ECON 5322
Macroeconomic Theory for Applications

Topic 5: Optimal Monetary Policy and the Basic New Keynesian model

Optimal Monetary Policy, Time Consistency: Rule vs. Discretion

In the context of New Neoclassical Synthesis:

- How and why should a central bank conduct monetary policy?
- Inflation Bias & Uncertainty: two big problems
- Time Inconsistency of Monetary Policy
- Rules versus Discretion - Why?

Sources: Romer - Chapter 9; Gali Ch. 5; Walsh Ch. 7

Kydland and Prescott (1977); Barro and Gordon (1981); Rogoff's conservative central banker

How to set interest rate? Instrument vs. Targeting rule

First of all, what should the big-picture objective of a central banker be in theory ? …

Basically, she's a type of social planner and thus should pursue an objective that's compatible with the private agents' incentives.

In a model, this translates in maximizing society's welfare (Chugh, 2015)

Depending on the setup this usually implies stabilizing inflation and maximizing output …

The problem though is that there is a **trade-off between these two objectives** (as we know from the NKPC)

Implementation:

To pursue the objectives the policy maker has a tool that can be set as part of a rule, or as a function of a explicit target

In reality: policy rules are relevant benchmarks all banks have in mind ...

But central bankers have favored the practice of establishing an official policy target for guiding their policy decisions (e.g., Inflation targeting, Exchange rate pegs, etc.)

Instrument rule: use i_t as a policy instrument

$$i_t = d_\pi \pi_t + d_x x_t + \varepsilon_{x,t}$$

Taylor principle (for US data): $d_{pi}>1$ (~1.5), d_x ~ 1/2

Targeting rule: spell out objective explicitly, and aim for FOC to reach such target

e.g. set inflation equal to optimal level: $\pi = \pi^*$

aim for FOC meaning: set policy tool such that private agents achieve the policy targeted allocation (equilibrium) with their own optimal conditions

Doable because private decisions are a function of policy tools

Time inconsistency and the inefficiency of discretionary monetary policy

- **Discretion:** each t, choosing what's optimal
- **Time/dynamic inconsistent policy:** optimal choice for action at t+1 is different ex ante at t vs. ex post at t+1

i.e. the preferred policy for period t is not the same before deciding it that right at the moment of doing so (or after)

This seemingly unimportant feature becomes relevant in an environment in which agents are forming expectations about the actions of policymakers.

We will see why central bankers want to keep this issue in mind

Monetary Policy Context:

Assume

$y_t = m_t - E_{t-1}(p_t)$ e.g. price is set one period in advance.

At t= 0: both firms and Central Bank (CB) want low inflation (low m_{t+1}); firms set prices

At t=1: firms already committed to $E_{t-1}(p_t)$, so CB may want to print money to boost output

Knowing this, firms anticipate higher m_{t+1}, and set higher $E_{t-1}(p_t)$

Remember: in modern macroeconomics … it's all about dynamics and expectations

Then agents expect high inflation, leading to actual higher inflation (**"inflation bias"**) and sub-optimal outcome

Solution?

Time inconsistency and the inefficiency

Time or Dynamically Inconsistent policy: preference for action at t+1 is different ex-ante at t vs. ex-post at t+1

Discretion: at each t, choose what is optimal

In the monetary policy context

Discretion leads to inefficiency, e.g., inflation bias

Commitment to a rule can lead to better outcomes (issue of credibility)

Solution: commit to a rule (and fight to stick to it ~ hard at times)

This is the framework (Taylor rule) we will add to our NK DSGE model to include monetary policy

Assembling the Basic New Keynesian Model

- We have obtained each part of the new model we were building
- The idea was to modernize the typical static AD-AS approach that stems from IS-LM
- The new version takes into account the tenets of modern macroeconomic theory: **rational expectations and dynamics (intertemporal decision-making)**
- In the following slides we will show the resulting model
- Furthermore, we will discuss on the merits and limitations of this framework and the potential variations of it that can be developed to improve it
- Note that shocks are introduced to each equation to allow for different sources of exogenous fluctuations ... but the structural equations could have been derived without the shocks
    - As seen in the RBC, simpler case, we need exogenous drivers of the variables to push the system out of their steady state values

The Basic New Keynesian Macroeconomic Model

- The simplest, log-linearized New Keynesian model consists of three equations

The Intertemporal or dynamic IS

- There is an equation that describes how output today depends on the *ex ante* real interest rate and on expected future output:

$$y_t = -\sigma\left[i_t - E_t\left(\pi_{t+1}\right)\right] + E_t\left(y_{t+1}\right) + u_t, \tag{1}$$

where, as usual, $\sigma > 0$ measures the responsiveness of today's output to the real interest rate, i_t is the nominal interest rate, π_{t+1} is inflation next period, $E_t(.)$ is the expectation of the variable inside the parentheses based on information available at time t, and u_t is an exogenous demand shock.

