EC3115 Monetary Economics
Lecture 12: Time inconsistency and inflation bias

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Relevant reading

Must-read articles


Relevant reading

**Must-read articles (cont.)**


Section 1

Dynamic inconsistency and inflation bias
A wide variety of social and economic interactions involve a temporal dynamic.

Sometimes moves may be made (or not made) because of some other hypothetical moves that may in fact never be carried out.

  E.g. a government may announce a zero-tax regime for a particular industry, but may then be tempted to actually collect tax revenues once the industry flourishes – and the lack of credibility in the announcement therefore discourages businesses to engage in that industry in the first place.

This is a theatre of threats and promises.

The key idea here is the credibility problem:

  when the government announces a policy move and is subsequently given an opportunity to cheat the public, they will attempt to do it

  but, knowing that they will be cheated, rational agents will change their response functions in adjustment to the anticipated cheating attempt by the government.
Thus policy makers may find it optimal to announce a commitment to a particular policy and the deviate from it after the people have made their decisions based on the announcement. This is the \textit{time-inconsistent} action.

- Depends on forward-looking (rational) expectations so that people take account of the “policy announcements” when making decisions.

There is still widespread belief among economists that inflation is largely a monetary phenomenon.

In this framework, if the CB can influence inflation, and if there is a positive statistical relationship between inflation and real output (or employment) in the short run, then governments (or politically motivated CBs) may be tempted to exploit these short run relationships in order to achieve different objectives.

- These may range from achieving temporary high real output, reducing unemployment, financing budget deficits and even attaining balance of payments objectives by generating surprise inflation.
While such outcomes may be feasible in the short-term, inflationary consequences distort economic agents incentives in the longer run.

What is more, economic agents learn the type of policy makers over time such that they can not be easily fooled.

Hence the announced policy may be “incredible” (time-inconsistent), and thus will eventually lead to other outcomes.

Once consumers, firms and other agents in the economy understand the incentives of policy makers to create surprise inflation, they adjust their inflation expectations accordingly such that even in the short run there can be no output gains to achieve.

The conclusion here is that discretionary policymaking can make everyone worse off compared with a situation in which the government could commit to a particular policy path credibly.

A simple game theoretic framework will allow us to analyse the importance of central bank credibility in the combat of inflation.
The game

- Two players: government and public.

- Choices:
  - Government chooses inflation, $\pi$.
  - Public sets expectations of inflation, $\pi^e$.

- Time-consistent (Nash) equilibrium:
  - Public signs wage and price contracts (based on $\pi^e$).
  - Government sets $\pi$.

- Time-inconsistent (Stackelberg) equilibrium:
  1. Government announces a commitment to a choice of $\pi$.
  2. Public forms rational expectations $\pi^e = \pi$. 
So far in this course we have stressed that money should be neutral in the long run but, using models such as the expectations-augmented Phillips curve or the Lucas supply curve, money can have real effects in the short run as well.

Here, we will use such a framework to show that in equilibrium, a positive rate of inflation may be present even though a zero rate may be optimal.

If there are no institutional or behavioural restrictions, the monetary authorities have an incentive to increase inflation (when inflation is zero) in an attempt to move along the Phillips curve to increase output.

An inflation bias may then result in the economy.

Let us call such policy makers as being “wet” and those policy makers who always aim for target inflation as being “hard nosed”.
Section 2

The Barro-Gordon framework
Consider for the aggregate supply given by:

\[ y_t = y^* + \alpha (\pi_t - \mathbb{E}_{t-1} [\pi_t]) + \varepsilon_t \]

where:
- \( y^* \) is the market clearing level of output, and
- \( \varepsilon_t \) is a zero-mean productivity shock.

Note that this is the same as an expectations-augmented Phillips curve or a Lucas supply curve, only we use inflation, \( \pi_t \), instead of the price level.

Suppose that the central bank can choose the inflation rate directly (implicitly through the use interest rate or the monetary base) and tries to minimize the following loss function:

\[ L = \pi_t^2 + \lambda (y_t - ky^*)^2 \]

where \( k > 1 \)

and \( \lambda \) is the usual preference parameter showing the CB’s preference for output fluctuations relative to inflation fluctuations.
Above we also assume that $k > 1$ so that a level of output greater than the market clearing level is desired reflecting political biases towards higher output.

