + rk\sigma^2)^{-1} < 1$
- Effort:
$$e_{FB} = (1/k) > (1 + rk\sigma^2)^{-1}(1/k) = e_{SB}$$
- Total surplus:
$$W_{FB} = \mu + (1/2)k^{-1} > \mu + (1/2)k^{-1}(1 + rk\sigma^2)^{-1} = W_{SB}$$

Project Choice Biased Against Innovation

Suppose there are several projects available, identified with characteristics (μ, σ^2, k).

Principal will choose the project to maximize her surplus:

$$\mu + (1/2)k^{-1}(1 + rk\sigma^2)^{-1}$$

Advantage in technologies (high μ) will be traded off against incentive considerations. Riskier/noisier projects more likely to be passed up in favor of more routine ones.

Monitoring

Enrich the model by introducing a monitoring variable:

$$z = e + \tilde{\eta}.$$

where $\tilde{\eta}$ is a normal independent random variable with mean μ' and variance σ'^2.

Then the optimal linear contract is:

$$s(y, z) = a + by + cz.$$

Monitoring: The Principal's Problem

The principal's problem is then:

$$\sup_{\{a,b,c,e\}} (\mu + e) - (a + b(\mu + e) + c(\mu' + e)),$$

subject to:

$$e \in \arg\max\{a + b(\mu + e) + c(\mu' + e) - (1/2)r(b^2\sigma^2 + c^2\sigma'^2) - ke^2/2\} \quad \text{(IC)}$$

and

$$a + b(\mu + e) + c(\mu' + e) - (1/2)r(b^2\sigma^2 + c^2\sigma'^2) - ke^2/2 \geq 0 \quad \text{(IR)}$$

Monitoring: The Principal's Problem

Because the (IR) constraint binds, we can rewrite the problem as:

$$\sup_{\{b,e\}} (\mu + e) - ((1/2)r(b^2\sigma^2 + c^2\sigma'^2) + ke^2/2),$$

subject to:

$$e \in \arg\max\{b(\mu + e) + c(\mu' + e) - (1/2)r(b^2\sigma^2 + c^2\sigma'^2) - ke^2/2\}. \quad \text{(IC)}$$

Monitoring is More Intense for Riskier/Noisier Tasks

Using the first-order condition, we know that:

$$e \in \arg\max\{b(\mu+e)+c(\mu'+e)-(1/2)r(b^2\sigma^2+c^2\sigma'^2)-ke^2/2\}. \text{ (IC)}$$

implies $e^* = (b+c)/k$.

Therefore, the principal's problem can be rewritten:

$$\sup_{\{b,c\}} (\mu + (b+c)/k) - \left((1/2)r(b^2\sigma^2 + c^2\sigma'^2) + k((b+c)/k)^2/2\right),$$

Solving for b and c yields:

$$b = \frac{\frac{rk\sigma'^2}{(1+rk\sigma'^2)}}{\frac{rk\sigma'^2}{1+rk\sigma'^2} + rk\sigma^2} \qquad c = \frac{\frac{rk\sigma^2}{(1+rk\sigma^2)}}{\frac{rk\sigma^2}{1+rk\sigma^2} + rk\sigma'^2}$$

Noisier/riskier activities rely more on monitoring:

$$\sigma^2 \uparrow \Longrightarrow b \downarrow, c \uparrow \Longrightarrow \sigma'^2 \downarrow$$

Agent's Flexibility

Suppose the agent could allocate some effort (e') to an outside activity with non-stochastic return $f(e')$.

There is no cost to effort, but total effort cannot exceed 1 (i.e. $c(e+e') = 0$ for $e+e' \leq 1$ and infinity for $e+e' > 1$.

Assume agent's private benefit $f(e') = \lambda_1 e'$ for $e' \leq n < 1$ and $\lambda_1 n + \lambda_2(e'-n)$ for $e' > n$, where $\lambda_1 > 1 > \lambda_2 > 0$.

The principal can choose to exclude the outside activity.

Agent's Flexibility Restricted for Riskier/Noisier Tasks

Proposition: When $\sigma^2 \leq (\lambda_1 - 1)n\{(r/2)(\lambda_2)^2\}^{-1}$, it is optimal to set $b = \lambda_2$.

Otherwise, it is optimal exclude the outside activity and set $b = 0$.

Proof: Follows from the trade-off between the cost of imposing risk on the agent:

$$(r/2)(\lambda_2)^2\sigma^2$$

and the opportunity cost of foregoing the outside return:

$$(\lambda_1 - 1)n.$$

Project Assignment

- Suppose there are several projects to be allocated between two identical agents.
- Assume only total cost of effort matters to the agents.
- The return of project i is

  $$y_i = f(e_i) + \text{normal error term}$$

  where f is concave and errors are independent.
- Principal observes only the aggregate output of each agent

Project Assignment: Innovation Activities Mix Poorly With Routine Activities

Proposition: Under the best allocation, projects assigned to one agent are uniformly more risky than projects assigned to the other agent.

