The Cost of Non-Decreasing Pay: Tenured Academics and Civil Servants

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7th Biannual Conference of the Society for Economic Design, Montreal, June 15-17, 2011
Long-term contracts with non-decreasing wages

Examples
- Civil servants
- Tenured academics

Legislation and usual practice

Hidden information vs. hidden action

Disincentives

Cost
Relation to literature

- **Non-decreasing wages**
  - Harris and Holmstrom (1982): incompl. sym. info, risk-neutral firms
  - Holmstrom (1982): career concerns
  - Stevens (2004): random matching and on-the-job search

- **Academic tenure**
  - Carmichael (1988): truthful revelation in OLG
  - Freeman (1977): sym. info about productivity
  - Glaeser (2002): faculty vs. administration
  - Khovanskaya, Sonin and Yudkevich (2007): university budgets
  - Li and Ou-Yang (2003): incentive effects
  - Oyer (2007): insider advantage
Infinite-horizon characterization
- Green (1987): temporary incentive compatibility
- Spear and Srivastava (1987): recursivity
- Abreu, Pearce and Stacchetti (1990): SGP equilibria in dyn games

Repeated moral hazard with hidden action
- Phelan and Townsend (1991): convexif. and APS on probabilities
- Wang (1997): APS on continuation utility
- Fernandes and Phelan (2000): history-dependence through action
- Doepke and Townsend (2006): history-dependence through income
- Sleet and Yeltekin (2001): income shocks and separations
Two periods
Assumptions

- Principal-agent
- Unobservable effort
- One-sided commitment
- Realized wage today becomes minimum wage tomorrow
- Outcomes: $y < \bar{y}$
- Effort: $a < \bar{a}$
Two periods
Assumptions

- Probability of \( y \) conditional on \( a \): \( \pi(y, a) \)
  - \( \pi \) := \( \pi(y, a) \)
  - \( \pi \) := \( \pi(y, \bar{a}) \)
  - \( 0 < \pi < \bar{\pi} < \pi < 1 \)

- Given outcome \( y \), effort \( a \), and wage \( w \)
  - principal’s period utility: \( y - w \)
  - agent’s period utility: \( v(w) - a \)
  - common discount factor: \( \beta \)

- Agent’s outside wage: \( v^{-1}(V) \)
Two periods with unrestricted pay

Single-period problem

\[
\max_{a,w(.), y \in Y} \sum (y - w) \pi (y, a) \quad \text{s.t.:}
\]

\[
a \in A
\]

\[
\sum_{y \in Y} (v(w) - a) \pi (y, a) \geq V
\]

\[
a \in \arg \max_{a' \in A} \sum_{y \in Y} (v(w) - a') \pi (y, a')
\]
Two periods with unrestricted pay

Optimal contract

\[ C < 0 \Rightarrow \text{low effort is optimal and implemented by } v \]

\[ C \geq 0 \Rightarrow \text{high effort is optimal and implemented by:} \]

\[
\begin{cases} 
  v - (1 - \pi)k & \text{if outcome is bad} \\
  v + \pi k & \text{if outcome is good}
\end{cases}
\]

\[ v := V + a \]

\[ k := \frac{a - \bar{a}}{\pi - \bar{\pi}} \]

\[ C := E(y|\bar{a}) - \bar{\pi}v^{-1}(v - (1 - \pi)k) - (1 - \bar{\pi})v^{-1}(v + \pi k) - E(y|a) + v^{-1}(v) \]
Myopia

MYOPIA = SHORT-TERMISM

- Ignoring future utility
- It could be driven by beliefs about:
  - changes in legislation
  - leaving the relationship
Two periods with non-decreasing pay

Full myopia

\[ G_0 \]

\[ G_1 \]

\[ G_2 \]
Two periods with non-decreasing pay

Full myopia

\[ C < 0 \text{ implies } G_0 \]

\[ C \geq 0 \text{ and } D < 0 \text{ imply } G_1 \]

\[ C \geq 0 \text{ and } D \geq 0 \text{ imply } G_2 \]

\[ D := E(y|\bar{a}) - E(y|a) + (1 - \pi) (v^{-1}(v + \pi k) - v^{-1}(v + (1 + \pi)k)) \]
Given an effective minimum wage $w_1$, the principal can implement:

