Monetary Economics: Macro Aspects, 2/4 2013

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Monetary credibility problems

1. Inflation and discretionary monetary policy
2. Reputational solution to credibility problems

Literature: Walsh (Chapter 7, pp. 269-290)

Note a small accompanying note on web, as well as an addendum at the end of slides on further solutions to credibility problems
Introductory remarks

• So far, we have treated monetary policy as some exogenous process

  Is this an innocent assumption?

  No, as one has not specified how the policymaker can be guaranteed to adhere to such rules

  – I.e., what are the policymaker’s incentives?
  – What if the policymaker responds to incentives?

• What if the policymaker under some circumstances has the incentive to conduct policy that differs from the rule?

  This may feed back into private sector behavior, as this is based on expectations and thus expected policy

  It therefore becomes of importance whether the policy rule is credible

• If it is not credible, private sector expectations will adjust towards what is believed the policymaker will do instead of the rule
• It therefore becomes important to understand the policymaker’s incentives, as this will determine whether it will adhere to the rule, or act discretionary.

• This, in turn, provides an understanding about the determination of private sector expectations and thus the macroeconomic equilibrium.

• General insight in frameworks where private sector expectations are important:
  
  – Policies that are optimal *ex ante*, are often not optimal *ex post*.
  
  – They are time inconsistent (Kydland and Prescott, 1977).

  => “good” rules may not be credible.
This implies that the policymaker often have an incentive to deviate from the optimal rule when private sector expectations are formed.

This is then taken into account in expectations formation, and the economy may end up in an equilibrium which is time consistent (a “discretionary” equilibrium), but suboptimal:

- Given the expectations that incorporate the policymaker’s incentive to deviate from the optimal rule. . .
- . . . monetary policy end up delivering a poor result
- This is the positive/descriptive aspect of time inconsistency models

If this is important for various policy scenarios, it raises the issue:

- How can the policymaker be endowed with commitment abilities, which overcome the time-inconsistency problem of the optimal plan?
- How can society though legislation, or institutional design, change the policymaker’s incentives such that the poor macroeconomic equilibrium is avoided?
- This is the normative aspect of the time inconsistency models
Inflation and discretionary monetary policy

• The “Barro Gordon model” exemplifies how optimal monetary policy can be time inconsistent, and demonstrates the negative consequences on the economy

The Barro-Gordon “inflation bias model”

• Economic structure is a very simple AS/AD setting
  • AS curve:
    \[ y_t = y_n + a (\pi_t - \pi_t^e) + e_t, \quad a > 0 \]  
    (7.3)
    Simple price/inflation surprise equation (in logs)
  • “AD curve:”
    \[ \pi_t = \Delta m_t + v_t \]  
    (7.4)
    Further simplification:
    \[ \pi_t = \Delta m_t \]  
    (7.4′)
    Inflation rate is taken as the monetary policy instrument
• Two variants of the model differing in terms of central bank’s preferences:

• **Variant 1. Utility linear in output:**

\[
U^1_t = \lambda (y_t - y_n) - \frac{1}{2}\pi_t^2, \quad \lambda > 0
\]  

(7.1)

The central bank wishes output to exceed the natural rate as much as possible, but dislikes deviations in inflation from zero (normalization of inflation goal)

• **Variant 2. Utility quadratic in output**

\[
U^2_t = -\frac{\lambda}{2} (y_t - y_n - k)^2 - \frac{1}{2}\pi_t^2, \quad k > 0,
\]  

(7.2)

The central bank:

– dislikes deviations in output from \( y_n + k > y_n \)

– dislikes deviations in inflation from zero.

