Monetary Policy and Business Cycle

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Lecture IV

Business Cycle Theory II: New Keynesian Economics

"Motto"

"There are long-lived nominal wage commitments out there in the world"

(Phelps, 1990)

Outline

- Some General Comments
- A Basic Model
  - Fischer model
  - Discussion
- Monetary Policy: New Keynesian Perspective
  - The Basic Model (Clarida, Gali and Gertler 1999)
  - Monetary Policy
- Summary

Some General Comments

- New Keynesian Economics covers a disparate range of papers that have appeared since the late 1970s
- their aim has been to prove Keynesian-style propositions within models which adopted rational expectations hypothesis and optimizing behaviour
- following Mankiw and Romer (1991), New Keynesian Economics can be divided into three categories concerned with
  - real rigidities
  - nominal rigidities
  - aggregate demand externalities
- as the models for monetary policy analysis do usually work with nominal rigidities we follow this orientation and concern the New Keynesians models with nominal rigidities

A Basic Model

- the aim is to show that monetary policy can be efficient even under rational expectations ...

- Fischer (1977) observes that the validity of the famous Sargent-Wallace policy ineffectivennes proposition presupposes not only rational expectations, but also wage and price flexibility

- suppose 'economic agents contract in nominal terms for periods longer than the time it takes the monetary authority to react to changing economic circumstances' (Fischer 1977) ...

- then activist monetary policy can play an effective role in stabilizing the economy

- Fischer(1977) model differs from the Lucas rational expectation model in exactly one respect: *wages are not set for one, but for two periods in advance*

- there are two equally sized groups of workers and wage setting is staggered: *one group negotiates wages at even dates, the other one at odd dates*

- so at each date t, half of the workers receive the wage w_t^I negotiated at $t-1$, and half receive the wage w_t^{II} negotiated at $t-2$

- the quantity theory holds, aggregate supply depends negatively on the real wages, expectations are rational, and central bank follows the money supply rule

$$
\begin{aligned}
m_t - p_t &= \phi y_t & (1)\\
\gamma y_t &= -\frac{(w_t^I - p_t) + (w_t^{II} - p_t)}{2} & (2)\\
w_t^I &= E_{t-1} p_t & (3)\\
w_t^{II} &= E_{t-2} p_t & (4)\\
m_t &= a + \sum_{j=1}^{\infty} b_j m_{t-j} + \eta_t & (5)
\end{aligned}
$$

- substituting for w_t^I and w_t^{II} from (3) and (4) in (2), one obtains aggregate output as a function of the price surprises:

$$2\gamma y_t = (p_t - E_{t-1} p_t) + (p_t - E_{t-2} p_t) \quad (6)$$

eliminating y_t using equation (1):

$$\phi[(p_t - E_{t-1} p_t) + (p_t - E_{t-2} p_t)] = 2\gamma (m_t - p_t) \quad (7)$$

and then taking expectations at $t-2$ and $t-1$ we obtain

$$\begin{aligned} E_{t-2}p_t &= E_{t-2}m_t & (8) \\ E_{t-1}p_t &= \frac{2\gamma}{\phi+2\gamma}E_{t-1}m_t + \frac{\phi}{\phi+2\gamma}E_{t-2}m_t & (9) \end{aligned}$$

respectively. Inserting these equations together with $p_t = m_t - \phi y_t$ into (6) output can be expressed as a function of the one-period and two-period money surprises:

$$(\phi+\gamma)y_t = \frac{\gamma}{\phi+2\gamma}(m_t - E_{t-1}m_t) + \frac{\gamma+\phi}{\phi+2\gamma}(m_t - E_{t-2}m_t) \tag{10}$$

According to the money supply rule:

$$\begin{aligned} m_t - E_{t-1}m_t &= \eta_t \\ m_t - E_{t-2}m_t &= b_1(m_{t-1} - E_{t-2}m_{t-1}) + \eta_t \\ &= b_1\eta_{t-1} + \eta_t \end{aligned}$$

