Question 1: Monetary Policy Rule and the zero nominal bound

We have considered the monetary policy rule of the form

$$i_t = \bar{i} + \gamma_\pi (\pi_t - \pi^*) + \gamma_y \left(\ln Y_t - \ln \overline{Y}_t \right) + \mu_t \tag{1}$$

where $\bar{i}$ is the natural interest rate, π^* is the inflation target that the central bank aims to credibly implement, $\ln \overline{Y}_t$ is the natural rate of output that would prevail in the absence of price stickiness, and μ_t is a monetary policy shock that reflects a discretionary deviation from the policy rule.

1. In the context of this policy rule, what does it mean to hit the zero nominal bound?

   Answer: *The zero nominal bound in this policy rule means that the central bank can not set the nominal interest rate, i_t, lower than zero. (5 points)*

2. Suppose you hit the zero nominal bound and inflation, as well as inflation expectations are both negative, i.e. $\pi_t < 0$ and $E_t \pi_{t+1} < 0$. What is the value of the real interest rate in that case?

   Answer: *According to the Fisher identity, the real interest rate, r_t, equals the nominal interest rate minus inflation expectations. That is*

   $$r_t = i_t - E_t \pi_{t+1}. \tag{2}$$

   If the central bank hits the zero nominal bound, such that $i_t = 0$, but households expect prices to decline, such that $E_t \pi_{t+1} < 0$, then there still might be a substantially positive real interest rate, because the real interest rate in that case equals

   $$r_t = -E_t \pi_{t+1}. \tag{3}$$

   (5 points)

3. Can monetary policy be used to further stimulate short-run economic activity once the zero nominal bound has been reached?

   Answer: *Once the zero nominal bound is reached, the only way that the central bank can stimulate short-run economic activity is by taking "unconventional" actions that prop up short-run inflation expectations and thus lower the real interest rate in that way. Of course, this comes at the trade off that, to maintain its credibility, the central bank needs to communicate that π^* is still its target inflation rate. Thus pinning down longer-run inflation expectations at π^*. (5 points)*

4. What could you do to the announced inflation target π^* to reduce the likelihood of hitting the zero nominal bound?

   Answer: Since it is the real interest rate, r_t, that matters (most) for the

allocation of resources in the economy, the steady state nominal interest rate

$$i_t = r_t + \pi^*. \tag{4}$$

Hence, the higher the inflation target, the more stimulus, in terms of the real interest rate, the central bank can provide before hitting the zero nominal bound. This suggests that, if the zero nominal bound turns out to be a severe constraint on policy, the central bank could consider raising π^*. Of course, raising π^* will come at the cost of credibility for the policymaker. Moreover, this argument ignores other costs of higher inflation. (5 points)

Question 2 Fiscal policy

We considered two dynamic budget constraints. The first was the household sector's budget constraint

$$\int_{t=0}^{\infty} e^{-R(t)} C(t)\, dt = K(0) + D(0) + \int_{t=0}^{\infty} e^{-R(t)} \left[W(t) - T(t)\right] dt.$$

The second was the government's budget constraint

$$\int_{t=0}^{\infty} e^{-R(t)} G(t)\, dt = -D(0) + \int_{t=0}^{\infty} e^{-R(t)} T(t)\, dt.$$

Here

- $K(0)$ is the initial capital stock in the economy
- $D(t)$ real government debt at time t
- $C(t)$ real consumption purchases at time t
- $G(t)$ real government purchases at time t
- $T(t)$ real net tax revenue at time t
- $r(t)$ real interest rate at time t
- $W(t)$ is real income of the household sector at time t
- $R(t) = \int_{\tau=0}^{t} r(\tau)\, d\tau$ is the compounded discount factor at time t

1. What does $D(0)$ represent in both the household sector's budget constraint as well as in the government budget constraint.

