Monetary Economics: Macro Aspects, 17/3 2004
Henrik Jensen

Plan for today:

Wrapping up the exercises (in particular (iv) from Recap 2).

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

Literature: Walsh (Chapter 8, pp. 363-384); Jensen (2003) (available on webpage))

3. Plan for next lectures

Introductory remarks

- So far we have treated monetary policy by 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

- What if the policymaker under some circumstances has the incentive to conduct policy that differs from the rule?
- This will feed back into private sector behavior, as that behavior is based upon expectations about policy
- It thus becomes of importance whether the policy rule is **credible**
- If it is **not** credible, private sector expectations will adjust towards what is **believed** that the policymaker will do instead of following 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 post*, are often not optimal *ex ante*
  - They are **time inconsistent**

- This implies that the policymaker **does** 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, but suboptimal:
  - Given the expectations that incorporate the policymaker's incentive to deviate from the optimal rule. . .
  - . . . monetary policy may be "tempted" and 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?
  - I.e., 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 importance of the potential problems arising from discretionary monetary policymaking isclearly seen in a simple model of inflation
- The model, the "Barro Gordon model" **exemplifies** how optimal monetary policy may be time inconsistent, and which negative consequences this hason the economy

The Barro Gordon "inflation bias model"

- Economic structure is a very simple variant of the AS/AD model with one-period nominal wage contracts
- AS curve:

$$y_t = y_n + a\left(\pi_t - \pi_t^e\right) + e_t, \quad a > 0 \tag{8.3}$$

Simple price/inflation surprise equation (in logs)

- "AD curve:"

$$\pi_t = \Delta m_t + v_t \tag{8.4}$$

Further simplification:

$$\pi_t = \Delta m_t \tag{8.4'}$$

This enables one to treat the inflation rate directly as the monetary policy instrument (not critical simplification as v_t is a demand shock, which will not pose a policy problem in the model)

- Two variants of the model differing in terms of central bank's preferences:
- **Variant 1. Utility linear in output:**

$$U_t^1 = \lambda\left(y_t - y_n\right) - \frac{1}{2}\pi_t^2, \quad \lambda > 0 \tag{8.1'}$$

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

- **Variant 2. Utility (= "minus loss") quadratic in output**

$$U_t^2 = -\frac{\lambda}{2}\left(y_t - y_n - k\right)^2 - \frac{1}{2}\pi_t^2, \quad k > 0, \tag{8.2'}$$

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 $k > 0$

- Close relationship between the two functions as

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

Same form as U_t^1 except the term $-\left(\lambda/2\right)\left(y_t - y_n\right)^2$ reflecting a preference for output stability

- Under both variants, the timing of events within the period is:

  1. π_t^e is formed
  2. e_t is realized
  3. π_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, π_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 opens room for stabilization of the economy against the shock, and even in absence of shocks, it opens the room for setting inflation **differently from expected**
    * I.e., there is possibility for creation of **unanticipated inflation** leading to output effects

- However, it is assumed that the private sector **knows** the incentives of the central bank

- This is **crucial** for the determination of π_t^e
  - It is assumed that $\pi_t^e = \mathrm{E}_{t-1}\pi_t$

Solution of model under Variant 1

- Solution concept is a time-consistent Nash equilibrium
  - Nash equilibrium: Agents' choices are best responses to other agents' choices
  - Time consistency: Agent's choices as prescribed by the solution will not be changed at a later stage

- To attain time consistency, one solves model by backward induction

- First, determine the optimal monetary policy, for given expectations and supply shock:

$$\begin{aligned}\max_{\pi_t} U_t^1 &= \lambda\,(y_t - y_n) - \frac{1}{2}\pi_t^2 \\ &= \lambda\,(y_n + a\,(\pi_t - \pi_t^e) + e_t - y_n) - \frac{1}{2}\pi_t^2 \\ &= \lambda\,[a\,(\pi_t - \pi_t^e) + e_t] - \frac{1}{2}\pi_t^2\end{aligned}$$

- First-order condition:

$$\lambda a = \pi_t \qquad (8.5')$$

  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. I.e.,

$$\pi_t^e = \mathrm{E}_{t-1}\pi_t = \lambda a$$

- Solution for output becomes

$$y_t = y_n + e_t$$

- 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 (not "delivering" the high inflation rate would be too expensive in output loss)

The time-inconsistency of the commitment solution

- Obviously, the central bank would be better off seting $\pi_t = 0$. If this is **credible**, $\pi_t^e = 0$, and output will become $y_t = y_n + e_t$. Same as under discretion, but now inflation is optimal
- The problem is that **this is a time-inconsistent solution**. If $\pi_t^e = 0$, it will be optimal, when the actual policy choice is implemented, to set $\pi_t = \lambda a$ driving output above the natural rate, $y_t = \lambda a^2 + y_n + e_t$
- The private sector can foresee this incentive to renege on the announcement, 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 strong example of how a well-meaning policymaker without credibility, i.e., without an ability to commit, can bring the economy into a "bad" equilibrium
- The **discretionary** nature of monetary policy brings about excessive inflation

Solution of model under Variant 2

- Main message also applies when utility is quadratic in output, but we will see that policy now responds to the supply shock
- When policy is implemented, inflation expectations and the supply shock are taken as given, and the central bank solves

$$\max_{\pi_t} U_t^2 = -\frac{\lambda}{2}(y_t - y_n - k)^2 - \frac{1}{2}\pi_t^2$$
$$= -\frac{\lambda}{2}\left(a(\pi_t - \pi_t^e) + e_t - k\right)^2 - \frac{1}{2}\pi_t^2$$