Proof: One can switch around two projects without affecting output. Risk is minimized by assigning the agent with lower incentive coefficient all projects with a variance above some cut-off level and assigning all low risk project to the agent with the higher incentive coefficient. (Since projects are independent and utility is exponential, diversification issues do not arise.)

Incomplete Contracts

- What if contracts cannot specify each side's rights and responsibilities in all future contingencies?
- Grossman and Hart (1986): Parties negotiate a solution. Ownership (residual rights) affects bargaining position.
- What does it have to do with innovation?
  - Exact nature of innovation is ill-defined ex-ante
  - Cannot contract for the delivery of a specific innovation

Aghion and Tirole (1994): "The Management of Innovation"

- A research unit (RU) performs research for a customer (C)
- The value of innovation to the customer is:

$$y = e_C + e_{RU} + \tilde{\epsilon}$$

where e_c represents effort by C, e_{RU} represents effort by RU, and $\tilde{\epsilon}$ is a normal random variable with mean μ and variance σ^2.

- The value y of innovation in not contractible. Contract specifies the allocation of property rights.

Who Should Own the Innovation?

- *C-Ownership* or *integrated case*: Property rights on innovation allocated to C, who can freely use the innovation.
- *RU-Ownership* or *non-integrated case*: Property rights on innovation allocated to RU, who bargain with C over the licensing fee once the innovation has been made. For simplicity, we assume parties split the income from innovation.

Under C-Ownership

- RU receives no reward and therefore supplies no effort: $e_{RU} = 0$.
- C has appropriate incentives to invest and therefore chooses $e_C = k_C^{-1}$.
- Utilities are given by:

$$U_{RU} = 0 \qquad\qquad U_C = \mu + (1/2)k_C^{-1}$$

Under RU-Ownership

- Each party receives $y/2$, and therefore $e_{RU} = (1/2)k_{RU}^{-1}$ and $e_C = (1/2)k_C^{-1}$
- Utilities are given by:

$$\tilde{U}_{RU} = (1/2)(\mu + (1/2)(k_{RU}^{-1} + k_C^{-1}) - (1/2)^3(r\sigma^2 + k_{RU}^{-1})$$

and

$$\tilde{U}_C = (1/2)(\mu + (1/2)(k_{RU}^{-1} + k_C^{-1})) - (1/8)k_c^{-1}$$

Allocation of Property Right

RU should own the property rights if:

$$\tilde{U}_{RU} + \tilde{U}_C \geq U_{RU} + U_C$$

Otherwise, C should own the property rights.

However, property rights allocation depends on initial bargaining power.

Allocation of Property Right

Proposition: The equilibrium allocation of property rights between RU and C is the following:

- If RU's effort is important enough that $\tilde{U}_C > U_C$, the property right is allocated to RU.
- If, on the other hand, $\tilde{U}_C < U_C$, the allocation of property rights depend on the ex ante relative bargaining strength.
  - If RU has the bargaining power, the allocation of property rights is efficient in that RU receives ownership iff $\tilde{U}_{RU} + \tilde{U}_C \geq U_{RU} + U_C$.
  - If C has the bargaining power, C always keep the property right as RU is cash constrained. The allocation may be inefficient.

Integration is Problematic: Less Innovation in Large Firms

- Innovation typically requires significant personal sacrifice from RU, which is impossible under integration.
- To compensate for the dillution of incentives, the integrated firm could intensify monitoring or reduce flexibility.
  - However, collusion between the monitor and the ones she monitors makes it hard.
  - Reducing flexibility may stifle innovation.
- Bureaucratization (e.g. promotion based on seniority, time cards, little flexibility, etc)

Conclusion of Part I

- Innovation is riskier, has noisier performance measures, and is often not contractible.
- Less reliance on pay-for-performance, more likely to pass up good projects, more reliance on monitoring, less flexibility, group riskier/noisier tasks with the same person, more difficult to implement in large firms (bureaucratization).
- What else is special about innovation?