Hence,

$$y_t = \frac{\eta}{\phi+\gamma} + \frac{b_1\eta_{t-1}}{\phi+2\gamma} \tag{11}$$

- it follows that unlike the Lucas model the policy ineffectiveness proposition is not valid, as the behaviour of aggregate production y_t depends on the policy parameter b_1

- for instance, Friedman k-percent money growth rule $(a = k, b_1 = 1)$, hence $\Delta m_t = k + \eta_t$ leads to

$$y_t = \frac{\eta}{\phi + \gamma} + \frac{\eta_{t-1}}{\phi + 2\gamma} \quad (12)$$

however, in order to minimize the variance of aggregate production, the central bank can decide to set $b_1 = 0$, which nullifies the impact of lagged shocks on y_t

$$y_t = \frac{\eta}{\phi + \gamma} \quad (13)$$

this is exactly the equation which determines aggregate production in the Lucas model ...

- the general lesson that can be drawn from the Fischer model is that monetary policy is effective, rational expectations notwithstanding, whenever monetary policy decisions are more frequent than wage negotiations

- however, the introduction of nominal rigidities has raised several questions:
  - first, why do agents not make use of indexation ?
  - it can be shown that fully indexed wage contracts, $w_t^I = w_t^{II} = p_t$, would make the aggregate output equal its equilibrium for all t

- one reason for this could be the fact that indexation precludes the necessary adjustment in response to real shocks, which is quite problematic once random productivity shocks are introduced
- second, even if indexation is not used, why do agents contract in nominal terms for several periods ?
- one strand of the literature (Akerlof and Yellen 1985, and Mankiw 1985) emphasizes the physical costs of changing prices ('menu costs')
- or as emphasized by Okun (1981), in markets with long-lasting employer-employee or buyer-seller relationship, firms hold wages (prices) fixed when the macroeconomic data change ('implicit contracts')

The Science of Monetary Policy: A New Keynesian Perspective

- the models of 1970s, 1980s, and early 1990s introduced the assumption of nominal rigidity, however, they were still linking the aggregate demand to the quantity of money

- this linkage was usually directly through a quantity theory equation in which nominal demand was equal to the nominal supply of money

- while the theoretical foundations of these models were weak, the approach proved remarkably useful in addressing a wide range of monetary policy topics

- more recently, attention has been placed on ensuring that the model structure is consistent with the underlying behavior of optimizing economic agents

- so, the standard approach today builds on optimizing behaviour, combined with some form of nominal wage and/or price rigidity

- as early examples of models with these properties can be seen Rotemberg and Woodford (1995, 1997) and McCallum and Nelson (1999)

- Clarida, Gali and Gertler (1999) then provide first sum up of the debate

The Basic Model

- the model consists of households that supply labor, purchase goods for consumption, and hold money and bonds and firms that hire labor and produce and sell differentiated products in monopolistically competitive goods markets

- each firm sets the price of the good it produces, but not all firms reset their price in each period

- households and firms behave optimally; households maximize the expected present value of utility, and firms maximize profits

- finally, there is also central bank that controls the nominal rate of interest, however, in contrast to households and firms, the central bank is not necessarily assumed to behave optimally

- Clarida, Gali and Gertler (1999) present simple macroeconomic framework based on the above mentioned conditions

- within the model monetary policy affects real economy in the short run, however, important implication of optimization is that current economic behavior depends critically on expectations of the future course of monetary policy, as well as on current policy

- in addition, the model accommodates differing views about how the macroeconomy behaves - in the limiting case of perfect price flexibility, the cyclical dynamics resemble those of real business cycle model, with monetary policy affecting only nominal variables

- the details of models derivation will be discussed during the seminars (based on Walsh 2003, pp. 231-255), here we directly introduce the key aggregate relationships

- the model is as follows:

  – first, we define the *'output gap'*, which is an important variable in the model, as the difference between actual and potential output:

$$x_t \equiv y_t - z_t \tag{14}$$

  where y_t is the stochastic component of output and z_t is the natural level of output that would arise if wages and prices were perfectly flexible

  – in addition, π_t is the period t inflation rate and i_t is the nominal interest rate

