Explicit vs. Implicit Incentives, Part 2: Performance Comparisons and Dynamic Incentives

Margaret Meyer
Nuffield College, Oxford

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Two different types of implicit incentives

The last lecture studied implicit incentives provided by **relational (= self-enforcing) contracts**, and how their design and performance interacted with explicit contracts.

- Focused on Baker, Gibbons, and Murphy, "Subjective Performance Measures in Optimal Incentive Contracts" (QJE, 1994)

This lecture will study implicit incentives stemming from **learning about agents' intrinsic characteristics**, and how they interact with explicit incentives.

- Focus on Meyer and Vickers, "Performance Comparisons and Dynamic Incentives" (JPE, 1997)

Comparative performance information and incentives

In many settings with moral hazard, information about performance of an agent's peers is available, whether as individual-level data or as aggregate data about a comparison group

When all incentives are provided by **explicit contracts**, theoretical prediction about impact of comparative performance information (CPI) is unambiguous: CPI improves incentives and efficiency, because it relaxes the tradeoff between incentives and insurance.

- Call this effect of CPI the **"insurance effect"**
- A principal who can fully commit to how all performance info will be used can never be made worse off by availability of extra info—can always commit to ignore it.

But many settings where CPI is used feature implicit incentives....

Comparative performance info and **implicit** incentives

Many settings where CPI is used feature implicit incentives:

- Managerial compensation:
  - performance targets are revised based on own past performance and past performance of peers (Casas-Arce et al, 2018)
- Regulation of utilities or hospitals:
  - pricing restrictions or reimbursement levels are revised based on agent's own past performance and that of similar agents in other regions (Shleifer, 1985)
- Banks and insurers:
  - use past performance to update beliefs about borrower's/customer's intrinsic quality and base credit scores/insurance premia on updated beliefs; this updating influences agents' implicit incentives to behave prudently (Frankel and Kartik, 2019 and 2020; Ball, 2020)
  - "big data" facilitates use of performance info about other borrowers/customers (Liang and Madsen, 2020)

Comparative performance info and **implicit** incentives

When all incentives are provided by **explicit contracts**, theoretical prediction about impact of comparative performance information (CPI) is unambiguous: CPI improves incentives and efficiency, because it relaxes the tradeoff between incentives and insurance.

- Call this effect of CPI the **"insurance effect"**

Meyer and Vickers (JPE, 1997) ask: **Does this result continue to hold when some or all incentives are implicit?**

Key findings:

- *Insurance effect is no longer the only effect of CPI.*
- *CPI may reduce or enhance incentives and efficiency; its impact depends upon the sources of correlation in agents' performances.*

"Performance Comparisons and Dynamic Incentives" (MV, 1997)

Outline:

1. Two examples showing that incentive effects of CPI are ambiguous when implicit incentives are present
   - Career concerns for managers
   - Ratchet effect for regulated firms

2. More general model with explicit as well as implicit incentives
   - Understand the interaction of implicit and explicit incentives
   - Demonstrate robustness of findings from the examples

3. Broader implications of the analysis
   - With implicit incentives, more information is not always beneficial
   - With implicit incentives, lessons from static models do not necessarily generalize to dynamic settings

Example 1: Managerial career concerns

1-manager model (Holmström, 1999):

- 2 periods
- Manager, M, is risk neutral and $U = w_1 - C(e_1) + w_2 - C(e_2)$
- Technology: output at any of many identical, risk neutral firms=

$$x_t = e_t + a + u_t,$$

where a = time-invariant characteristic of indiv. or activity and u_t = transient shock

- Information structure:
  - e_t privately chosen by M in period t
  - x_t publicly observed at end of period t
  - a, u_1, u_2 initially unknown to everyone; independently and normally distributed with mean 0
  - $\tau \equiv \frac{var(a)}{var(a)+var(u_t)} = \frac{cov(a,x_t)}{var(x_t)} = corr(x_1, x_2)$
- No explicit contracts: w_t fixed and paid at start of period t

