Optimal Contracts for Central Bankers

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In this Paper …

• It is shown that Central banker’s incentives induce socially optimal policy.

• The Contract between the government and central banker makes such an incentive.
In this Paper …

- Inflationary bias is eliminated in a discretionary regime.

- Optimal response to the shocks is achieved even in presence of imperfect information.
Previous Researches …

Rules rather than Discretion …

• Kydland & Prescott (1977)

- Economic agents are rational.
- Discretionary Regime does not result in socially optimal Plan.
- Rules, rather than Discretion proposed.
Previous Researches ...

Rules, Discretion and Reputation ...

• Barro & Gordon (1983)

  ➢ Cheating may be desirable for policy maker.
  ➢ Policy Rule may be unenforceable, for example in zero inflation targeting.
  ➢ Credible Policy Rules should be selected.
Central Bankers have their self incentives ...

- Rogoff (1985), Lohmann (1992) and Waller (1992)

- There are many potential bankers with different preferences
- We can pick the “preservative”, that is more interested in small inflations.
- The inflationary bias may be reduced, at the cost of output fluctuation.
Previous Researches …

**Government can affect banker’s incentives …**


- Banker should be punished when the disturbance is big or the target of rule is not achieved.
- It is like a ”contract” between government and central banker, which affects the conduct of monetary policy.
Previous Researches …

The Contracts in this Principal-Agent problem...

- Walsh (1993b)

- Legislated budget procedures, targeting rules or conditions under which the central banker will be fired, can be costly to change.

- A dismissal rule can be substituted for a state-contingent rule contract.
Previous Researches …

**Problem of studied contracts …**


  - Trade-off between inflationary bias and suboptimal stabilization.
  - Private Information of central bank makes it difficult to determine whether the central bank is cheating.

OPTIMAL CONTRACT HAS NOT STUDIED!
The key Questions

• Is there an **optimal** contract, the government should offer to the central banker?

• How the rewards to the central bank should be structured, in order to **induce** the socially optimal policy?
Assumptions

• Preferences are based on the Standard model of time inconsistent monetary policy.

• Government would like to eliminate inflationary bias in the discretionary policy making of central banker.

• Government would like to preserve the ability of central bank in order to response to the shocks, flexibly.
Assumptions

• The Government offers the central bank head, a wage contract in the one-period model.

• The Wage should be based on the publicly observable variable of economy.

Is this Contract effective?
Game Theory Approach

Nature

Select Shock

Government

Offer the Contract

Central Bank

Set money growth

Inflation, Output
The Key Results

• The inflationary bias caused by discretion policy making is eliminated.

• The trade-off between low inflation and stable economy disappears.

• Imperfect information is not important, optimal policy can be achieved.
Model

- The preference of both The Government and people
  \[ V = (y - y^*)^2 + \beta \pi^2. \]

- Philips curve
  \[ y = y^c + \alpha (\pi - \pi^e) + \varepsilon \]

- To provide an incentive for the policymaker
  \[ k \equiv y^* - y^c > 0. \]
Model

- The examined contracts attempt to influence the central bank's choice of operating procedures.
- It will be useful to distinguish between inflation and the central bank's policy instrument.

\[ \pi = m + \nu - \gamma \varepsilon \]

- \( \nu \): either a control error or a velocity shock taken to be W.N. process, whose realization occurs after \( m \) is set.
- \( \gamma \varepsilon \): allows aggregate supply shocks to have a direct negative impact on inflation.
Solving The Model

The optimal policy rule that minimizes expected social loss function conditional on $\theta$ is:

\[(5) \quad m(\theta) = \left( \gamma - \frac{\alpha}{\alpha^2 + \beta} \right) s\theta \equiv \delta s\theta.\]
Intuitions

- If the direct effect of aggregate supply shocks on inflation is zero ($\gamma = 0$):
  - Positive supply shock $\rightarrow$ Rise output $\rightarrow$ Reduce money supply

- If direct effect of aggregate supply shocks on inflation is not zero:
  - Positive supply shock $\rightarrow$ Rise output $\rightarrow$ Decrease or Increase money supply
  - Decrease or Increase money supply

- Decreasing functionality of money growth by $\beta$. 
Time inconsistency

- The Socially Optimal Policy rule of money growth is **time-inconsistent**.

- It is not credible if implemented **directly** either by the government or by a central bank.
Principal-Agent Problem

Agent: (Central Bank)

- Shares the government's preferences
- Is risk neutral
- Receives a monetary transfer payment from the government
- Has preferences, separable in social loss and income

(6) \[ U = t - V. \]
**Principal-Agent Problem**

**Principal: (Government)**

- Designs a transfer function.
- Induces the central bank to choose $m = m(\theta)$.

$$m(\theta) = \left( \gamma - \frac{\alpha}{\alpha^2 + \beta} \right)s\theta \equiv \delta s\theta.$$
The contract

• If the government can verify $\theta$ ex post: lots of contracts exist.
• The contract must depend only on the observable variables $m$, $\pi$ & $y$.
• The transfer is taken to be a function, solely of either $m$ or $\pi$. 
The contract