Outline of Part II: Innovation as Experimentation

3 Setup

4 Compensation

5 Commitment

6 Termination

7 Feedback

8 The Principal's Choice

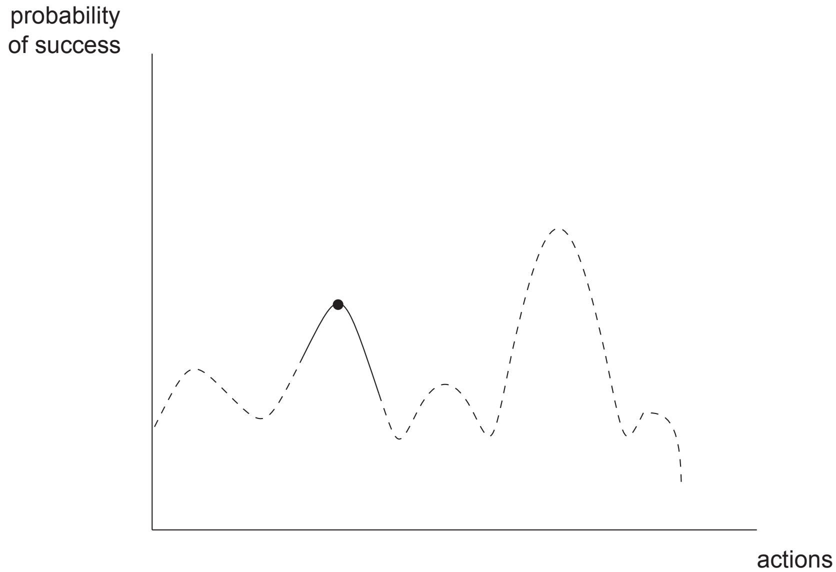
9 Implementation

10 Additional Literature

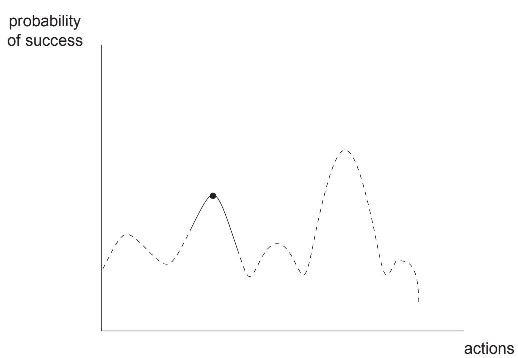
Innovation is the Result of Exploration

1. Innovation is the production of knowledge through experimentation: Arrow (1969).
2. Bandit problems: Thompson (1932).
3. Exploration vs exploitation: March (1991).

The Tension Between Exploitation and Exploration



Incentives for Exploration are Fundamentally Different from Standard Pay–for–Performance



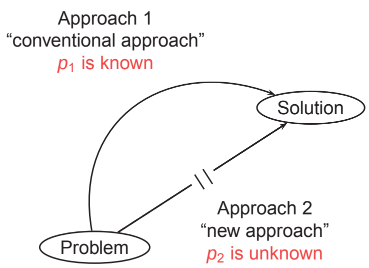
compensation?

termination?

commitment?

feedback?

The Single–Agent Decision Model



Two periods.

Two outcomes $\{S, F\}$.

Exploratory nature:

$$E[p_2] < p_1 < E[p_2|S,2].$$

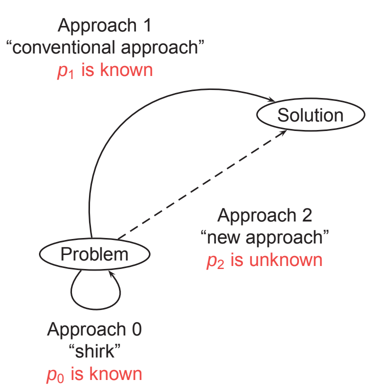
Two action plans:

1. action plan $\langle 1 {}^1_1 \rangle$ (“exploitation”).
2. action plan $\langle 2 {}^2_1 \rangle$ (“exploration”).

Exploration is better than exploitation iff

$$E[p_2] \geq \left(1 - \underbrace{\frac{(E[p_2|S,2] - p_1)}{1 + (E[p_2|S,2] - p_1)}}_{\text{information premium}}\right) p_1.$$

The Principal–Agent Model



Value of Effort:

$$p_0 < E[p_i], \text{ for } i = 1, 2.$$

Private Costs:

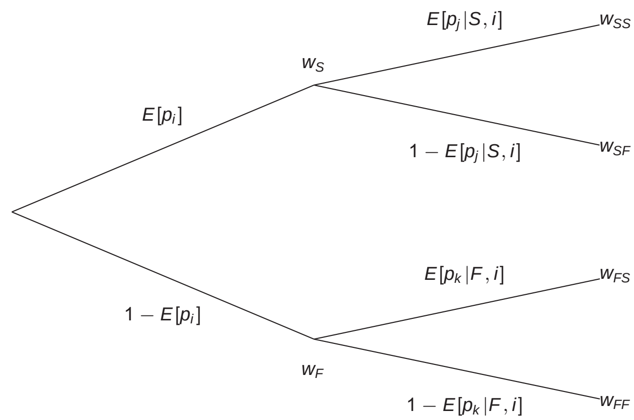
$$c_0 = 0, c_1 \geq 0, c_2 \geq 0.$$

Relative costs c_2/c_1.
The principal offers the agent a contract

$$\vec{w} = \{w_S, w_F, w_{SS}, w_{SF}, w_{FS}, w_{FF}\}.$$

Limited liability: non–negative wages.