Example 1: Managerial career concerns

- Conditions determining eqm. level of e_1 (eqm. level of e_2=0):
  1. Manager chooses e_1 to max. $E[\overline{w}_1 - C(e_1) + (w_2 - C(0))]$, given how he expects w_2 to depend on $x_1 = e_1 + a + u_1$.
  2. Each firm chooses w_2 optimally, given observed x_1, given wages it expects other firms to offer, and given its conjecture $\widehat{e}_1$ about e_1.
  3. Firms' conjecture $\widehat{e}_1$ is correct.
- Cond. 2. $\Longrightarrow$ competition to hire manager in pd 2 yields

$$w_2 = E(a \mid x_1) = \tau(x_1 - \widehat{e}_1).$$

- Then Cond. 1. $\Longrightarrow$ manager chooses e_1 to maximize

$$E[\overline{w}_1 - C(e_1) + \tau(e_1 + a + u_1 - \widehat{e}_1) - C(0)].$$

- Since M chooses e_1 *privately*, he does so taking firms' conjecture $\widehat{e}_1$ as *fixed*. So M's FOC for e_1 is $\tau = C'(e_1)$.
  - NB: M's optimal e_1 is independent of $\widehat{e}_1$.
- Hence, the equilibrium level of e_1, $\widetilde{e}_1$, satisfies $C'(\widetilde{e}_1) = \tau \leq 1$.
- Cond. 3. then $\Longrightarrow \widehat{e}_1 = \widetilde{e}_1$.

Special features of this analysis of career concerns (1)

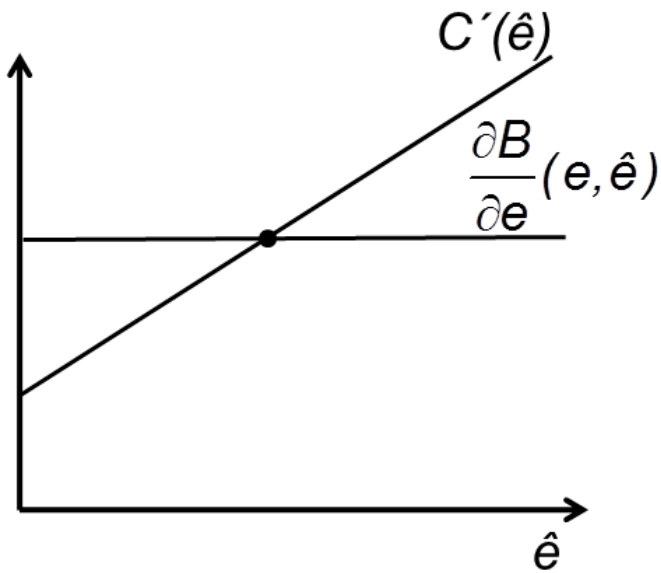
Two periods vs. Holmström's (1999) ∞-horizon analysis:

- 2-period model is **simplest** that allows analysis of effect on implicit incentives of CPI. CPI will affect only pd-1 effort.
- Holmström shows that, if ability remains **constant** over time, eqm effort decreases over time: As firms learn more about manager's ability, they place less weight on new observations in updating their beliefs, so marginal return to effort $\downarrow$ and $\rightarrow 0$ as $t \rightarrow \infty$.
- Holmström also shows that, if ability follows a **random walk**, eqm effort approaches a steady state level $\bar{e}$.
  - $\bar{e}$ is $\uparrow$ in manager's discount factor.
  - $\bar{e}$ is $\uparrow$ in variance of shocks to ability but $\downarrow$ in variance of transient shocks to output.

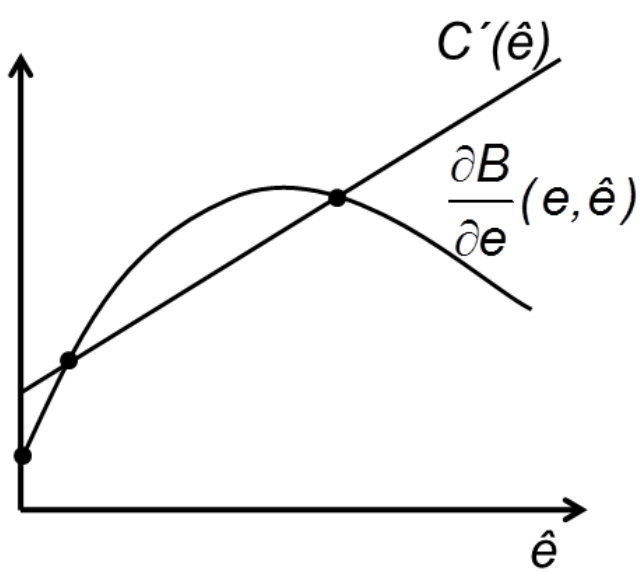
Special features of this analysis of career concerns (2)