- The first-order condition is

$$-\lambda a\left(a(\pi_t - \pi_t^e) + e_t - k\right) = \pi_t$$

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

- "Reaction function" becomes

$$\pi_t = \frac{\lambda a}{1 + \lambda a^2}\left(a\pi_t^e - e_t + k\right) \tag{8.6}$$

  - 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

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

implying

$$\pi_t^e = \lambda ak > 0$$

- **Actual** discretionary inflation becomes:

$$\pi = \lambda ak - \frac{\lambda a}{1+\lambda a^2}e_t$$

- **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. The supply shock poses a stabilization trade-off: Note high value of λ implies low effect of the shock on output, but high effect on inflation (and vice versa for a low value of λ)
- **If** commitment to a policy rule $\pi_t = b_0 - b_1 e_t$ was possible, it follows that optimal values of coefficients are

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

- **Stabilization properties** of discretionary policy are optimal, but **average properties are inefficient** due to the inflation bias

- Hence, the private sector sets $\pi_t^e = \lambda ak$, such that the output gains of $\pi_t > \pi_t^e$ cannot outweigh the costs for the central bank
- I.e., the central bank acting under discretion cannot credibly implement the optimal policy!

- Note that earlier debates 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. 377 in Walsh

An alternative exposition

- Many practitioners have criticized the Barro Gordon model for giving a distorted picture of monetary policymaking
- Monetary policymakers are not attempting to "surprise" the public!
- Note that the model's equilibrium **does not predict that either**!
- In equilibrium, inflation expectations are set so high, that the central bank's optimal strategy indeed is no to "surprise" the public
- In any case, one can explain the excessive inflation result — wothout "surprises" — by reformulating the model
- Consider an "inverted" AS curve, in this model's notation:

$$\pi_t = \pi_t^e + (1/a)\,(y_t - y_n) - (1/a)\,e_t$$

A conventional expectations augmented Phillips curve

- Then assume that monetary policy affects aggregate demand through the nominal interest rate, but for simplicity, take y_t to be the policy instrument
- The central bank then solves

$$\begin{aligned} \max_{y_t} U_t^1 &= \lambda\,(y_t - y_n) - \frac{1}{2}\pi_t^2 \\ &= \lambda\,(y_t - y_n) - \frac{1}{2}\left(\pi_t^e + (1/a)\,(y_t - y_n) - (1/a)\,e_t\right)^2 \end{aligned}$$

- The first-order condition is

$$\lambda = (1/a)\left(\pi_t^e + (1/a)\,(y_t - y_n) - (1/a)\,e_t\right)$$

Marginal gain in terms of output is equal to the marginal loss in terms of inflation

- When forming expectations, the private sector knows that this first-order condition holds, and taking expectations on both sides:

$$\lambda = (1/a)\,\pi_t^e$$

or,

$$\pi_t^e = \lambda a$$

which is the same as in the standard Barro-Gordon model

- Setting this back into the first order condition gives the solution for output:

$$y_t = y_n + e_t$$

which again is the same as before

- Finally, actual inflation follows from the Phillips curve as $\pi_t = \pi_t^e = \lambda a$ (same as before....)

- Hence, the equilibrium outcomes are unaffected by the alternative exposition
- There is excessive high inflation, but the "surprise" explanation can be avoided
  - The private sector knows that the central bank has a preference for stimulating demand and output
  - They know that this has inflationary effects via the Phillips curve
  - Therefore they push up inflation expectations, thereby further increasing inflation
  - In equilibrium, inflation expectations are so high that the central bank will not try to bring output above the natural rate, as the inflationary consequences will be too large

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 next time): 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: If the central bank shows it delivers low inflation, the private sector may gradually start to believe that it will not attempt to create "surprise inflation"
- Can be modelled in a very 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 the we are examining Variation 1 utility (linear in output)

- The central bank promises $\overline{\pi}$. The potential punishment behavior by the private sector is modelled by a simple "trigger strategy":

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

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

  - "Tit for tat" staregy in game-theoretic language

- Note that this is just one of infinitely many punishment strategies, and one can discuss how the private sector agents can coordinate on a particular one. This issue is ignored here, where the main purpose is to show that it is **possible** to obtain a reputation for low inflation
- The central bank now takes decisions knowing that breaking a promise will have 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?

- Assume $\pi_t^e = \overline{\pi}$. What is the optimal deviation policy in a period? From before, $\pi_t = \lambda a$. Associated **net** gain — **temptation** — for the central bank:

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

- What is optimal policy under the punishment $\pi_t^e = \lambda a$? From before: $\pi_t = \lambda a$. Associated **net** loss — **enforcement** — against the central bank

$$-\frac{\beta}{2} (\overline{\pi})^2 + \frac{\beta}{2} (\lambda a)^2 = \frac{\beta}{2} \left[(\lambda a)^2 - (\overline{\pi})^2 \right] = C(\overline{\pi}) \qquad (8.13)$$

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

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

- This means that any policy $\overline{\pi}$

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

is credible in the repeated game.

- Note that the minimum sustainable inflation rate is decreasing in β (and for $\beta \to 1$, it goes to zero). This is because the enforcement of a deviation increases

Summary

- Time-inconsistency problems of optimal monetary policy creates suboptimal outcomes when the cenrtal 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
  - (Much) more on this next time

Plan for next lectures

Monday, March 22

1. Further solutions to credibility problems
2. Delegation and independent central banks

Literature: Walsh (Chapter 8, pp. 393-425)

Wednesday, March 24

1. Operating procedures and choice of monetary policy instrument
2. Intermediate targets in policymaking

Literature: Walsh (Chapter 9, pp. 429-448)

Monday, March 29
Interest rate policies (I)

1. Price level (in)determinacy
2. The term structure of interest rates
3. Models for monetary policy analysis and the impact of interest rate rule parameters

Literature: Walsh (Chapter 10, pp. 473-480; pp. 488-499; pp. 499-507)