Sensorveiledning: Exam-spring 2006: ECON 4325 Monetary policy and business fluctuations

The exam consists of two parts: A and B. Both parts carry equal weights. You should answer both parts.

Part A consists of four questions, of which you shall answer three. You can choose yourself which question you will leave out. Answer briefly, intuitively and precisely. Part B consists of one question. Answer in depth and in detail.

PART A

Question 1
Define potential output and the output gap. Explain briefly how one can extract both components from the data.

<u>Define</u>
In a situation where employment is high compared to the total labour force and the available capital is fully used, there will be a tendency that price and wage growth picks up, (and vice versa when there are available resources). That means that at all time, there will be a level on the use of resources that will be compatible with a stable development in prices and wages. The corresponding level for production is usually called *potential production*. The deviation between actual production and potential production is given by the *output gap*. If actual production increases above the potential, output gap will be positive. This implies that there are pressures in the economy, which isolated will imply higher inflation. A negative output gap implies available resources which isolated will imply falling inflation.

<u>Extract components</u>
Need to say something about how to measure the trend in the data. Need to take an explicit stand on the data generating process. A good answer should briefly discuss the difference between deterministic trend and stochastic trend. Trend need to be consistent with the underlying tine series properties in the data (i.e. test for unit root). Most data have a unit root so need to use a stochastic trend. Examples are Hodrick-Prescott (HP) filter, Beveridge Nelson, Unobserved Components methods etc. In most of these methods, the output gap will be the difference between actual data and trend. Cycles will not be invariant to how one describes the trend component in the data.
Note, different methodologies may give different output gaps. Inappropriate detrending may give rise to spurious cycles.

Question 2
Discuss to what extent a standard Real Business Cycle (RBC) model driven by technology shocks and intertemporal substitution of leisure is able to generate the joint behaviour (positive correlation) of real wages, employment and output that is observed over the business cycle.

To answer this one could refer to the model put forward in the lecture (two-period model where leisure is in the utility). Maximization would give an expression relating relative labor supply between two periods to relative wages between the periods and elasticity of substitution.

RBC theory stresses the pro-cyclicality of real wage rate and claims that the supply of labour is strongly positively related to transitory movements in the real wage rate.

Hence, to be able to generate positive correlation we need a) high elasticity of substitution between leisure in two periods b) Movements in aggregated real wage should be temporary.

Critique:

- Empirically the pro-cyclicality of real wages is not very clear. Incentives to substitute intertemporarily are weak.
- 2/3 of variation in total hours employment take form as movements in and out of the labour force rather than adjustments in average hours work chosen
- Unemployed tend to work less than they want to (they tend to be off their assumed labour supply curves).
- The RBC model itself gives little persistence. Rely on a strongly autocorrelated and relatively volatile process for the productivity shocks. The variability and autocorrelation in output and other variables are mostly explained by the exogenous random variable. Output dynamics are essentially the same as impulse dynamics.

Question 3

Briefly discuss how one can solve the problem of dynamic inconsistency of a discretionary monetary policy. Why may it be beneficial for an inflation targeting central bank to commit itself to a certain interest rate path (i.e. publishing interest rate prognosis like Norges Bank has recently done)?

<u>Define dynamic inconsistency of a discretionary monetary policy (inflation bias) briefly</u>
Walsh, chapter 8.1 for brief introduction.

<u>Solve problem</u>
The problem of inflation bias can only be eliminated by having authorities that actually does what they are expected to, and resist the temptation of setting higher money growth rates. Possible elimination methods (explain briefly):

- Reputation
- Preferences – delegating to conservative central banker
- Contracts,
- Institutional structure
- Explicit targeting rules

Endogenous interest rates: Another time inconsistency problem (Clarida, Gali, Gertler). Inflation expectations and price setting depends on current and expected future monetary policy.

- If a cost shock occurs, the central bank may dampen the increase in inflation expectations by raising the interest rate now, and by promising to raise interest rates in the future. (By promising to raise interest rates in the future, the contemporaneous interest rate can be increased less).
- However, in the future, in may no longer be optimal for the central bank to follow its promise and set the high interest rates.
- If private agents realize this, a much larger interest rate is required now. May therefore be beneficial for the central bank to commit itself to a certain interest rate path
- Argument for central bank publishing an interest rate prognosis, as recently done by Norges Bank (and in New Zealand before this)

Question 4

Explain the main differences between a targeting regime and an instrument rule. Briefly emphasize the transmission channels for monetary policy that exist in an open inflation-targeting economy (like Norway).