(a) low effort by $\max\{v(w_1), v\}$;

(b) high effort by $v_2$ after a bad outcome and $v_2 + k$ after a good outcome, where $v_2 := \max\{v(w_1), v - (1 - \pi) k\}$.
Two periods with non-decreasing pay

Myopic agent

If the principal chooses among $G_0$, $G_1$ and $G_2$:

(a) $K < 0$ and $(1 + \beta \bar{\pi}) C + (1 - \beta) \bar{\pi} \max\{K, L\} < 0$ imply $G_0$;

(b) $(1 + \beta \bar{\pi}) C + (1 - \beta) \bar{\pi} L \geq 0$ and $K < L$ imply $G_1$;

(c) $(1 + \beta \bar{\pi}) C + (1 - \beta) \bar{\pi} K \geq 0$ and $L \leq K < 0$; or $K \geq 0$ imply $G_2$.

$$K := E \left( y|a \right) - \bar{\pi} v^{-1} (v + \pi k) - (1 - \bar{\pi}) v^{-1} (v + (1 + \pi) k) - E \left( y|a \right) + v^{-1} (v)$$

$$L := v^{-1} (v) - v^{-1} (v + \pi k)$$
Two periods with non-decreasing pay

Myopic agent
Two periods with non-decreasing pay
No myopia

- Binding minimum wages imply that second-period individual rationality is slack

- Downward adjustment of first-period wages is not constrained by single-period individual rationality as long as two-period individual rationality holds

⇒ Principal is better off when agent is fully rational
Infinite horizon
Framework

- Repeated moral hazard
- Hidden action
- One-sided commitment
- Realized wage today is a minimum wage tomorrow
Infinite horizon
Assumptions

- Discrete time, $t$
- Initial period of contracting 0
- Stationary set of $N$ distinct outcomes, $Y$
- Stationary, compact set of actions, $A$
- Stationary, compact set of transfers, $W$
- Current outcome depends on current action only
- For any action, the support of the distribution is $Y$
Infinite horizon

Assumptions

- **Principal**
  - $u : \mathcal{W} \times \mathcal{Y} \rightarrow \mathbb{R}$, cont., decr. in transfer, incr. in outcome;
  - discounts the future by a factor $\beta_P \in (0, 1)$;
  - commits to long-term contracts

- **Agent**
  - $\nu : \mathcal{W} \times \mathcal{A} \rightarrow \mathbb{R}$, cont., incr. in transfer, decr. in action;
  - discounts the future by a factor $\beta_A \in (0, 1)$;
  - reservation utility $V$
Infinite horizon

Notation

- $c := (a, w)$ a supercontract signed at the beginning of period 0
- $U_t(c, y^{t-1})$ principal’s expected discounted utility at node $y^{t-1}$
- $V_t(c, y^{t-1})$ agent’s expected discounted utility at node $y^{t-1}$
Infinite horizon
Dynamic contract

\[
\sup_c U_0(c) \quad \text{s.t.}:
\]

\[
a_t(.) \in A \quad \text{(fa)}
\]

\[
w_t(y^{t-1},.) \in W \cap [w_{t-1}(y^{t-1}), \infty) \quad \text{(fw)}
\]

\[
V_t(a,.) \geq V_t(a',.), \ \forall \text{feasible } a' \quad \text{(iic)}
\]

\[
V_t(.) \geq V \quad \text{(ir)}
\]
Optimal contract with unrestricted pay

- Agent’s continuation utilities (Spear and Srivastava (1987))
- Start with large initial guess, iterate on an APS operator and converge to largest fixed point (e.g., Wang (1997))

A natural initial guess is $V_0 = \left[ \frac{v(\min W, \max A)}{1-\beta_A}, \frac{v(\max W, \min A)}{1-\beta_A} \right]$.