Additive technology vs. Dewatripont, Jewitt, and Tirole's (1999) analysis of more general technology:

- With $x = e + a + u$, manager's marginal benefit of effort is independent of market's conjecture $\hat{e}$; hence, equilibrium is unique.
- With $x = ea + u$, DJT (1999) observe that marginal benefit of effort varies with $\hat{e}$, so multiple equlibria are possible. Moreover, explicit incentives, by raising $\hat{e}$, can directly affect implicit incentives. (In our analysis, explicit and implicit incentives have independent effects.)



$x = e + a + u$
(Holmström)



$x = ea + u$
(DJT)

Example 1: Managerial career concerns **and CPI**

2-manager model: comparative performance evaluation

$$x_{ti} = e_{ti} + a_i + u_{ti}$$
$$x_{tj} = e_{tj} + a_j + u_{tj}$$

- a_i, a_j identically distributed; $\{u_{tk}\}$ identically dist., indep. across time, indep. of a_i, a_j
- $\tau = corr(x_{1i}, x_{2i}) =$ correlation across time
- $\eta \equiv corr(a_i, a_j)$
- $\rho \equiv corr(u_{ti}, u_{tj})$
- $\kappa \equiv corr(x_{1i}, x_{1j}) = \eta\tau + \rho(1-\tau) =$ correlation across agents

Now, competition in period 2 $\Longrightarrow$

$$w_{2i} = E(a_i | x_{1i}, x_{1j}) = \frac{\tau}{1-\kappa^2}[(1-\eta\kappa)(x_{1i} - \hat{e}_{1i}) + (\eta - \kappa)(x_{1j} - \hat{e}_{1j})].$$

Hence, equilibrium level of e_{1i}, $\widetilde{e}_{1i}$, solves M_i's FOC:

$$C'(\widetilde{e}_{1i}) = \tau\left(\frac{1-\eta\kappa}{1-\kappa^2}\right) \equiv \psi \leq 1.$$

Example 1: Managerial career concerns and CPI

Proposition 1: *Effort incentives and efficiency are greater with performance comparisons than without if and only if*

$$\psi > \tau \Longleftrightarrow \kappa(\rho - \eta) > 0.$$

Special cases:

- $|\rho| > 0$, $\eta = 0$: First use x_{1j} to reduce variance of "noise" u_{1i}; then place more weight on x_{1i} in estimating a_i.
- $|\eta| > 0$, $\rho = 0$: First use x_{1j} to reduce "prior" variance of a_i; then place less weight on x_{1i} in estimating a_i.

Contrast with explicit incentives:

- Base i's pay on $x_i - E(x_i|x_j)$
- Use x_j to reduce variance with which i's effort is measured; hence increase weight on x_i in i's incentive scheme
- $|\rho| > 0$, $\eta = 0$ case is similar; $|\eta| > 0$, $\rho = 0$ case is different

Example 2: The ratchet effect and yardstick regulation

1-firm model:

- in each of 2 periods, risk neutral firm faces inelastic demand curve for 1 unit; firm maximizes sum of expected profits
- unit cost in pd $t = k - x_t + C(e_t)$, where $x_t = e_t + a + u_t$
- $a =$ firm's intrinsic efficiency, initially unknown
- $k - x_t$ publicly observable; k a known constant
- e_t, $C(e_t)$ privately observed by firm

Assume regulator's policy in period t is to set

$$p_t = E(k - x_t + C(e_t) | \text{information before period } t\ )$$

In period 2, regulator sets $p_2 = k - E(a|x_1) - \hat{e}_2 + C(\hat{e}_2)$

Hence, equilibrium e_1, $\widetilde{e}_1$, solves FOC: $C'(\widetilde{e}_1) = 1 - \tau \leq 1$

Example 2: The ratchet effect and yardstick regulation

2 separately owned firms: yardstick regulation

$$p_{ti} = E(k - x_{ti} + C(e_{ti}) | \text{information re } (i,j) \text{ before period } t)$$

Hence, equilibrium e_{1i}, $\widetilde{e}_{1i}$, solves FOC:

$$C'(\widetilde{e}_{1i}) = 1 - \tau\left(\frac{1-\eta\kappa}{1-\kappa^2}\right) = 1 - \psi \leq 1$$

Proposition 2: *The incentives of an individual firm for cost-reduction are stronger, and efficiency is greater, under yardstick regulation than in its absence if and only if*

$$\psi < \tau \Longleftrightarrow \kappa(\rho - \eta) < 0.$$

CPI's effect on efficiency in Ex. 2 is opposite to that in Ex. 1. Both examples show that whether CPI raises or lowers efficiency depends on sources of correlation in performances.