Contingent Wages and Expected Probabilities Induced by Action Plan $\langle i \, {}^{j}_{k} \rangle$



The Incentive Problem

1. The optimal contract $\vec{w}(\langle i \, {}^{j}_{k} \rangle)$ that implements $\langle i \, {}^{j}_{k} \rangle$ minimizes

$$W(\vec{w}, \langle i \, {}^{j}_{k} \rangle),$$

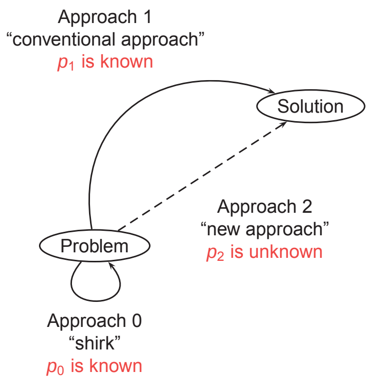
subject to

$$W(\vec{w}, \langle i \, {}^{j}_{k} \rangle) - C(\langle i \, {}^{j}_{k} \rangle) \geq W(\vec{w}, \langle l \, {}^{m}_{n} \rangle) - C(\langle l \, {}^{m}_{n} \rangle). \qquad (\mathrm{IC}_{\langle l \, {}^{m}_{n} \rangle})$$

2. The principal's problem is then to choose $\langle i \, {}^{j}_{k} \rangle$ that maximizes

$$\Pi(\langle i \, {}^{j}_{k} \rangle) = R(\langle i \, {}^{j}_{k} \rangle) - W(\vec{w}(\langle i \, {}^{j}_{k} \rangle), \langle i \, {}^{j}_{k} \rangle).$$

Two Special Cases of the Model



1. If $c_2 = \infty$, then standard principal–agent model.

2. If $c_1 = c_2 = 0$, then classical two–armed bandit problem.

Incentive Compatibility Constraints to Implement Exploitation

Shirking:

$$(p_1 - p_0)(w_{SS} - w_{SF}) \geq c_1 \qquad (\mathrm{IC}_{\langle 1\, {}^{0}_{1} \rangle})$$

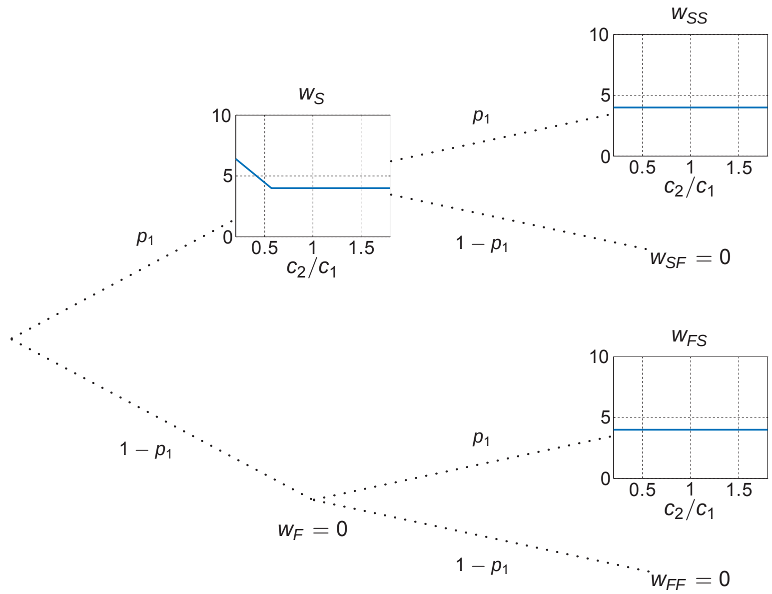
$$(p_1 - p_0)(w_{FS} - w_{FF}) \geq c_1 \qquad (\mathrm{IC}_{\langle 1\, {}^{1}_{0} \rangle})$$

$$(p_1 - p_0)(w_S - w_F) + (p_1^2 - p_0 p_1)(w_{SS} - w_{SF}) - (p_1^2 - p_0 p_1)(w_{FS} - w_{FF}) \geq c_1 \qquad (\mathrm{IC}_{\langle 0\, {}^{1}_{1} \rangle})$$

Exploration:

$$(p_1 - E[p_2])(w_S - w_F) + (p_1^2 - E[p_2]E[p_2|S,2])(w_{SS} - w_{SF}) - (p_1^2 - E[p_2]p_1)(w_{FS} - w_{FF}) \geq c_1 - c_2 + E[p_2](c_1 - c_2) \qquad (\mathrm{IC}_{\langle 2\, {}^{2}_{1} \rangle})$$