  – it is then possible to represent the model in terms of two equations: an 'IS' curve that relates the output gap inversely to the real interest rate, and a 'Phillips curve' that relates inflation positively to the output gap

$$x_t = -\phi[i_t - E_t\pi_{t+1}] + E_t x_{t+1} + g_t \quad (15)$$
$$\pi_t = \gamma x_t + \beta E_t \pi_{t+1} + u_t \quad (16)$$

where g_t and u_t are disturbances terms

- the 'IS' curve is obtained by log-linearizing the consumption Euler equation that arises from household's optimal saving decision

- it differs from the traditional IS curve mainly because current output depends on expected future output as well as the interest rate

- it follows that whereas higher expected future output raises current output, rise in real interest rate forces the current output to decline (reflecting the intertemporal substitution of consumption)

- it is instructive to iterate equation (15) forward to obtain

$$x_t = E_t \sum_{i=0}^{\infty} \{-\phi[i_{t+i} - \pi_{t+1}] + g_{t+i}\} \quad (17)$$

as the equation (17) makes transparent the degree to which beliefs about the future affect current output

- the output gap depends not only on the current real rate and the demand shock, but also on the expected future paths of these two variables
- to the extent monetary policy has leverage over the short term real rate due to nominal rigidities, equation (16) suggests that expected as well as current policy actions do matter
- the 'Phillips curve' evolves from staggered nominal price settting, in the spirit of Fischer (1977)
- a key difference is that the individual firm price decision is derived from an explicit optimization problem
- the starting point is an environment with monopolistically competitive firms: when it has the opportunity, each firm chooses its nominal price to maximize profits
- under standard scenario, each period the fraction $1/X$ of firms set prices for $X > 1$ period
- however, aggregating the decision rules of firms who are setting prices on a staggered basis is quite difficult
- for this reason, for the derivation of the 'Phillips curve' an assumption due to Calvo (1983) is applied: in any given period a firm has a fixed probability ω it must hold its price fixed during

that period and, hence a probability $1-\omega$ that it may adjust

– accordingly, the average time over which a price is fixed is $\frac{1}{1-\omega}$; thus, for example, if $\omega = 0.75$, prices are fixed on average for a year

– the Calvo formulation thus captures the spirit of staggered setting, but facilitates the aggregation by making the timing of firms' price adjustment independent of its history

– since the equation (16) relates the inflation rate to the output gap and expected inflation, it has the flavour of a traditional expectations-augmented Phillips curve

– however, a key difference is that expected future inflation, $E_t\pi_{t+1}$ enters, as opposed to expected current inflation, $E_{t-1}\pi_t$

– the implications of this distinction are critical: to see, iterate (16) forward to obtain

$$\pi_t = E_t \sum_{i=0}^{\infty} \beta^i [\gamma x_{t+i} + u_{t+i}] \qquad (18)$$

in contrast to the traditional Phillips curve, there is no arbitrary inertia or lagged inflation

– rather, inflation depends entirely on current and expected future economic conditions

- the model forward-lookingness is implied by rational expectations hypothesis, which implies that the history does not matter for the future

- however, the attempts to estimate (16) have not been successful and empirical research on inflation has generally found that when lagged inflation is added to (16), its coefficient is statistically and economically significant

- in order to capture the inflation persistence, it is common to augment the basic forward-looking inflation equation with the addition of lagged inflation

$$\pi_t = \gamma x_t + (1-\theta)\beta E_t \pi_{t+1} + \theta \pi_{t-1} + u_t \qquad (19)$$

- Fuhrer (1997b) finds little role for future inflation once lagged inflation is added; Rudenbusch(2002a) estimates (19) using U.S. data and argues that θ is on the order of 0.7, suggesting that inflation is predominantly backward-looking

- on the other hand, Gali and Gertler (1999) argue that standard output gap measures (employed by both Fuhrer and Rudenbusch), typically derived by detrending GDP, are poor proxies for the theoretically correct measure of the deviation from the flexible price equilibrium level of output

- Gali and Gertler (1999) argue that the model should be tested by estimating (16) directly using real marginal cost rather than using an output gap variable to proxy for marginal cost