If output is at the market clearing level, a social loss is still incurred, i.e. $(y_t - ky^*)^2 > 0$, since the socially optimum level of output may be greater than the market clearing level.

This may be due to the fact $y^*$ is too low because of the monopoly powers of firms, for example, which causes output levels to be sub-optimal and hence unemployment to be too high.
Initially, we are at point A, where $y = y^*$ and $\pi = 0$.

If output equals its market clearing level in the long term, this point is the best (welfare-maximising) that can be achieved.

However, the CB knows that by increasing inflation unexpectedly, it can move along the Phillips curve to point B, obtaining a higher level of welfare.
Time-inconsistency illustrated (cont.)

At point B the inflation rate is higher than expected since \( E[\pi] = 0 \). Expected inflation therefore increases and the Phillips curve shifts up.

The equilibrium compatible with expected inflation, point E, is the point where the Phillips curve is tangential to the indifference curve.
At this point the authorities have no incentive to increase inflation since to do so will result in lower social welfare.

Note that at point E, we have a positive rate of inflation, the inflation bias, and we are on a lower level of social welfare than at point A, our starting point.
Lesson: The central bank can't raise output anyway, so it might as well concentrate on price stability.

- Barro-Gordon innovation: It is useful to think of society’s first choice as $y = y^*$ (and $\pi = 0$), even if it is unattainable. (Point A).

- If $\pi^e$ would stay at 0, then to get the higher $y$ it would be worth paying the price of $\pi > 0$. (Point B).

- But $\pi^e$ adjusts upward in response to observed $\pi > 0$. The Rational Expectations equilibrium must imply $\pi^e = \pi$.
  
  - Result: inflationary bias $\pi, \pi^e > 0$, despite failure to raise $y$ above $y^*$. (Point E).

- The country would be better off “tying the hands” of the central bank.
  
  - Result: $\pi = 0$, and yet $y = y^*$ (no worse than the average under discretion).
To calculate the inflation bias, substitute the Phillips curve into the loss function:

\[
L = \pi_t^2 + \lambda \left( (y^* + \alpha (\pi_t - \mathbb{E}_{t-1} [\pi_t]) + \varepsilon_t) - k y^* \right)^2
\]

\[
= \pi_t^2 + \lambda \left( (1 - k) y^* + \alpha (\pi_t - \mathbb{E}_{t-1} [\pi_t]) + \varepsilon_t \right)^2
\]

Differentiating this with respect to the choice variable, \( \pi_t \), taking expectations of inflation as given and setting equal to zero we have:

\[
\frac{\partial L}{\partial \pi_t} = 2\pi_t + 2\alpha \lambda \left( (1 - k) y^* + \alpha (\pi_t - \mathbb{E}_{t-1} [\pi_t]) + \varepsilon_t \right) = 0
\]

which is solved by:

\[
2\pi_t + 2\alpha \lambda \left( (1 - k) y^* + \alpha (\pi_t - \mathbb{E}_{t-1} [\pi_t]) + \varepsilon_t \right) = 0
\]

\[
2\pi_t + 2\alpha^2 \lambda \pi_t + 2\alpha \lambda \left( (1 - k) y^* - \alpha \mathbb{E}_{t-1} [\pi_t] + \varepsilon_t \right) = 0
\]

\[
\left( 1 + \alpha^2 \lambda \right) \pi_t = \alpha^2 \lambda \mathbb{E}_{t-1} [\pi_t] - \alpha \lambda \left( (1 - k) y^* + \varepsilon_t \right)
\]
Taking expectations of the above conditional on information known at time $t - 1$ gives:

$$(1 + \alpha^2 \lambda) \mathbb{E}_{t-1} \left[ \pi_t \right] = \alpha^2 \lambda \mathbb{E}_{t-1} \left[ \mathbb{E}_{t-1} \left[ \pi_t \right] \right] - \mathbb{E}_{t-1} \left[ \pi_t \right]$$

$$= \mathbb{E}_{t-1} \left[ \pi_t \right] - \alpha \lambda \left( (1 - k) \mathbb{E}_{t-1} \left[ y^* \right] + \mathbb{E}_{t-1} \left[ \epsilon_t \right] \right)$$