– Note that preferred output level is *higher* than the natural rate as \( k > 0 \)
• Under both variants, the timing of events within the period is:

1. $\pi_t^e$ is formed
2. $e_t$ is realized
3. $\pi_t$ is set
4. $y_t$ is determined

• Central features of this move structure:

  – Private sector is “committed” to a fixed inflation expectation as nominal wage contracts are written in the beginning of the period
  – The private sector does not know $e_t$ at the time they sign contracts; hence, $\pi_t^e$ is not conditioned on $e_t$
  – The central bank performs policy after having observed the shock, and after inflation expectations are formed

    * This makes unanticipated inflation leading to output effects possible—even in absence of shocks

• However, it is assumed that the private sector knows the incentives of the central bank, which is crucial for the determination of $\pi_t^e$

• It is assumed that

$$\pi_t^e = E_{t-1}\pi_t$$
Solution of model under Variant 1

- Solution concept is time-consistent Nash equilibrium
  - Nash equilibrium: Agents’ choices are best responses to other agents’ choices
  - Time consistency: Agents’ choices as prescribed by the solution will not be changed later
- To attain time consistency, one solves model by backward induction
- First, determine the optimal monetary policy, for given expectations and supply shock:
  \[
  \max_{\pi_t} U_t^1 = \lambda(y_t - y_n) - \frac{1}{2}\pi_t^2
  = \lambda(y_n + a(\pi_t - \pi_t^e) + e_t - y_n) - \frac{1}{2}\pi_t^2
  = \lambda[a(\pi_t - \pi_t^e) + e_t] - \frac{1}{2}\pi_t^2
  \]
- First-order condition:
  \[
  \lambda a = \pi_t \tag{7.5'}
  \]
  Marginal gain of inflation equals the marginal loss
- This readily gives the solution for monetary policy. Inflation expectations are found to be the same, as the private sector can foresee the policy as given by (7.5’). I.e.,
  \[
  \pi_t^e = E_{t-1}\pi_t = \lambda a
  \]
  Solution for output:
  \[
  y_t = y_n + e_t
  \]
• Equilibrium features a positive rate of inflation—an inflation bias—which has no effect on output, since it is perfectly anticipated by the public

Why? Because the private sector understands the central bank’s incentive to raise output by creating an “inflation surprise.” The private sector incorporates this into expectations, and inflation becomes inefficiently high

The time-inconsistency of the optimal solution

• The central bank would be better off setting $\pi_t = 0$. If this is credible, $\pi_t^e = 0$, and output will become $y_t = y_n + e_t$.

• Problem: This is time-inconsistent. If $\pi_t^e = 0$, it is optimal to set $\pi_t = \lambda a$ driving output above the natural rate, $y_t = \lambda a^2 + y_n + e_t$

The private sector foresees this incentive, and will not set $\pi_t^e = 0$ in the first place.....only $\pi_t^e = \pi_t = \lambda a$ is a time-consistent solution

• A simple, but strong, example of how a well-meaning policymaker without credibility, i.e., without an ability to commit, brings the economy into a “bad” equilibrium

The discretionary nature of monetary policy brings about excessive inflation
Solution of model under Variant 2

- Main message applies, but policy will now respond to the supply shock
- When policy is implemented, inflation expectations and the supply shock are taken as given, and the central bank solves

$$\max_{\pi_t} U_t^2 = -\frac{\lambda}{2} (y_t - y_n - k)^2 - \frac{1}{2} \pi_t^2$$

$$= -\frac{\lambda}{2} [a(\pi_t - \pi_t^e) + e_t - k]^2 - \frac{1}{2} \pi_t^2$$

The first-order condition is

$$-\lambda a [a(\pi_t - \pi_t^e) + e_t - k] = \pi_t$$

Marginal benefit of inflation in terms of output equals the marginal loss in terms of inflation per se