Optimal Contract that Implements Exploitation



Incentive Compatibility Constraints to Implement Exploration

Shirking:

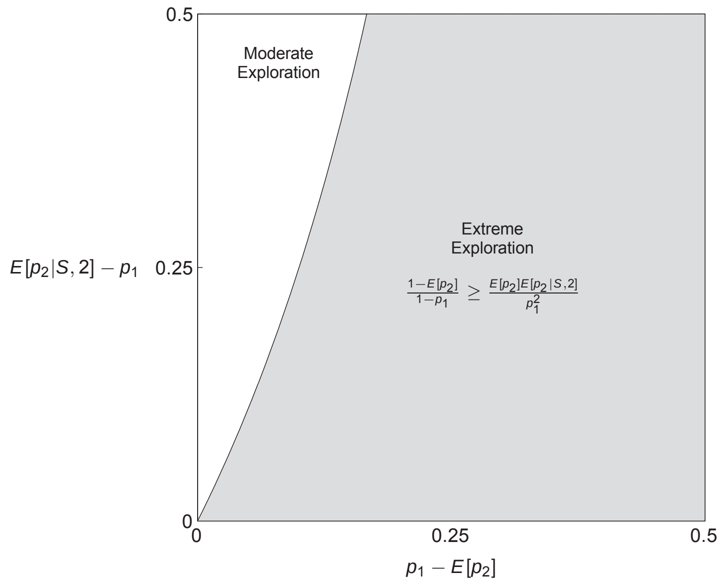
$$(p_1 - p_0)(w_{FS} - w_{FF}) \geq c_1 \qquad (\text{IC}_{\langle 2\,{}^{2}_{0} \rangle})$$

$$\begin{aligned}(E[p_2]E[p_2|S,2] - p_0E[p_j])(w_{SS} - w_{SF})\\ + (E[p_2] - p_0)(w_S - w_F)\\ \geq (1 + E[p_2])c_2 - p_0c_j\\ + (E[p_2] - p_0)p_0w_{FS} \qquad (\text{IC}_{\langle 0\,{}^{j}_{1} \rangle})\end{aligned}$$

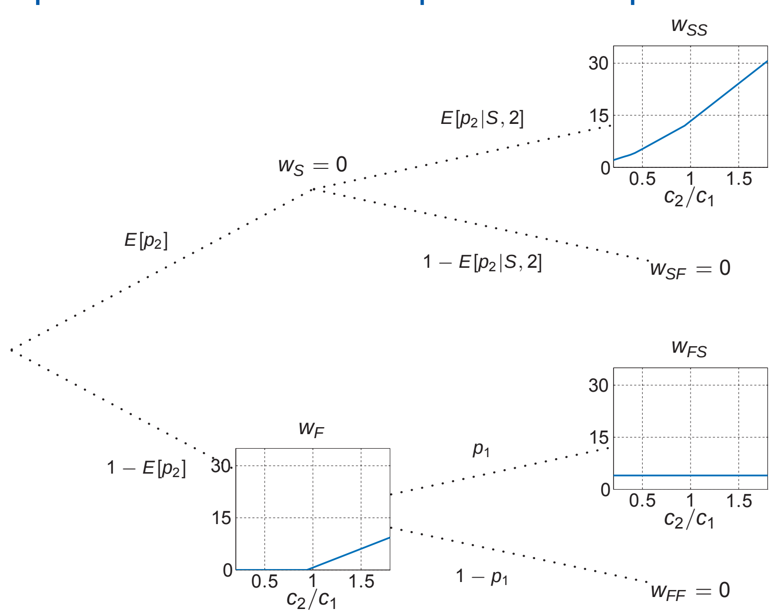
Exploitation:

$$\begin{aligned}(E[p_2]E[p_2|S,2] - p_1^2)(w_{SS} - w_{SF})\\ - (p_1 - E[p_2])(w_S - w_F)\\ \geq (1 + E[p_2])c_2 - (1 + p_1)c_1\\ - (p_1 - E[p_2])p_0w_{FS} \qquad (\text{IC}_{\langle 1\,{}^{1}_{1} \rangle})\end{aligned}$$