   Answer: $D(0)$ *is the initial level of debt that the government sector owes the household sector in this economy. (3 points)*

   We solved the government budget constraint under the No-Ponzi-Scheme condition

$$\lim_{s \to \infty} \int_{t=0}^{s} e^{-R(t)} D(t)\, dt = 0.$$

2. Explain what this No-Ponzi-Scheme condition means and why we assume it for the derivation of the government budget constraint.

   Answer: *This condition means that the government can not finance all future debt repayments by issuing new debt. Suppose it does (and for simplicity assume that it runs a balanced budget from time* 0 *onwards), then the path of government debt follows the following differential equation*

$$\dot{D}_t = r_t D_t. \tag{5}$$

   Solving this yields that

$$D_t = e^{R(t)} D(0). \tag{6}$$

   This implies that the above conditions does not hold because the present discounted value of the debt does not go to zero. If this was the case in this economy the household sector would not want to lend to the government sector. Normally, it would lend in anticipation of the future consumption flow it gets from the repayment of the debt. However, if the government keeps on paying off the debt by issuing new debt then this future consumption flow will never occur. Hence, the household sector would have no incentive to borrow to the government in such a case. (3 points)

3. Interpret the current Greek government debt crisis in the context of this No-Ponzi-Scheme condition.

   Answer: *The Greek debt burden is currently so high that financial markets doubt that Greece will be able to pay off its debt from tax revenue. The result is that financial markets expect that there is a chance that Greece either does not pay off its debt or simply continuously rolls it over, as in a Ponzi scheme. In either case there is a substantially reduced incentive to lend to Greece. (3 points)*

4. Combine the two budget constraints above to obtain the aggregate budget constraint for the whole economy.

   Answer: *The aggregate budget constraint can be derived by realizing that*

$$\begin{aligned}
\int_{t=0}^{\infty} e^{-R(t)} C(t)\, dt &= K(0) + D(0) + \int_{t=0}^{\infty} e^{-R(t)} \left[W(t) - T(t)\right] dt \\
&= K(0) + \int_{t=0}^{\infty} e^{-R(t)} W(t)\, dt - \left[\int_{t=0}^{\infty} e^{-R(t)} T(t)\, dt - D(0)\right] \\
&= K(0) + \int_{t=0}^{\infty} e^{-R(t)} W(t)\, dt - \int_{t=0}^{\infty} e^{-R(t)} G(t)\, dt,
\end{aligned}$$

   such that

$$\int_{t=0}^{\infty} e^{-R(t)} C(t)\, dt + \int_{t=0}^{\infty} e^{-R(t)} G(t)\, dt = K(0) + \int_{t=0}^{\infty} e^{-R(t)} W(t)\, dt.$$

   (4 points)

5. Use this aggregate budget constraint to explain why the choice whether to finance current government expenditures through the issuance of debt or the generation of tax revenue does not matter for the overall level of economic activity in this economy.

   Answer: *This budget constraint shows that the households' lifetime budget constraint does not depend on the way the government finances it purchases. It only depends on the present discounted value of government purchases, i.e. on* $\int_{t=0}^{\infty} e^{-R(t)} G(t)\, dt$. *Because the households' budget constraint does not depend on the way the government finances its spending neither do the households' consumption decisions. (3 points)*

6. Discuss three different assumptions that deviate from the framework above under which the government's financing decision of its spending would affect economic activity. Be specific about which assumptions that we made to derive the result above would be violated and whether debt financing of government expenditures would increase or decrease overall economic activity.

   Answer: *Here are three of many possible violations of the assumptions: (i) the derivation assumes that the households and the government pay the same interest rate on their debt. In reality governments tend to pay lower rates than households and businesses. In this case deficit spending by the government has the potential to increase overall economic activity. (ii) The derivation assumes that households and governments are infinitely lived and forward looking. In an overlapping generations setup where parents discount their kids future higher than their own, deficit spending could increase consumption since the parents do not care that much about their children having to pay off the currently incurred government debt. (iii) We have assumed that government spending has no effect on the marginal product of labor and thus wages. Spending on infrastructure, for example, seems to increase economywide productivity and would actually affect the righthand side of the overall budget constraint. (4 points)*