$$(1 + \alpha^2 \lambda) \mathbb{E}_{t-1} \left[ \pi_t \right] = \alpha^2 \lambda \mathbb{E}_{t-1} \left[ \pi_t \right] - \alpha \lambda (1 - k) y^*$$

$${\mathbb{E}_{t-1} \left[ \pi_t \right]} = -\alpha \lambda (1 - k) y^*$$

$${\mathbb{E}_{t-1} \left[ \pi_t \right]}$$ is the inflation bias and represents the vertical distance $\Delta \mathbb{E}$ in the graphs above.
Substituting this back into the FOC solution above gives:

\[
(1 + \alpha^2 \lambda) \pi_t = \alpha^2 \lambda \mathbb{E}_{t-1} \left[ \pi_t \right] - \alpha \lambda \left( (1 - k) y^* + \epsilon_t \right)
\]
\[
(1 + \alpha^2 \lambda) \pi_t = \alpha^2 \lambda \left( -\alpha \lambda (1 - k) y^* \right) - \alpha \lambda \left( (1 - k) y^* + \epsilon_t \right)
\]
\[
(1 + \alpha^2 \lambda) \pi_t = \left( 1 + \alpha^2 \lambda \right) \left( -\alpha \lambda (1 - k) y^* \right) - \alpha \lambda \epsilon_t
\]
\[
\pi_t = -\alpha \lambda (1 - k) y^* - \frac{\alpha \lambda \epsilon_t}{1 + \alpha^2 \lambda}
\]

Therefore, the unexpected part of inflation is:

\[
\pi_t - \mathbb{E}_{t-1} \left[ \pi_t \right] = -\frac{\alpha \lambda \epsilon_t}{1 + \alpha^2 \lambda}
\]
There are three elements that determine the level of inflation bias:

- the political bias towards higher output parameter \( (k > 1) \),
- the degree of central bank inflation aversion in the loss function \( (\lambda) \),
- the responsiveness of inflation to output in the Phillips curve \( (\alpha) \).
Degrees of aversion

If $\lambda$ is equal to 1, indifference curves are round circles and the central bank assigns equal weights to inflation and real output aversion.

In alternative scenarios where $\lambda$ is not equal to 1, indifference curves are elliptical.
**Degrees of aversion (cont.)**

- If $\lambda < 1$, the central bank is more inflation averse.
- The central bank responds more aggressively to stabilise inflation if current inflation deviates from a target inflation level.
If $\lambda > 1$, the CB is more real output gap (or unemployment) averse.

The central bank’s response will be muted when inflation deviates from its target level since it is more concerned with real output.
The parameter $\alpha$ measures the slope of the Phillips curve or alternatively, the responsiveness of inflation to changes in output.

The higher the parameter $\alpha$, the more responsive is inflation to changes in output.

Given the central bank preferences, a steeper Phillips curve implies less aggressive policy response when the inflation deviates from the target level.

A steeper Phillips curve allows the central bank to do less in response to an inflation shock since inflation responds strongly to a fall in output associated with a tight monetary policy.
Section 3

Ways of reducing the inflation bias
How can the central bank credibly commit to a low-inflation monetary policy?

We’ve learned that simply announcing a target $\pi = 0$ is time-inconsistent and therefore not credible, because the central bank with discretion will be tempted to inflate *ex post*, and everyone knows this *ex ante*.
Pre-commitment mechanisms

- Rules (Kydland and Prescott, 1977\textsuperscript{1}).
  - money supply, NGDP, inflation or exchange rate targets.

- Reputation (Barro and Gordon, 1983).
  - investment in credibility pays off.

- Delegation (Rogoff, 1985).
  - independence of the central bank and a conservative central banker.

- Contract for the central bank (Walsh, 1995).
  - central banking as a principal-agent problem.

\textsuperscript{1}First paper to describe the time-inconsistency problem in monetary policy. Fun fact: they came upon it while doing something else: “The original objective of this research was to demonstrate the applicability of optimal control methods in a rational expectations world”. However their Nobel Prize was awarded “for their contributions to dynamic macroeconomics: the time consistency of economic policy and the driving forces behind business cycles”.

Rules

- We’ve already previously discussed that one way that the inflation bias can be reduced is for the monetary authorities to implement policy according to a rule or formula that is chosen to be applicable over a large number of periods.