Optimal contract with non-decreasing pay

- Enlarge the state space by including lower bounds on wages: $\{(V, w) : V \in V^C(w), w \in W\}$
- Start with large initial guess, iterate on an APS operator and converge to largest fixed point

A natural initial guess is $\{(V, w) : V \in V_0, w \in W\}$.
Infinite horizon
Recursivity: Stationary contracts

- \( c_s := \{(a_s, w_s(y), V_s(y)) : y \in Y\} \) maps state space into actions, contingent minimum wages and continuation utilities.

- Bellman equation which holds for any point \((V, w)\) of the state space:

\[
U(V, w) = \max_{c_s} E_{a_s} \left\{ u\left(w_s, \cdot \right) + \beta P U(V_s) \right\} \quad \text{s.t.:}
\]

\[
a_s \in A \quad \text{(fa)}
\]

\[
w_s(\cdot) \in \mathcal{W} \cap [w, +\infty) \quad \text{(fw)}
\]

\[
V = E_{a_s} \left\{ v\left(w_s, a_s\right) + \beta A V_s \right\} \geq
\]

\[
E_{a'} \left\{ v\left(w_s, a'\right) + \beta A V_s \right\}, \forall a' \in A \quad \text{(tic, pk)}
\]

\[
V_s(\cdot) \in V^C\left(w_s(\cdot)\right) \quad \text{(cp)}
\]
Infinite horizon
Extension: Base salary and bonus

- $c_s := \{(a_s, w_s, w_s(y), V_s(y)) : y \in Y\}$ maps state space into actions, minimum wages, contingent wages and continuation utilities

- Bellman equation which holds for any point $(V, w)$ of the state space:

$$U(V, w) = \max_{c_s} E_{a_s} \{u(w_s, .) + \beta P U(V_s)\} \text{ s.t.:

\[
\begin{align*}
    a_s & \in A \quad \text{(fa)} \\
    w_s(.) & \in W \cap [w, +\infty) \quad \text{(fw)} \\
    w_s & = \min_{y \in Y} w_s(y) \quad \text{(mw)} \\
    V & = E_{a_s} \{v(w_s, a_s) + \beta_A V_s\} \geq \quad \text{(tic,pk)} \\
    E_{a'} \{v(w_s, a') + \beta_A V_s\}, \forall a' \in A \quad \text{(tic,pk)} \\
    V_s(.) & \in V^C(w_s) \quad \text{(cp)}
\end{align*}
\]$$

Morfov, S. (Higher School of Economics)
Infinite horizon

Generalization

- \( c_s := \{(a_s, w_s(y), w_s(y), V_s(y)) : y \in Y\} \) maps state space into actions, contingent minimum wages, wages and continuation utilities.
- Let \( f : W^N \rightarrow W^N \) continuous.
- Bellman equation which holds for any point \((V, w)\) of the state space:

\[
U(V, w) = \max_{c_s} E_{a_s} \left\{ u(w_s,.) + \beta P U(V_s) \right\} \quad \text{s.t.:}
\]

\[
a_s \in A \quad \text{(fa)}
\]

\[
w_s(.) \in W \cap [w, +\infty) \quad \text{(fw)}
\]

\[
w_s(y_n) = f_n(\{w_s\}), \forall y_n \in Y \quad \text{(mw)}
\]

\[
V = E_{a_s} \left\{ v(w_s, a_s) + \beta_A V_s \right\} \geq E_{a'} \left\{ v(w_s, a') + \beta_A V_s \right\}, \forall a' \in A \quad \text{(tic,pk)}
\]

\[
V_s(.) \in V^{C''}(w_s(.)) \quad \text{(cp)}
\]
Conclusion

- **Finite-horizon results:**
  - If principal is myopic, she is slow to adjust to binding wages in the future
    - disincentive effects show up late, at an inherently good state, and are permanent
  - If agent is myopic, principal cannot slash current wages to compensate for the rise of agent's second-period utility above reservation values
    - disincentive effects may show up early
  - If there is no myopia, cost decreases

- **Infinite-horizon results:**
  - Recursive characterization
  - Base salary and bonus