• Maximizing $E_\theta (t_m - \nu)$ in the discretionary policy making by central banker results in

\[
(7) \quad m^{CB}(\theta) = \frac{\alpha k}{\beta} + \left( \frac{1}{2\beta} \right) E_\theta(\partial t / \partial m)
\]

\[
+ \frac{\alpha^2}{2(\alpha^2 + \beta)\beta} \left[ E(\partial t / \partial m) - E_\theta(\partial t / \partial m) \right] + \delta s \theta
\]
In the Optimal Contract:

**Incentives should Conduct the Discretionary policy of central bank toward the Optimal Policy Rule.**

In fact, Incentives make the optimal rule, time-consistent, so credible.
Optimal Contract

- Setting \( m^C_B(\theta) = m(\theta) \) for all \( \theta \):

\[
\frac{1}{2} E_\theta(\partial t/\partial m) + \frac{\alpha^2}{2(\alpha^2 + \beta)\beta} [E(\partial t/\partial m) - E_\theta(\partial t/\partial m)] = -\alpha k \leq 0.
\]

- The Transfer function is solved:

\[
t(m) = t_0 - 2\alpha km
\]
In this Contract …

- The inflationary bias is eliminated.
- The central bank is leaved free to respond with discretion to $\theta$.
- Private information is not entered in the optimal transfer.
Some Practical Notes

• If the government's loss function in (1) took the form

$$(y - y^*)^2 + \beta (\pi - \pi^*)^2$$

$$t = t_0 - 2ak(m - m^*)$$

• we can use inflation instead of money in contract

$$E_\theta \frac{\partial \pi}{\partial m} = 1 \quad \rightarrow \quad t = t_0 - 2ak\pi$$
Comparison with Canzonery (1985)

• Canzonery:
  o Central bank claims about $\theta$, it is difficult to find out he is honest or not
  o Impossible to remove its bias from Central bank announcement

• Walsh:
  o Inflation bias could be eliminated.
  o It doesn’t dependent on $\theta$ or $v$, even if $v$ is observable
Comparison with Rogoff (1985)

Rogoff Contract: 

\[ t' = t_0 - (y - y^*)^2 - \beta \pi^2 \]

- Rogoff talk about optimum beta
- It can’t eliminate inflation bias, because of absence of linear term
- Parameterizing contract can eliminate this bias at the cost of no stabilization and variable marginal cost of inflation

Walsh Contract: 

\[ t = t_0 - 2\alpha k \pi - (y - y^*)^2 - \beta \pi^2 \]

- There is no problem because of introducing the new term
Contract based on performance measure

- Central Bank does not care about inflation or Output
- Central Bank has different preferences on output or inflation from government

Our plan:
Find contract function that leads to $m = \delta s \theta$, the Optimal Policy Rule.
Contract based on performance measure

- Transfer function includes reward to desirable inflation and output:

\[ T(\pi, y) = b_0 + b_1 \pi + b_2 \pi^2 + b_3 (y - y^*) + b_4 (y - y^*) + b_5 \pi (y - y^*) \]

- Solving \( \max \ E_\theta \tau(\pi, y) \):

\[ (b_1 + b_3 \alpha) + 2(b_2 + \alpha^2 b_4 + \alpha b_5)(m - \gamma s\theta) + (2\alpha b_4 + b_5)[s\theta - k + \alpha E(m)] = 0 \]
Contract based on performance measure

- Using rational expectation:

\[ m^* = \left\{ - (b_1 + ab_3) + (2ab_4 + b_5)k/2 b_2 + ab_5 \right\} - \left\{ -(2ab_4 + b_5) s\theta / 2(b_2 + a^2b_4 + ab_5) \right\} + \gamma s\theta \]

- \( m^* \) should be \( \delta s\theta \)

\[ \alpha b_4 + 0.5b_5 / (b_2 + a^2b_4 + ab_5) = \alpha / (a^2 + \beta) \]

\[ - (b_1 + ab_3) + (2ab_4 + b_5)k = 0 \]
Parameters are more than we need

By these parameters:

- $b_4 = -1$
- $b_3 = b_5 = 0$
- $b_1 = 2ab_4k = -2\alpha k$
- $b_2 = \beta b_4 = -\beta$

Contract based on performance measure
Contract based on performance measure

The optimal transfer function shape is

\[ t(\pi, y) = b_0 - 2\alpha k\pi - \beta\pi^2 - (y - y^*)^2 = t(\pi) - v \]

It is the same Optimal Contract obtained in previous approach!
Contract based on performance measure

- Note: not unique optimum assumption: but it needs output restriction

Inflation is not enough to make optimal incentive

$$\alpha b_4 + 0.5 b_5 / (b_2 + \alpha^2 b_4 + \alpha b_5) = \alpha / (\alpha^2 + \beta) = 0$$

- Examples: new Zealand - Europe
- Notice to the output preference of central bank
Contract based on performance measure

\[ \tau(\pi, y) = b_0 + b_1 \pi + b_2 \pi^2 \]

Maximization

\[ m^* = \gamma s \theta - b_1 / 2b_2 \]

So there is bias in inflation, unless \( b_1 = 0 \).

Optimal Rule is not achieved, unless

\[ b_1 = 0 \]

\[ \theta = \varepsilon = 0 \]

\[ \alpha = 0 \]

\[ \beta = \infty \]
Question?
Thanks to

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