- This equation is an intertemporal IS equation.
  - GDP contracts if real interest rate increases; today's GDP rises if it is expected to rise tomorrow.
  - u_t is an exogenous demand shock.
- This equation follows from the log-linearized Euler equation for bond (or any interest-bearing asset) holdings once equilibrium conditions are imposed
- It describes the demand-side of the economy.

The Basic New Keynesian Macroeconomic Model, Continued

The New Keynesian Phillips Curve

- describes how today's inflation depends on today's output and on expected future inflation:

$$\pi_t = \lambda y_t + \beta E_t (\pi_{t+1}) + z_t, \tag{2}$$

  where $\lambda > 0$ and $\beta > 0$ are parameters (β is the households' discount factor, λ is a parameter that depends on the extent of nominal rigidity and on the extent of monopoly power), and z_t is an exogenous shock.

  – Current inflation rises if GDP rises and if inflation is expected to rise tomorrow.

- This equation is known as New Keynesian Phillips Curve (NKPC) and it describes the supply-side of the model.

- We obtained it as in Calvo-Yun (83), but remember it can also be obtained in the Rotemberg framework, e.g., by log-linearizing the non-linear NKPC shown in Sanjay Chugh's book (Chapter 23) and imposing additional equilibrium conditions.

The Basic New Keynesian Macroeconomic Model, Continued

Monetary Policy

- Finally, monetary policy is set in terms of what is known as a Taylor-type rule for interest rate setting (Taylor, 1993).

- For instance:

$$i_t = \alpha_1 \pi_t + \alpha_2 y_t + x_t, \tag{3}$$

  where $\alpha_1 > 0$ and $\alpha_2 > 0$ are policy response parameters, and x_t is an exogenous policy shock.

- Equations (1)-(3) are a system of three dynamic equations for the three endogenous variables y_t, π_t, and i_t as functions of the exogenous shocks u_t, z_t, and x_t.

- Usually, it is assumed that these shocks follow so-called first–order autoregressive processes, in which the level of the shock today depends on its level last period and on an innovation in the current period.

Solving the Basic New Keynesian Macroeconomic Model

- If the policy response parameters α_1 and α_2 satisfy the following restriction:

$$(\alpha_1 - 1)\,\lambda + \alpha_2\,(1 - \beta) > 0,$$

  the log-linear system (1)-(3) has a unique solution.

  – This can be verified using a method described in an appendix to the slides on the RBC model.

- If the central bank is not responding to GDP (i.e., $\alpha_2 = 0$), the condition for a unique solution reduces to $\alpha_1 > 1$:

  – The central bank must respond to inflation more than proportionally.

- This is known as Taylor Principle and it captures the idea that, to stabilize the economy, the central bank should cause the real interest rate to rise (by having the nominal interest rate rise more than inflation) when the economy is "overheating" and inflation is increasing.

- Requiring that monetary policy be such that it ensures a unique equilibrium is important:

  – Doing no harm (i.e., not introducing sunspot fluctuations in the economy by creating indeterminacy) should be the minimum that is expected of policy!

Solving the Basic New Keynesian Macroeconomic Model, Continued

- Provided the condition for determinacy (uniqueness) of the solution is satisfied, the solution of the model can be written as:

$$\begin{aligned} y_t &= \eta_{yu} u_t + \eta_{yz} z_t + \eta_{yx} x_t, \\ \pi_t &= \eta_{\pi u} u_t + \eta_{\pi z} z_t + \eta_{\pi x} x_t, \\ i_r &= \eta_{iu} u_t + \eta_{iz} z_t + \eta_{ix} x_t, \end{aligned} \tag{4}$$

  where the η's are coefficients that can be found with the method of undetermined coefficients

- We did this in the RBC topic: expressing decision variables as linear functions of exogenous states
- Notice: We can solve fully for output, inflation, and the interest rate without any reference to money and money supply.
- This happens because of the implicit assumption that, if we had money in the model, we would have introduced it via money-in-the-utility function in a separable way.
- Under this assumption, once monetary policy is conducted through interest rate setting, we need not worry about money, and its only role is to affect the interest rate through the central banks' market operations

Some Properties of the Solution and Some Model Variants

- The shocks u_t, z_t, and x_t describe the minimum state vector of the model.
- There is no endogenous, predetermined state (such as capital in the RBC model).
- Thus, the endogenous variables y_t, π_t, and i_t are only as persistent as the shock themselves, and will return monotonically to the steady state after shocks, without displaying any hump.
- This is a **well known weakness of the basic New Keynesian framework**, as empirical evidence points to hump-shaped responses to shocks that this model cannot replicate.
- A solution to generate hump-shaped responses of inflation to shocks is to build models in which current inflation also depends on past inflation, so that the NKPC becomes:

$$\pi_t = \rho\pi_{t-1} + \lambda y_t + \beta E_t\left(\pi_{t+1}\right) + z_t,$$

  with $0 < \rho < 1$.