- These are simple rules thus by definition not reflecting *optimal* choice of the monetary policy instrument given the state of the economy as done in the previous sections.

- Following a rule is transparent: by committing to follow a rule, policy makers can communicate and explain their policy actions easily and should at least in principle enhance the accountability and credibility of the central bank.

- Despite reducing the inflation bias, possibly to zero, depending on the rule, such policy will not be able to counter the productivity shocks that hit the economy.
Reputation

- Policy credibility is at the core of monetary policymaking.
- A “hard nosed” central bank cares only about inflation, whereas a “wet” central bank attempts to exploit short-term relationships.
- However, even a “wet” central bank can avoid inflation bias problem by establishing a reputation that it is serious about inflation.
- Such reputation can only be achieved in a multi-period game between sceptical wage setters and the policy maker.
Consider a two period game.

In period 1, the society chooses an expected inflation \( E[\pi_1] \) with the knowledge that there is a certain probability, \( p \), that the central bank is serious about inflation.

Equipped with this knowledge, the central bank chooses output at, say, \( y_1 \).

In period 2, the society chooses \( E[\pi_2] \) knowing how the central bank behaved in period 1 (i.e. they observe \( y_1 \)).

The central bank once again chooses \( y_2 \) knowing \( E[\pi_2] \), and so on.

In this scenario, even a “wet” central bank will behave in period 1 as if it is “hard nosed” about inflation. This is because by behaving tough on inflation in period 1, inflation will be on target and output on equilibrium.
In period 2 (terminal period), however, the central bank can set output above the equilibrium by creating surprise inflation.

When the reasoning is extended to many periods, it pays off for the central bank to build a reputation of being tough on inflation.

The “wet” central bank would behave as if it is a “hard nosed” central bank in all periods except the very last one of the game.

The model provides a justification for the incentives to build a reputation of inflation toughness when the society is sceptical about the nature (type) of the central bank.
Conservative and independent central banker

- If the role of monetary policy was delegated to a conservative central bank that is less concerned with output variations than the government – in other words, has a loss function of the form:

\[ L_{CB} = \pi_t^2 + \lambda_{CB} (y_t - ky^*)^2 \]

as compared to the government:

\[ L_{Gov} = \pi_t^2 + \lambda_{Gov} (y_t - ky^*)^2 \]

where \( \lambda_{CB} < \lambda_{Gov} \), then the CB would still be faced with an inflation bias but the bias will be of the form:

\[ \mathbb{E}_{t-1} [\pi_t] = -\alpha \lambda_{CB} (1 - k) y^* \]

- Since \( \lambda_{CB} < \lambda_{Gov} \), the inflation bias will be lower in this case.
One way to formalise a conservative central bank is to establish an independent central bank with a formal price stability mandate.

An independent central banker avoids the political business cycle, since he obviously does not need to run for election and is thus less likely to vary \( \lambda_{CB} \) according to the political cycle (increasing \( \lambda_{CB} \) in years ahead of election).

The popularity of independent central banks during the 1990s can be seen as an attempt to separate monetary policymaking from political interference.

Establishing an independent central bank, of course, is not sufficient to guarantee price stability if price stability is not part of their mandate.

In order to ensure their commitment to price stability, most central banks in advanced economies recently adopted the so formal inflation targeting regimes.
Inflation contract for the central bank

- Suppose the central bank was penalised, by way of reduced salary, for allowing any inflation above the socially desired level, set in this case at zero.

- The loss function that would be minimised would then be:

\[
L^{Contract} = \pi_t^2 + \mu (y_t - ky^*)^2 + \Psi \pi_t
\]

- So that the central bank’s loss depends on the level of inflation through the \( \Psi \) parameter as well as squared inflation and squared output deviations.
If we substitute the Phillips curve into the above and minimise the loss function by choosing \( \pi_t \) as before, then the inflation bias will be given by:

\[
E_{t-1} \left[ \pi_t \right] = -\alpha \lambda (1 - k) y^* - \frac{\Psi}{2}
\]

Therefore, if the contract was written for the central bank such that

\[
\Psi = 2\alpha \lambda (1 - k) y^*
\]

then the inflation bias would be zero and one would achieve the point of highest attainable welfare, point A in the graphs above, as a time-consistent equilibrium.