Instrument rules

Set interest rates directly, e.g. Taylor rule

$$i_t = \pi^T + \overline{r} + \alpha(\pi_t - \pi^T) + \beta(\ln Y_t - \ln \overline{Y})$$

where π^T is the target inflation rate, Taylor rules do not match economic policy when using data actually available at the time policy was conducted (not revised data).

Optimal values of the rule can be obtained when the CB can commit to the rule.

Alternative rules (i.e. the Orphanides rule, rule with interest abroad etc.)

Implication of different rules

Targeting regimes

A targeting regime, in which the CB is assigned an objective, is defined by 1) The variables in the CB's loss function (objectives) and 2) the weights assigned to these objectives, with policy implemented under discretion to minimize the expected discounted value of the CB's loss function.

Alternative targeting regimes; Inflation targeting, price level targeting, nominal income growth targeting regimes, average inflation targeting etc.

Inflation targeting
The objective function of the CB can take the form:

$$L = E\left[(\pi - \pi^T)^2\right] + \lambda E\left[(y - y^*)^2\right]$$

where π^T is the target inflation rate, y* is the natural rate of output and λ is the weight assigned to achieving the output gap objective relative to the inflation objective, (λ=0, strict inflation targeting, λ>0, flexible inflation targeting).

If policy decisions in time t only affect future values of inflation and output, then the CB must rely on forecasts.

Is inflation targeting, an (instrument) rule or constrained discretion?

- Many central banks that target inflation does not only control inflation, but try to smooth output fluctuations and keep exchange rates and interest rates stable.
- Target is often low and within a range of a few percentage points.
- Central banks in inflation targeting countries place more weight on the behaviour of inflation than other central banks do.
- Central banks aim for lower inflation than previously.
- Inflation targeting matters (credibility, transparency and accountability)

<u>Transmission mechanisms of monetary policy in open economies</u>
Expenditure channel: A contractionary monetary policy that increases the interest rate lowers output and other real variables temporarily. Minimum after a year. Inflation and real wage fall significantly, reaches minimum after 2-3 years.
Exchange rate channel: Strong evidence of an interaction between monetary policy and exchange rates. Hence, the exchange rate is an important transmission mechanism. For Norway: The exchange rates appreciates immediately. No evidence of delayed overshooting.
Expectations: Woodford: Get the expectations anchored at the target, most of the job is done.

PART B

Monetary policy operating procedures
Assume an IS-LM model that is represented by (1) an IS equation and (2) a LM equation:

$$y_t = -ai_t + u_t \tag{1}$$
$$m_t = -bi_t + cy_t + v_t \tag{2}$$

where y_t is output, i_t is the interest rate, m_t is money supply and u_t and v_t are mean zero disturbances that are uncorrelated with each other and have variances given by $Var(u_t) = \sigma_u^2$, $Var(v_t) = \sigma_v^2$ respectively.

Assume policy makers objective is to minimize the variance of output deviations, given by the Loss function

$$E(y_t)^2, \tag{3}$$

where all variables have been normalized so that the economy's equilibrium level of output in the absence of shocks is $y=0$. Assume the following timing: The Central Bank decides on either m_t or i_t at the start of the period. The shocks then occur, determining the values of the endogenous variables.

a) *Derive the value of the loss function under both a money-supply operating procedure and an interest rate operating procedure.*

Rearrange (2) to get an expression for the interest rate:

$$i_t = \frac{1}{b}(cy_t + v_t - m_t)$$

Insert expression for interest rate into (1), rearrange with respect to output

$$y_t = -\frac{a}{b}(cy_t + v_t - m_t) + u_t$$
$$\Leftrightarrow$$
$$(1 + \frac{ac}{b})y_t = -\frac{a}{b}(v_t - m_t - \frac{b}{a}u_t)$$
$$\Leftrightarrow$$
$$y_t = \frac{a(m_t - v_t) + bu_t}{b + ac}$$