- “Reaction function” becomes

$$\pi_t = \frac{\lambda a}{1 + \lambda a^2} (a\pi_t^e - e_t + k) \quad (7.6')$$

- Higher inflation expectations drive up inflation, as the marginal gain in terms of higher output increases
- A positive supply shock is met by a contractive monetary policy, as stabilization of output now is a concern
- The more the output goal exceeds the natural rate (the higher $k$) the higher inflation
The private sector can foresee this reaction function, but doesn’t know the value of the supply shock. Assuming a mean-zero shock, inflation expectations are found from

$$\pi_t^e = \frac{\lambda a}{1 + \lambda a^2} (a \pi_t^e + k)$$

implying

$$\pi_t^e = \lambda a k > 0$$

Actual discretionary inflation becomes:

$$\pi_t = \lambda a k - \frac{\lambda a}{1 + \lambda a^2} e_t \tag{7.7'}$$

Actual discretionary output becomes:

$$y_t = y_n + \frac{1}{1 + \lambda a^2} e_t$$

Again, an inflation bias prevails with no effect on output.

If commitment to a policy rule $\pi_t = b_0 - b_1 e_t$ was possible, the optimal values of coefficients are (see note on web)

$$b_0 = 0, \quad b_1 = \frac{\lambda a}{1 + \lambda a^2}$$

Stabilization property of discretionary policy is optimal, but the average is inefficient due to the inflation bias.
• Earlier debates (pre 1980s) about rules versus discretion in monetary policy would end up favoring discretion, if there was a need and scope for stabilization against economic shocks.

• With time-inconsistency problems this may not be the case.
  
  – A rigid rule that does not respond to shocks, $\pi_t = 0$, may be desirable in the Barro and Gordon model under Variant 2.
  
  – . . . if the variability of $e_t$ is not too large.
  
  – See condition on p. 282 in Walsh.
Reputational solutions to credibility problems

- Is it impossible to avoid the excessive inflation result?
  - No. For the remainder we consider a “market-based” solution (as opposed to more institutional based solutions mentioned at the end): Namely one of reputation building

Interactions between the private sector and policymakers are rarely of a one-shot nature. They occur repeatedly, and this opens the possibility for reputation building

- This can be modelled in a simple manner. Assume that the interaction between the private sector and the central bank, the game, is repeated infinitely

  Then, “doing bad” today, may cause loss of reputation tomorrow that in effect prevents the central bank from “doing bad” today

  For this to be the case, the private sector must “punish” bad behavior of the central bank; i.e., punish a deviation from a promised inflation rate

- Assume there are no supply shocks, and Variation 1 utility applies
• The central bank promises $\bar{\pi} < \lambda a$. The potential punishment behavior by the private sector is modelled by a simple “trigger strategy”:

$$
\pi_t^e = \bar{\pi} < \lambda a \text{ if } \pi_{t-1} = \pi_t^{e-1} \\
\pi_t^e = \lambda a \text{ otherwise}
$$

I.e., if the central bank did not “surprise” in the previous period the public keeps expecting the promise, $\pi$. If not, it reverts to the “bad” equilibrium inflation expectations for one period

— “Tit for tat” strategy in game-theoretic language

• Note that this is one of infinitely many punishment strategies (how can private sector agents coordinate on a particular one?—issue is ignored here, where purpose is to show that it is possible to obtain a reputation for low inflation)

• The central bank now makes decisions knowing that breaking a promise has implications for future private sector behavior

• The central bank’s objective is to maximize the discounted sum of per-period utilities:

$$
\max \sum_{t=0}^{\infty} \beta^t U_t^1, \quad 0 < \beta < 1
$$

• Which inflation rates, if any, can the central bank get a reputation for delivering?
• What is the optimal deviation from $\pi$ in a period? From before: $\pi_t = \lambda a$. Associated current net gain—temptation—for the central bank:

$$\lambda a (\lambda a - \pi) - \frac{1}{2} (\lambda a)^2 + \frac{1}{2} (\pi)^2 = \frac{1}{2} (\lambda a - \pi)^2$$