- **In this case, π_{t-1} becomes part of the state vector**, and the model can generate humps in inflation responses to shocks.

Some Properties of the Solution and Some Model Variants, Continued

- We could also assume that **habits in consumption** imply that output today depends also on output yesterday, so the intertemporal IS becomes:

$$y_t = \varkappa y_{t-1} - \sigma \left[i_t - E_t \left(\pi_{t+1} \right) \right] + E_t \left(y_{t+1} \right) + u_t,$$

  with $0 < \varkappa < 1$.

- **In this case, y_{t-1} becomes part of the state vector.**

- Another variant of the model assumes that central bank policy is characterized by interest rate smoothing, so that the interest rate today depends also on the interest rate yesterday:

$$i_t = \alpha_1 \pi_t + \alpha_2 y_t + \alpha_3 i_{t-1} + x_t,$$

  with $\alpha_3 > 0$.

- **In this case, i_{t-1} becomes part of the state vector.**

- If no other change to the model is made (i.e., equations (1) and (2) continue to hold) the condition for a unique solution becomes:

$$\left(\alpha_1 + \alpha_3 - 1 \right) \lambda + \alpha_2 \left(1 - \beta \right) > 0.$$

Monetary Policy and the New Keynesian Phillips Curve

- But let us return to the basic model (1)-(3).
- Suppose the central bank commits to a policy of zero inflation, so that $\pi_t = E_t(\pi_{t+1}) = 0$.
- We can use the NKPC equation (2) to back out the implied path of output:

$$y_t = -\frac{1}{\lambda} z_t.$$

- And we could then use the intertemporal IS equation (1) to back out the path of the interest rate that would be consistent with this outcome:

$$-\frac{1}{\lambda} z_t = -\sigma i_t - \frac{1}{\lambda} E_t \left(z_{t+1} \right) + u_t,$$

  or,

$$i_t = \frac{1}{\sigma} u_t + \frac{1}{\sigma\lambda} \left[z_t - E_t \left(z_{t+1} \right) \right].$$

- If we assume that the shock z_t is such that $z_t = \phi_z z_{t-1} + \varepsilon_{z,t}$, where $\varepsilon_{z,t}$ is a zero-mean innovation, $E_t \left(z_{t+1} \right) = \phi_z z_t$, and:

$$i_t = \frac{1}{\sigma} u_t + \frac{1}{\sigma\lambda} \left(1 - \phi_z \right) z_t. \tag{5}$$

Monetary Policy and the New Keynesian Phillips Curve, Continued

- This is why it's said that monetary policy in the New Keynesian model works through the NKPC:
  - Once the central bank choses the path of inflation it wants to implement, the NKPC delivers the implied path of output, and the intertemporal IS then delivers the associated interest rate path.
- **Does this imply that if the central bank wants to pursue a policy of zero inflation there is no role for the policy rule (3)? ... No!**
- In fact, we could verify that if the policy rule (3) were replaced by equation (5) the model would not have a unique solution.
  - The equilibrium would be indeterminate!
- Having the interest rate respond to endogenous variables of the model (such as inflation and output) and not just to exogenous shocks is crucial to deliver uniqueness of the solution.
  - This is a point that Michael Woodford showed in his 2003 book on *Interest and Prices*.

Implementing Zero Inflation

- If the central bank wants to deliver zero inflation (and ultimately the interest rate path (5)), it must commit to the policy:

$$i_t = \alpha_1 \pi_t + \alpha_2 y_t,$$

  i.e., no exogenous monetary policy shock ($x_t = 0$), with a very high value of the response coefficient α_1.

  – In fact, you could verify from the solution equations in (4), once you have found the η's, that $\pi_t = 0$ when the policy coefficient tends to ∞.

- Of course, this is a policy that works well to deliver $\pi_t = 0$ without problems in this simple model.

- In reality, a huge coefficient α_1 would cause problems from large volatility of the interest rate in response to even minuscule deviations of inflation from 0 that could happen for many reasons.

- This explains why the recommendation of a huge response coefficient can be good for a model, but not for reality.

What is next:

Now we are ready to see some computational applications of the New Keynesian model

For that we have to discuss how this models are solved and mention:

- What represents a solution
- What types of solution methods exist
- How to obtain such solution
- What is the difference between solving and estimating/calibrating a model

We will use Dynare for this application module (I will show how to install and use it in technical slides #3)

Dynare is an extension library of Matlab (made by economists at CEPREMAP in France)

It is built specifically to solve, estimate and simulate macroeconomic models, and much more

However, before we jump into the application module we will do a detour and cover another type of friction that justifies policy: **Financial Frictions**

We consider another policy toolkit here: Financial Regulation (has gained prominence since the financial crisis of 2008)