Moderate vs. Extreme Exploration



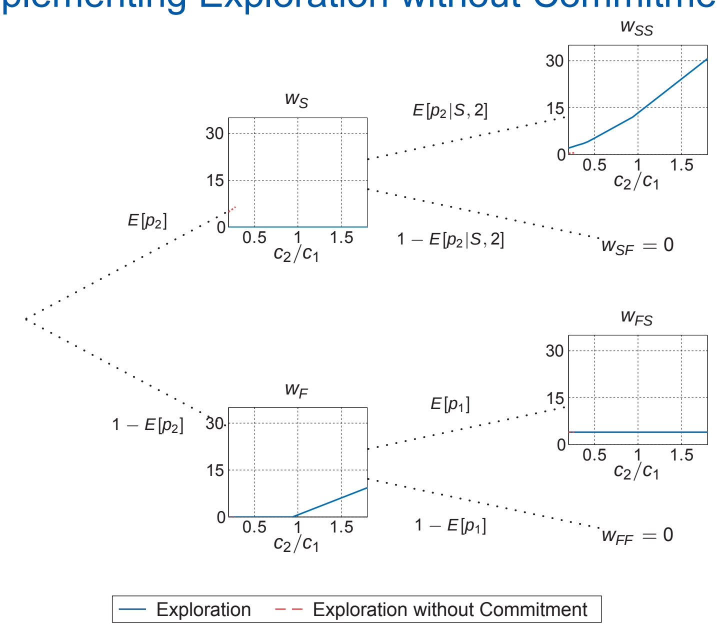
Optimal Contract that Implements Exploration



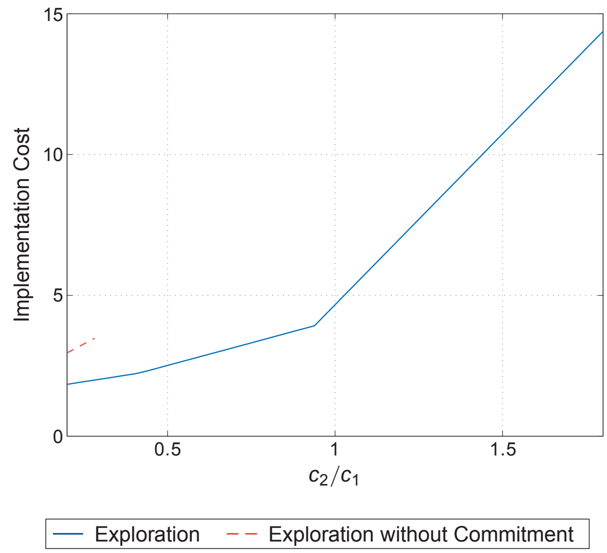
Implementing Exploitation Without Commitment

The optimal long-term contract that implements exploitation can be realized through a sequence of short-term contracts.

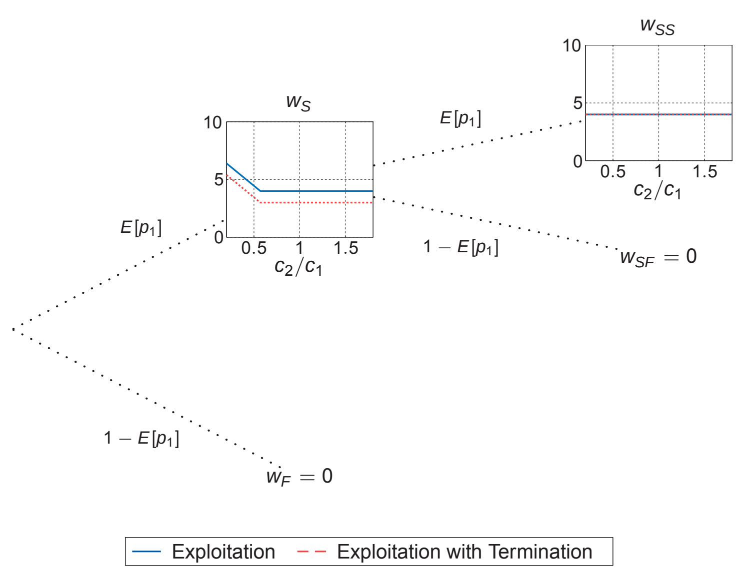
Implementing Exploration without Commitment



Cost of Implementing Exploration Without Commitment



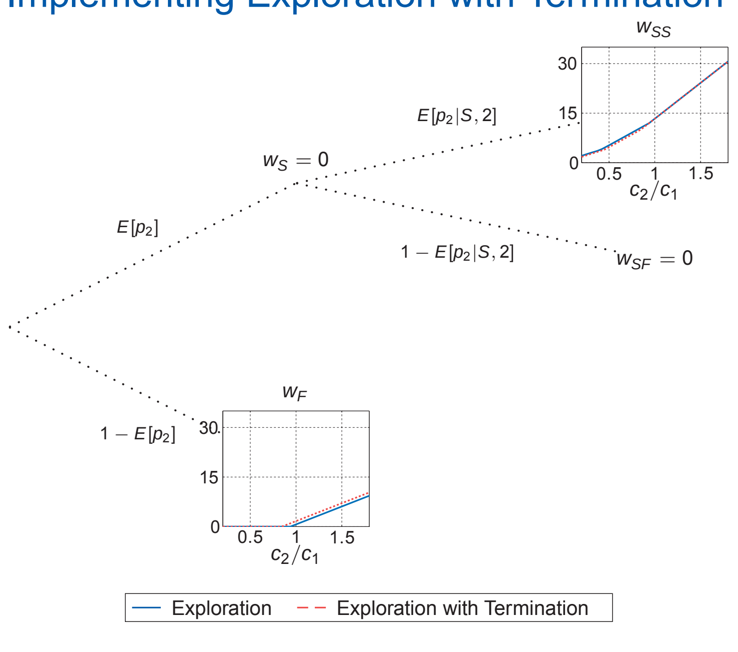
Implementing Exploitation with Termination



Optimal Termination Policy with Exploitation

There is inefficient termination with exploitation.