From the examples to a more general model

Shortcomings of these two examples:

- Ignore possibility of any explicit contracts, even short-term ones
- Ignore value of CPI for improving insurance or, more broadly, for improving ex post decisions

Build a more general model:

- Within each period, explicit contracts used; across periods, implicit mechanisms operate (both career concerns and ratchet effect).
- With risk-averse agents, explicit 1-period contracts introduce an insurance benefit of CPI.

Questions:

- **How do career concerns and ratchet effect affect welfare? Is one more important than the other?**
- **How does CPI (specifically, the sources of correlation) affect implicit incentives and overall welfare?**

Model of implicit and explicit incentives (1)

Formally, model builds on Holmström and Milgrom (1991) and Gibbons and Murphy (1992).

Casas-Arce et al (2018) empirically test a slightly simplified version of the Meyer-Vickers model

- Data from 354 units of a government employment agency
- Data on form/strength of correlations between own and peer group performance
- Performance targets ($\equiv$ short-term contracts) revised annually based on managers' own and peer group performance
- Ratchet effect measured by extent to which managers withheld end-of-year effort to avoid increases in targets
- Model's predictions about impact of CPI on target revisions and on strength of ratchet confirmed

Model of implicit and explicit incentives (2)

Agent A_i works for 2 periods for principal P, who also observes A_j

Technology and information: same as career concerns example

$$x_{ti} = e_{ti} + a_i + u_{ti}$$
$$x_{tj} = e_{tj} + a_j + u_{tj}$$

- $a_k \sim N(0, \tau\sigma^2)$, $u_{tk} \sim N(0, (1-\tau)\sigma^2)$, $\{u_{tk}\}$ indep. across time, indep. of a_i, a_j
- So $\sigma^2 = var(x_{tk})$ and $\tau = corr(x_{1k}, x_{2k})$
- $\eta \equiv corr(a_i, a_j)$, $\rho \equiv corr(u_{ti}, u_{tj})$, $\kappa \equiv corr(x_{ti}, x_{tj})$
- A_i's utility $= -exp[-r\left(w_{1i} - \frac{1}{2}e_{1i}^2 + w_{2i} - \frac{1}{2}e_{2i}^2\right)]$
- P's payoff $= x_{1i} - w_{1i} + x_{2i} - w_{2i}$
- Only 1-period contracts are enforceable
- Contracts are linear: $w_{ti} = \alpha_t + \beta_t x_{ti} + \epsilon_t x_{tj}$
  - α_2, β_2, and ϵ_2 can depend on x_{1i} and x_{1j}

Model of implicit and explicit incentives (3)

P chooses sequence of 1-period contracts to maximize

$$E[x_{1i} - w_{1i} + x_{2i} - w_{2i}], \qquad \text{subject to}$$

- A_i's participation constraints:
  - Period-1 reservation utility $\bar{u}$ is exogenous
  - For every unit $\uparrow$ in total pd-2 CE, A_i's pd-2 reservation utility (in CE terms) $\uparrow$ by $b \in [0, 1]$
    - Parameter b measures A_i's period-2 bargaining power and generates career concerns
- ICC's: in each pd, A_i chooses effort to maximize EU
- Time-consistency constraint: In pd 2, P chooses contract optimally, using information from pd 1

The model analyzing the ratchet effect in 1st-year lectures was a special case of this model. There, we assumed

- only one agent, so no CPI available
- $b = 0$, so A had no bargaining power

Model of implicit and explicit incentives (4)

Use period-1 participation constraint to substitute for $E[w_{1i} + w_{2i}]$
$\Longrightarrow$ maximand becomes $W - \bar{u}$, where

$$W = e_{1i} - \frac{1}{2}e_{1i}^2 + e_{2i} - \frac{1}{2}e_{2i}^2 - \frac{1}{2}r\text{var}[w_{1i} + w_{2i}],$$

so optimal sequence of contracts maximizes sum of P's and A's certainty equivalents (CEs).