Utility from surprise - Utility from promise

$$\equiv G(\pi)$$

• What is optimal policy under the punishment $\pi^e_t = \lambda a$? From before: $\pi_t = \lambda a$. Associated future net loss—enforcement—for the central bank following a deviation:

$$\frac{\beta}{2} (\pi)^2 + \frac{\beta}{2} (\lambda a)^2 = \frac{\beta}{2} [(\lambda a)^2 - (\pi)^2]$$

Utility from promise - Utility from punishment

$$\equiv C(\pi)$$

(7.13)

• An inflation rate policy promise, $\bar{\pi}$, is credible if $C(\bar{\pi}) \geq G(\bar{\pi})$; i.e., if the temptation is not stronger than the enforcement. This implies

$$\frac{\beta}{2} [(\lambda a)^2 - (\bar{\pi})^2] \geq \frac{1}{2} (\lambda a - \bar{\pi})^2$$

• This means that any policy $\bar{\pi}$ is credible in the repeated game if

$$\lambda a \geq \bar{\pi} \geq \frac{1 - \beta}{1 + \beta} \lambda a$$

• Note that the minimum sustainable inflation rate is decreasing in $\beta$ (and for $\beta \to 1$, it goes to zero).
Summary and addendum

- Time-inconsistency problems of optimal monetary policy create suboptimal outcomes when the central bank cannot credibly commit.

  The Barro and Gordon model provides a simple example of the basic nature of such credibility problems.

- Credibility problems in monetary policymaking (and other branches of policymaking) have costs which can be identified by economic models.

- More importantly, models of credibility problems provide a natural platform for start thinking about how society can overcome credibility problems and their associated costs.
  
  - Either through some form of reputation building . . .
  
  - . . . or through establishment of economic institutions which shape the policymakers’ incentives in a direction that mitigates the incentives to deviate from the optimal plan; often referred to as “delegation theories”.
  
  * Of these, the “Rogoff central banker”, “Walsh contracts” and Inflation targeting have received lots of attention. See Walsh (Chapter 7, pp. 297–323) and ensuing addendum.
Addendum: Delegation and independent central banks

- The incentive to “surprise” inflation is often interpreted as arising from political pressures. “Solution” to time-inconsistency problem could be achieved by
  
  - Delegating monetary policy conduct to independent central banks
  - Create monetary institutions securing independence and appropriate policy incentives
  - I.e., appropriate design of policy regime in broadest sense

- Analyses are cast in versions of Barro Gordon model with Variant 2 utility

- Under delegation, the “institutional design stage” is added to move structure:
  
  1. Establishment of monetary delegation regime
  2. $\pi^e$ is formed
  3. $e$ is realized
  4. $\pi$ is set
  5. $y$ is determined
Delegation to a “conservative” central banker

- The idea is to appoint a central banker, who puts relative more weight on inflation stabilization than society.

I.e., monetary policy is delegated to central banker with utility

\[ U_c = -\frac{\lambda}{2} (y - y_n - k)^2 - \frac{1 + \delta}{2} \pi^2, \quad \delta > 0 \]

This is Rogoff’s “conservative” central banker; \( \delta \) measures the “degree of conservativeness” (Rogoff, 1985, QJE).

- Monetary policymaking by the central banker (taking as given \( \pi^e \) and \( e \)) is characterized by the first-order condition

\[-\lambda a [a (\pi - \pi^e) + e - k] = (1 + \delta) \pi \quad (\ast)\]

Note that \( \delta > 0 \) increases the marginal cost of inflation.