Implementing Exploration with Termination



Optimal Termination Policy with Exploration

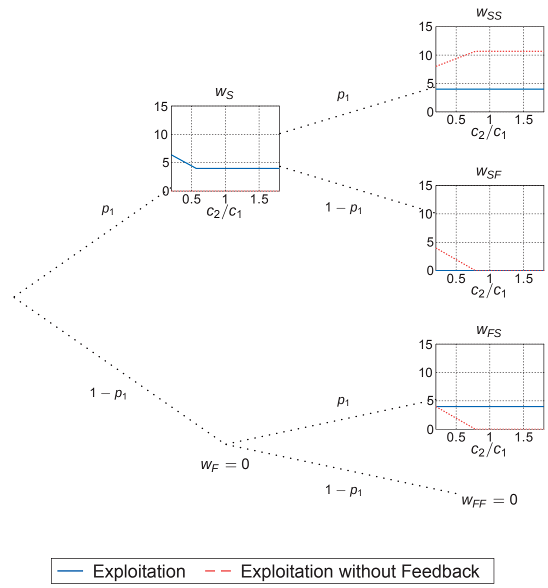
If c_2/c_1 is low, then there is inefficient termination with exploration.

If c_2/c_1 is high, then there is inefficient continuation with exploration.

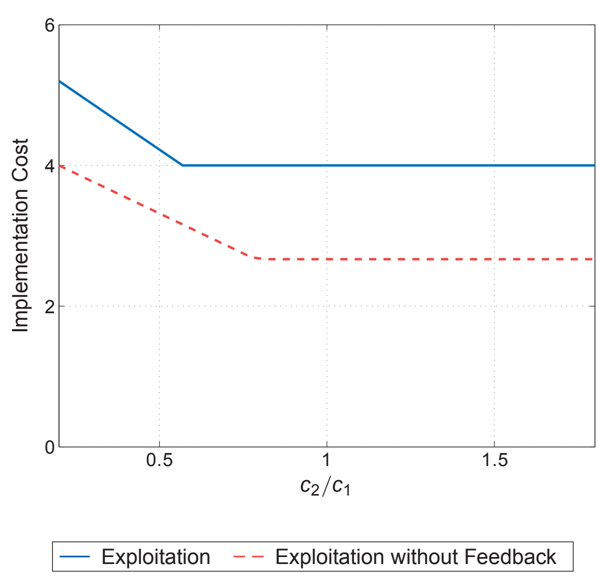
Implementing Exploitation When the Principal Privately Observes Interim Performance

It is optimal for the principal not to provide feedback on performance to the agent.

Implementing Exploitation Without Feedback



Cost of Implementing Exploitation Without Feedback



Implementing Exploration When the Principal Privately Observes Interim Performance

1. The principal must provide feedback on performance to the agent.
2. Same contract as when performance is publicly observable.

The Principal's Choice between Exploration and Exploitation

The principal chooses the action plan $\langle\begin{smallmatrix} i & j \\ & k\end{smallmatrix}\rangle$ that maximizes his expected profit:

$$\Pi(\langle\begin{smallmatrix} i & j \\ & k\end{smallmatrix}\rangle) = R(\langle\begin{smallmatrix} i & j \\ & k\end{smallmatrix}\rangle) - W(\vec{w}(\langle\begin{smallmatrix} i & j \\ & k\end{smallmatrix}\rangle), \langle\begin{smallmatrix} i & j \\ & k\end{smallmatrix}\rangle).$$

Therefore, the principal chooses exploration over exploitation if and only if

$$R(\langle\begin{smallmatrix} 2 & 2 \\ & 1\end{smallmatrix}\rangle) - W(\vec{w}(\langle\begin{smallmatrix} 2 & 2 \\ & 1\end{smallmatrix}\rangle), \langle\begin{smallmatrix} 2 & 2 \\ & 1\end{smallmatrix}\rangle) > R(\langle\begin{smallmatrix} 1 & 1 \\ & 1\end{smallmatrix}\rangle) - W(\vec{w}(\langle\begin{smallmatrix} 1 & 1 \\ & 1\end{smallmatrix}\rangle), \langle\begin{smallmatrix} 1 & 1 \\ & 1\end{smallmatrix}\rangle)$$