- Maximizing W is equivalent to minimizing $L \equiv 1 - W$
  - $L =$ welfare loss relative to first-best

Two benchmarks:

1. **One-period model:** insurance effect of CPI
2. Sequentially optimal incentives **without CPI**

Benchmark 1: 1-pd model and insurance effect of CPI

1-pd contract with CPI: $w_i = \alpha + \beta x_i + \epsilon x_j$

- P chooses β and ϵ to minimize 1-period welfare loss

$$l = \frac{1}{2}\left\{(1-e_i)^2 + rvar(\beta x_i + \epsilon x_j)\right\} \qquad \text{s.t.} \quad e_i = \beta$$

- Given β, optimal ϵ minimizes $var(w_i) = var(\beta x_i + \epsilon x_j)$, so optimal $\epsilon = -\beta\kappa$, where $\kappa = corr(x_i, x_j)$

Hence optimal contract has form: $w_i = constant + \beta[x_i - E(x_i|x_j)]$,

$$\text{and} \quad var(w_i) = \beta^2 var(x_i|x_j) = \beta^2(1-\kappa^2)\sigma^2$$

- Optimal $\beta = \frac{1}{1+r\cdot var(x_i|x_j)}$
- Minimized $l = \lambda(1-\kappa^2)$, where $\lambda(v) \equiv \frac{\frac{1}{2}r\sigma^2 v}{1+r\sigma^2 v}$, $\lambda'(\cdot) > 0$

In the 1-period benchmark, CPI is always beneficial: CPI reduces welfare loss from $\lambda(1)$ to $\lambda(1-\kappa^2)$.

- **This is the "insurance effect" of CPI.**

Benchmark 2: Sequentially optimal incentives without CPI

Pd-2 contract: $w_{2i} = \alpha_2^0 + \beta_2^0 x_{2i}$: α_2^0 and β_2^0 can depend on x_{1i}

- Optimal $\beta_2^0 = \frac{1}{1+r \cdot var(x_{2i}|x_{1i})}$: time-consistency constraint
- A_i's pd-2 participation constraint has the form

$$ACE_2 = s + b(TCE_2), \quad \text{with } s = \text{ a constant}$$

- Using this constraint to solve for α_2^0, given optimal β_2^0, and substituting into $w_{2i} = \alpha_2^0 + \beta_2^0 x_{2i}$ yields

$$w_{2i} = constant + bE(a_i|x_{1i}) + \beta_2^0[x_{2i} - E(x_{2i}|x_{1i})]$$

- The coefficient on x_{1i} in $E(a_i|x_{1i})$ and $E(x_{2i}|x_{1i})$ is $\tau = corr(x_{1i}, x_{2i})$
- So A_i's **effective incentive** in pd-1 (the coefficient on x_{1i} in overall wage $w_{1i} + w_{2i}$) is

$$\tilde{\beta}_1^0 = \beta_1^0 + b\tau - \beta_2^0\tau = e_{1i}$$

- $b\tau$ = **career concerns** and $\beta_2^0\tau$ = **ratchet effect**.

Benchmark 2: Sequentially optimal incentives without CPI

Using the above expressions to evaluate $var(w_{1i} + w_{2i})$, P chooses $\tilde{\beta}_1$ to minimize welfare loss

$$\frac{1}{2}\left[(1-\tilde{\beta}_1^0)^2 + (1-\beta_2^0)^2 + r\left((\tilde{\beta}_1^0 + \beta_2^0\tau)^2 var(x_{1i}) + (\beta_2^0)^2 var(x_{2i}|x_{1i})\right)\right]$$

Prop. 3a: *Under sequentially optimal contracts, efforts e_{1i}, e_{2i} and welfare loss L are* **independent** *of A_i's period-2 bargaining power b.*

- Changes in b affect how the pd-2 pie is split, but have no efficiency effects because it's costless to adjust (explicit) β_1^0 to leave (effective) $\tilde{\beta}_1^0 = e_{1i}$ unchanged.
  - Contrast results in absence of explicit 1-pd contracts.