- Rational inflation expectations follow by taking expectations on both sides of (\( \ast \)):

\[ \lambda ak = (1 + \delta) \text{E}[\pi] \]

\[ \implies \text{E}[\pi] = \frac{\lambda ak}{1 + \delta} < \lambda ak \]
• With a conservative central banker, the inflation bias is reduced from \( \lambda \kappa \) to \( \lambda \kappa / (1 + \delta) \)

• Conservativeness, however, has a cost. The solution for actual inflation becomes [plug the solution for \( \pi^e = E[\pi] \) back into (*)]

\[
\pi = \frac{\lambda \kappa}{1 + \delta} - \frac{\lambda a}{1 + \delta + \lambda a^2} e
\]

• Stabilization of the shock is distorted

  – Compared to the socially optimal response to a supply shock, a conservative central bank responds less to the shock
  
  – Result is too stable inflation and too unstable output

• Appointing a conservative central bank thus involves a trade-off between

  a) Lower average inflation

  b) Poorer macroeconomic stabilization

• So, will it ever be optimal to have \( \delta > 0 \)? Yes, always

  – At \( \delta = 0 \), a marginal increase in \( \delta \) involves a first-order social gain of lower average inflation (at \( \delta = 0 \) average inflation is suboptimal)

  – At \( \delta = 0 \), a marginal increase in \( \delta \) involves a second-order social loss of poorer stabilization (at \( \delta = 0 \) stabilization is optimal)
Incentive contracts

• Under this approach, the government appoints a central bank, and offers him/her a “performance contract”

This contract rewards or punishes the central bank depending on its performance

The contract could be “pecuniary” but more generally, it could represent public embarrassment if the central bank doesn’t fulfill its “contract”

Real world analogy: The Federal Reserve Act of 1989 in New Zealand: The governor can be fired, if he performs poorly; other central bankers are in other ways held accountable for their actions.

• Formally, the central bank is offered a contract, such that it maximizes

$$ U + t $$

where $t$ is the contract transfer
Assume that the contract transfer cannot be made contingent on the supply shock, and only a transfer depending on observed inflation is considered: \( t = t(\pi) \)

- Task of government is to choose the optimal \( t(\pi) \) (at institutional design stage)

- Central bank takes expectations and the supply shock as given, and maximizes

\[
-\frac{\lambda}{2} (a (\pi - \pi^c) + e - k)^2 - \frac{1}{2} \pi^2 + t(\pi)
\]

The first-order condition is

\[
-\lambda a [a (\pi - \pi^c) + e - k] = \pi - t'(\pi) \tag{**}
\]

- If \( t'(\pi) < 0 \) we see that the marginal cost of inflation is higher than without the transfer; i.e., the contract punishes inflation increases

Rational inflation expectations follow by taking expectations on both sides of (**):

\[
\lambda ak = E[\pi] - E[t'(\pi)]
\]

\[
\implies E[\pi] = \lambda ak + E[t'(\pi)]
\]
• Insert these expectations back into (**) to get actual inflation

\[-\lambda a (a (\pi - \lambda ak - E[t'(\pi)]) + e - k) = \pi - t'(\pi)\]

\[\pi = \lambda ak + \frac{\lambda a^2}{1 + \lambda a^2}E[t'(\pi)] + \frac{t'(\pi)}{1 + \lambda a^2} - \frac{\lambda a}{1 + \lambda a^2}e\]

• Optimal policy is implemented if the transfer function satisfies

\[\lambda ak + \frac{\lambda a^2}{1 + \lambda a^2}E[t'(\pi)] + \frac{t'(\pi)}{1 + \lambda a^2} = 0\]

• This is accomplished if

\[t'(\pi) = -\lambda ak\]

A transfer function with this property:

\[t(\pi) = t_0 - \lambda ak \pi\]

A linear inflation contract

• Linear because the incentive to “surprise” the private sector is a constant in equilibrium; hence, a constant marginal punishment eliminates the inflation bias (also for non-quadratic utility)

• In contrast to a conservative central banker, the linear inflation contract portrays the optimal incentive structure
Plan for next lectures

Tuesday, April 9, Exercises:
   Exercise posted on web.

Thursday, April 11, Lectures:
   1. Operating procedures and choice of monetary policy instrument
   2. Intermediate targets in policymaking
      Literature: Walsh (Chapter 11, pp. 512–530)