If there were no agency problems, however, it would be optimal for the principal to choose exploration over exploitation if and only if

$$R(\langle\begin{smallmatrix} 2 & 2 \\ & 1\end{smallmatrix}\rangle) - C(\langle\begin{smallmatrix} 2 & 2 \\ & 1\end{smallmatrix}\rangle) > R(\langle\begin{smallmatrix} 1 & 1 \\ & 1\end{smallmatrix}\rangle) - C(\langle\begin{smallmatrix} 1 & 1 \\ & 1\end{smallmatrix}\rangle)$$

The Principal's Choice between Exploration and Exploitation

The principal is biased against exploration if

$$W(\vec{w}(\langle 2\,{}^{2}_{1} \rangle), \langle 2\,{}^{2}_{1} \rangle) - C(\langle 2\,{}^{2}_{1} \rangle) > W(\vec{w}(\langle 1\,{}^{1}_{1} \rangle), \langle 1\,{}^{1}_{1} \rangle) - C(\langle 1\,{}^{1}_{1} \rangle)$$

and the principal is biased towards exploration if

$$W(\vec{w}(\langle 2\,{}^{2}_{1} \rangle), \langle 2\,{}^{2}_{1} \rangle) - C(\langle 2\,{}^{2}_{1} \rangle) < W(\vec{w}(\langle 1\,{}^{1}_{1} \rangle), \langle 1\,{}^{1}_{1} \rangle) - C(\langle 1\,{}^{1}_{1} \rangle)$$

Proposition: The principal is biased against exploration if c_2/c_1 is large, and is biased towards exploration if c_2/c_1 is small.

Bank of America - Incentives in Experimental Divisions

HBS Case - Thomke (2002)

- 25 branches as real–life laboratories.
- What is different in terms of incentives?

target failure rate: at least 30%.

Recent Public Outcry on Executive Compensation

Press: "The (Fat) Wages of Scandal," Business Week, September 2002.

Investors: CALPERS.

Academics: "Pay without Performance," Bebchuk and Fried, November 2004.

Government Agencies: "Rewards for Failure," British Department of Trade and Industry, June 2003.

The Risk of a Regulatory Overreaction

. . . an effort to regulate the system so that such outrage will never again occur would be overly costly and counterproductive. It would lead to inflexibility and fear of experimentation. In today's uncertain climate, we probably need more organizational experimentation than ever.

"The State of US Corporate Governance,"
Holmstrom and Kaplan (2003)

Rationale to Widespread Compensation Instruments

exploration with termination: stock option + golden parachute.

exploration: stock option + option repricing.

inefficient continuation: entrenchment.

Empirical Literature on Incentives for Innovation

- Corporate governance:
  - Managerial compensation (Lerner and Wulf, 2007; Ederer and Manso, 2013; Baranchuk, Kieschnick, and Moussawi, 2014; Gonzalez-Uribe and Xu, 2015),
  - Firm's going public decision (Bernstein, 2012; Chen, Gao, Hsu, and Li, 2015)
  - Private equity/venture capital involvement (Lerner, Sorensen, and Stromberg, 2011; Tian and Wang, 2014; Chemmanur, Loutskina, and Tian, 2014)
  - Anti-takeover provisions (Atanassov, 2013; Chemmanur and Tian, 2014; Sapra, Subramanian, and Subramanian, 2014)
  - Institutional ownership (Aghion, Van Reenen, and Zingales, 2013)
  - Conglomerate structure (Seru, 2014)
- Academic research (Azoulay, Graff-Zivin, and Manso, 2011)
- Bankruptcy laws (Acharya and Subramanian, 2009)
- Labor laws (Acharya, Baghai, and Subramanian, 2013)

Additional Literature

1. Alternative principal–agent models: Lambert (1986), Holmstrom and Milgrom (1991), Dewatripont and Maskin (1995), and Von Thadden (1995).
2. Bandit Problems: Gittins and Jones (1974), Gittins (1989), Berry and Fristedt (1984), Karatzas (1984)
3. Bandit Problems in Economics: Survey by Bergemann and Valimaki (2008)
4. Incentives for Experimentation: Bergemann and Hege (2005), Horner and Samuelson (2013), Garfagnini (2012), Gerardi and Maestri (2012), Klein (2012), Ederer (2013), Gomes, Gottlieb, and Maestri (2014), Guo (2015), Halac, Kartik, and Liu (2015a, 2015b), Moroni (2015), Ferreira, Manso, and Silva (2014)

Conclusion

- Beyond measurement/contractibility issues, innovation is about experimentation
- Incentive schemes that motivate innovation/experimentation are fundamentally different from standard pay–for–performance incentive schemes used to induce effort.
  - tolerance for early failure, reward for long-term success.
  - job security and golden parachutes.
  - timely feedback on performance.
  - commitment to a long-term contract.