Prop. 3b: *Under sequentially optimal contracts and risk aversion, implicit incentives influence welfare* **only** *through the ratchet effect $\beta_2^0\tau$. Welfare is lower, the larger is the ratchet effect.*

- When $\beta_2^0\tau$ increases (*cet. par.*), the risk imposed on A_i in inducing any given $e_{1i} = \tilde{\beta}_1^0$ increases, so welfare falls.

Prop. 3c: *These conclusions continue to hold when CPI is used.*

Main model: Sequentially optimal incentives with CPI

Pd-2 contract: $w_{2i} = \alpha_2 + \beta_2 x_{2i} + \epsilon_2 x_{2j}$: $(\alpha_2, \beta_2, \epsilon_2)$ can depend on (x_{1i}, x_{1j})

- Given any β_2, P chooses ϵ_2 to minimize $var(w_{2i}|x_{1i}, x_{1j})$
- Optimal $\beta_2 = \frac{1}{1+r \cdot var(x_{2i}|x_{1i}, x_{1j}, x_{2j})}$
- A_i's period-2 participation constraint, $ACE_2 = s + b(TCE_2)$, determines α_2
- Ratchet effect is now measured by $\beta_2\gamma$, where γ is the coefficient on x_{1i} in $E(x_{2i}|x_{1i}, x_{1j}, x_{2j})$ (the target against which A_i's pd-2 output is judged)

Pd-1 contract: $w_{1i} = \alpha_1 + \beta_1 x_{1i} + \epsilon_1 x_{1j}$

- Given β_2, ϵ_2, and $\tilde{\beta}_1$ (coeff. on x_{1i} in $w_{1i} + w_{2i}$), P chooses $\tilde{\epsilon}_1$ (coeff. on x_{1j} in $w_{1i} + w_{2i}$) to minimize $var(w_{1i} + w_{2i})$
- Finally, P chooses $\tilde{\beta}_1$ to minimize overall welfare loss

We can now evaluate the minimized welfare loss under sequentially optimal contracts with CPI....

What is the impact on welfare of CPI?

- Recall $var(x_{1i}) = \sigma^2$ and $var(x_{2i}|x_{1i}) = (1-\tau^2)\sigma^2$
- Define $v_1\sigma^2 \equiv var(x_{1i}|x_{1j})$ and $v_2\sigma^2 \equiv var(x_{2i}|x_{1i}, x_{1j}, x_{2j})$
- Recall $\lambda(v) =$ 1-pd welfare loss when var of "noise" $= v\sigma^2$

With CPI, minimized welfare loss

$$= L(\eta, \rho) = \lambda(v_1)\{1 + \beta_2\gamma\}^2 + \lambda(v_2)$$

In absence of CPI, minimized welfare loss

$$= L(0,0) = \lambda(1)\{1 + \beta_2^0\tau\}^2 + \lambda(1-\tau^2)$$

Hence welfare impact of introducing CPI $= L(0,0) - L(\eta, \rho)$

$=$ benefit from improved insurance $(\downarrow \lambda(v_1), \downarrow \lambda(v_2))$

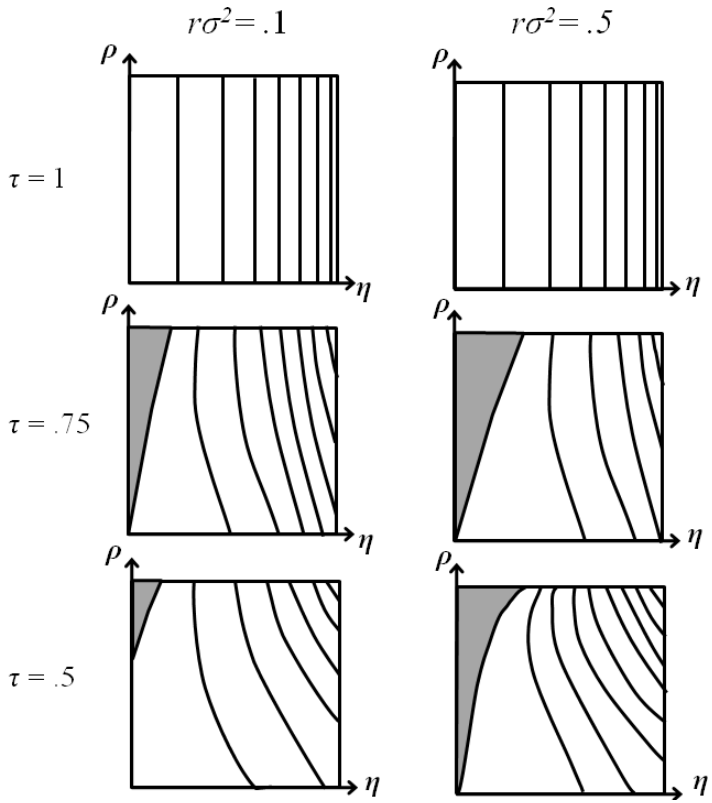
$+$ change from altered ratchet effect $(\uparrow$ or $\downarrow \beta_2\gamma)$