- Christiano, Eichembaum and Evans (2001) derived the Phillips curve as (19) from firms' optimisation:
  - they make distinction between firms that reoptimize in setting their price and those that do not
  - similarly, in their formulation, each period a fraction $1-\omega$ of all firms optimally set their price
  - the remaining firms, however, do not hold their price constant, instead they adjust their price based on the average rate of inflation or on the most recently observed rate of inflation
  - both these yield Phillips curve as (19) and introduce inertia into the inflation process

Monetary Policy

- to close the model, nominal interest rate is taken as the instrument of monetary policy, as opposed to a money supply aggregate (money supply becomes an endogenous variable)

- Taylor (1993a) or Bernanke and Mihov(1998) show that this assumption provides reasonable description of Federal Reserve behavior

- basically, there are two ways how to derive the setting for the policy instrument:
  - first starts with specification of the central bank's objective function as for instance
$$L = \frac{1}{2} E_t \{ \sum_{i=0}^{\infty} \beta^i [\alpha x_{t+i}^2 + \pi_{t+i}^2] \} \qquad (20)$$
  - then using the model as constraint the optimal setting for the policy instrument is found minimizing the central bank's objective function
  - however, this becomes rather difficult once the model consists of more than just few equations
  - in addition to it, the resulting equation for interest rate setting becomes quite complicated and hard to interpret intuitively

- an alternative approach specifies an instrument rule directly
- the most famous of such instrument rules is the Taylor rule (Taylor 1993a)

$$i_t = \pi_t + 0.5x_t + 0.5(\pi_t - \pi^T) + r^* \qquad (21)$$

  where π^T was the target level of average inflation (Taylor assumed it to be 2%) and r^* was the equilibrium real rate of interest (Taylor assumed that this too was 2%)
- for general coefficients the Taylor rule is often written as

$$i_t = r^* + \pi^T + \alpha_x x_t + \alpha_\pi(\pi_t - \pi^T) \qquad (22)$$

- the nominal interest rate deviates from the level consistent with economy's equilibrium real rate and the target inflation rate if
  * inflation deviates from the target
  * the output gap is nonzero
- the α_π coefficient must satisfy so called Taylor principle ($\alpha_\pi > 1$), so that the nominal rate is changed more than one for one with deviation of inflation from the target
- a lower than one-for-one reaction of i_t does not ensure that the economy has a unique, stationary, rational expectations equilibrium

- two extensions of Taylor rule have been developed recently:
  - first, Clarida, Gali and Gertler (2000) have estimated Taylor rules for the Federal Reserve, the Bundesbank, and the Bank of Japan replacing actual inflation by expected future inflation so that the central bank is assumed to be forward-looking in setting policy
  - second, the basic Taylor rule when supplemented by the addition of the lagged nominal interest rate, does quite well in matching the actual behaviour of the policy interest rate
- then, the general policy rule takes the form as

$$i_t = \delta i_{t-1} + (1-\delta)[r^* + \pi^e_{t+\tau} + \alpha_x x_t + \alpha_\pi(\pi^e_{t+\tau} - \pi^T)] \tag{23}$$

- the interpretation of the coefficient on the lagged interest rate has been subject of debate
  - it has been interpreted to mean that the central banks adjust gradually toward a desired interest rate level to avoid large changes in interest rates (financial market stability)
  - however, the view that central banks adjust gradually has been criticized; for instance, Rudenbusch (2002b) argues that the presence of lagged interest rate is result of imperfect information

about the degree of persistence in economic disturbances

- this induces behaviour that appears to reflect graduall adjustment, however, if the central bank followed rule for graduall adjustment the future changes in the policy rate would be predictable, which is not supported by empirical evidence

Summary

- most monetary models designed to address short-run monetary issues
  - assume that wages and/or prices do not adjust instantaneously in response to changes in economic conditions
  - assume that the central bank operates the nominal interest rate instead of money supply
  - and can be viewed as linear approximation to fully specified general equilibrium models based on optimizing behaviour of households and firms

- however, one important omission must be mentioned; the analysis has so far dealt only with closed economy while monetary policy can affect the economy through additional chanels once the linkages between economies are recognized

- Lectures XI and XII deal with these issues