The value of the objective function under a money supply procedure:

$$E_m(y_t)^2 = E\left(\frac{a(m_t - v_t) + bu_t}{b+ac}\right)^2 = \left(\frac{a^2\sigma_v^2 + b^2\sigma_u^2}{(b+ac)}\right)$$

Since the normalisation of y=0, requires i=m=0. Under an interest rate procedure, place the IS-equation directly into the objective function. Set i_t such that $E(y_t)=0$, hence output will equal u_t and the loss function equals:

$$E_i(y_t)^2 = E(-ai_t + u_t)^2 = \sigma_u^2$$

b) *Show and explain why* $E(y_t)^2$ *is minimised when* $m_t=0$ *under a money-supply operating procedure and* $i_t=0$ *under an interest rate operating procedure.*

Minimize with respect to money supply (the policy instrument)

$$\partial E_m(y_t)^2 / \partial m = 2E\left(\frac{a(m_t - v_t) + bu_t}{b+ac}\right)a = 0$$

If this expression is equal to zero, the nominator in the bracket needs to be zero. Hence:

$$2aE(a(m_t - v_t) + bu_t) = 0 \ \ if \ \ m_t = 0$$, as the shocks are iid

Minimize with respect to the interest rare (the policy instrument) yields:

$$\partial E_i(y_t)^2 / \partial i = 2E(-ai_t + u_t)(-\alpha) = 0 \quad \text{if } i_t=0$$

c) *Under what conditions is an interest rate operating procedure preferred to a money-supply operating procedure? Interpret your results. What procedure is preferable if the income elasticity of money demand is large?*

Loss function under an interest rate procedure is less than the loss function under a money supply procedure if:

$$E_i(y_t)^2 < E_m(y_t)^2$$
$$\Leftrightarrow$$
$$\sigma_u^2 < \frac{a^2\sigma_v^2 + b^2\sigma_u^2}{(b+ac)^2}$$
$$\Leftrightarrow$$
$$2bac\sigma_u^2 + (ac)^2\sigma_u^2 < a^2\sigma_v^2$$
$$\Leftrightarrow$$
$$\sigma_v^2 > (c^2 + 2bc/a)\sigma_u^2$$

Interest rate procedure preferred if variance of money demand shocks σ_v^2 large, LM curve steeper (slope 1/b) and the IS curve flatter (slope (-1/a). Money supply procedure preferred if variance of aggregate demand shocks σ_u^2 is large etc.

Money supply procedure preferable if the income elasticity of money demand is large.

Further, assume instead that the shocks are now serially correlated (but still uncorrelated with each other):

$$u_t = p_u u_{t-1} + \varepsilon_t \qquad (4)$$
$$v_t = p_v v_{t-1} + \gamma_t \qquad (5)$$

where ε_t and γ_t are white noise processes.

d) *Derive the optimal value of m_t that minimises the loss function under a money-supply operating procedure, and, the optimal value of i_t that minimises the loss function under an interest rate operating procedure. Interpret the results and compare the results with those in question (b).*

Use the minimization with respect to money supply (the policy instrument) from above, but replace the shock-terms (v and u) with the serial correlation-expressions:

$$\partial E_m (y_t)^2 / \partial m = 2E\left(\frac{a(m_t - v_t) + bu_t}{b + ac}\right) a = 0$$

$$2aE(a(m_t - v_t) + bu_t) = aE(m_t - v_t) + bu_t = 0$$

The value of the money supply that minimizes the loss function is therefore:

$$m_t = p_v v_{t-1} - (b/a) p_u u_{t-1}$$

Minimize with respect to the interest rate (the policy instrument) and replace the shock-term u with the serial correlation-expressions above, the value of the interest rate that minimizes the loss function is therefore::

$$\partial E_i (y_t)^2 / \partial i = 2E(-ai_t + u_t)(-\alpha) = 0 \rightarrow i_t = \frac{p_u}{a} u_{t-1}$$

Because the optimal policy will involve trying to insulate output from the two shocks Under certainty equivalence the optimal policy simply replaces u_t and v_t with the best **forecast** of the shocks, $\rho_u u_{t-1}$ and $\rho_v v_{t-1}$.