CPI may strengthen or weaken ratchet effect $\beta_2\gamma$

- CPI increases optimal β_2, since reduces period-2 "noise" (CPI makes time-consistency constraint tighter)
- But ratchet coeff. $\gamma > (<) \tau$ acc. as $\rho > (<0)\, \eta$ (as in Ex. 2)

Conclusion: Even with short-term explicit incentives, the findings from the examples are robust—CPI may raise or lower welfare, depending on sources of correlations in performances.

- CPI lowers welfare when i) ratchet effect is significant (τ large but < 1), ii) ratchet effect is worsened by CPI ($\rho >> \eta$), and iii) risk aversion is important ($r\sigma^2$ large).
- Iso-welfare contours in (η, ρ)-space are shown: In shaded regions, CPI reduces welfare.



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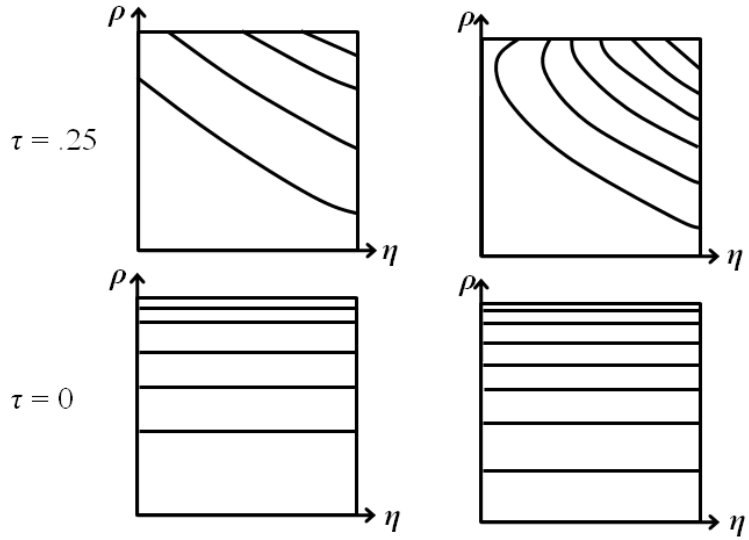

Broader implications of this analysis (1)

The availability of CPI is just one example of an improvement in P's information.

In static P-A models, or in dynamic models with full commitment to long-term explicit contracts, an improvement in P's information can never be harmful to P and will generally be beneficial.

Broader Implication No. 1: In dynamic P-A relationships with limited commitment to long-term contracts, better information for P may reduce his expected payoff and ex ante welfare, because when P uses the extra information ex post optimally, this may worsen A's ex ante (implicit) incentives.

- See Cremer (95), Dewatripont, Jewitt, and Tirole (99), Avery and Meyer (12), and Prat (05) for illustrations of this point.
- See Besley and Case (95) and Besley and Smart (07) on yardstick competition.

Broader implications of this analysis (2)

Broader Implication No. 2: Many prescriptions from incentive theory that are based on static analyses are *not robust* in dynamic settings with limited commitment.

- The effects of decisions about job/organization design on implicit incentives differ *in nature* from explicit incentive effects, can operate in the same or opposing directions, and may be the dominant ones.
- Even if a decision about job/orgn design confers static incentive benefits, it may worsen the ratchet effect by so much that welfare falls.
- See Meyer (95) on cooperation vs. competition; Meyer et al (96) on task assignment; Olsen (96) on vertical integration; and Friebel et al (02) on teamwork.