Question 1: Monetary Policy Rule and the Great Inflation of the 1970's

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.

In the 1970's we faced a situation in which inflation rates were persistently very high in many industrialized countries and output growth was relatively low. Because of the former, this episode is often referred to as the "Great Inflation of the 1970's." This question asks you to explain three different interpretations of the causes of the great inflation.

1. **Dynamic inconsistency and lack of credibility** Kydland and Prescott (1977) argue that the great inflation of the 1970s might be a result of central banks continuously exploiting the short-run output inflation trade off and that this will reduce their credibility. How can Kydland and Prescott's explanation be interpreted in terms of the monetary policy rule (1)? Give your explanation in terms of changes in the parameters of the policy rule.

   Answer: *Kydland and Prescott argue that if the central bank continuously use a discretionary deviation from the policy rule to exploit the output inflation trade-off, then firms and consumers will not believe that the central bank is really aiming to stabilize the economy around* π^* *and* $\ln \overline{Y}_t$*. That is, if the central bank continously chooses* $\mu_t < 0$ *then inflation expectations by private agents in the economy will increase to above* π^* *and the effect of monetary policy on output will be reduced. (8 points)*

2. **Uncertainty about the output gap** Orphanides (2002) argues that the great inflation could have been caused by the central bank following the policy rule (1) but implementing it incorrectly because of uncertainty about the size of the output gap. How can Orphanides' explanation be interpreted in terms of the monetary policy rule (1)? Give your explanation in terms of changes and measurement error in the parameters of the policy rule.

   Answer: *Orphanides (2002) argues that in the 1970's trend output growth decline (this is known as the productivity slowdown of the 1970's). However, it took central banks time to realize there was a change in trend. As a result they imputed too high a level of potential output,* $\ln \overline{Y}_t$*. They therefore thought that* $\ln Y_t - \ln \overline{Y}_t$ *was much more negative than it actually was. As a result they took an overly accomodative monetary policy stance which led to inflation rather than output growth. (8 points)*

3. **Passive monetary policy** Another explanation is that the central banks in many countries during the 1970's pursued passive monetary policy. In terms of the parameters of (1) what is passive monetary policy and how can it lead to inflation and inflation expectations getting out of hand?

   Answer: *Passive monetary policy exists when $\gamma_\pi < 1$. In that case the central bank does not increase the nominal interest rate enough in response to inflation to get the desirable effect on the real interest rate. For example, if in that case inflation increases then the real interest rate, approximated by $i - \pi_t$, decreases. Hence, in response to overheating of the economy the central bank does not increase interest rates enough to increase the incentives to save and, therefore, slow down economic activity. In this case, inflation expectations are not pinned down. That is, if people expect future inflation and therefore increase their current prices, then the central bank reduces the real interest rate, causing an increase in economic activity and as a result causes inflation that confirms the private agents' expectations. (4 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 at time 0. (2 points)*

2. Combine these two budget constraints 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

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

   (2 points)

3. 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. (4 points)*

4. 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)

Governments can not only finance their expenditures through tax revenue or issuing debt, they can also finance them by printing money. The generation of such seignorage revenue comes at the cost of inflation, however.

5. Use the equation for the demand for real money balances that underlies the LM-Curve in the IS-LM model to illustrate why inflation can, in principle, be interpreted as a distortionary tax on moneyholdings.

   Answer: *Using, the Fisher Identity that relates the nominal interest rate, i_t, to the real interest rate, r_t, and inflation, π_{t+1}, we can write the demand for real moneybalances in the IS-LM-model as*

$$\frac{M(t)}{P(t)} = L(r_t + \pi_{t+1}, Y_t).$$

   Hence as inflation increases π_{t+1} the opportunity cost of holding money increases. Because inflation is the per-period percentage decline in purchasing power of these moneybalances, this can actually be interpreted as a tax (here inflation is the tax rate and real money balances are the tax base). Since this tax distorts the marginal costs and marginal benefits of holding money, it will thus affect the choice of real moneybalances. Therefore, it is a distortionary tax. In particular, the higher (expected) inflation the fewer real money balances households will tend to hold. (4 points)

   In recent years, the government of Zimbabwe has, almost exclusively, relied on seignorage revenue to finance its expenditures. Table lists five data points on the Zimbabwean level of money supply and the price level, as well as three derived columns with the annualized inflation rate, the change in the nominal moneybalances and the change in the real moneybalances. The nominal amounts are all in the Zimbabwean Dollar.

6. Did Zimbabwe ever hit the downward-sloping part of the moneydemand Laffer Curve? If so, when and at what inflation rate? Be specific about from which statistics in the table you derive your answer.

   Answer: *The Laffer Curve relates real tax revenue, in this case real seignorage revenue, given by $(\mathbf{M}_t - \mathbf{M}_{t-1})/\mathbf{P}_t$, to the tax rate, in this case π_t. The downward sloping part of the Laffer Curve is the part where the tax revenue is decreasing in the tax rate. In Zimbabwe this seems to have happened for seignorage revenue between March 2008 and June 2008*

Table 1: Hyperinflation in Zimbabwe

Date	$\mathbf{M}_t$	$\mathbf{P}_t$	π_t annualized	$(\mathbf{M}_t - \mathbf{M}_{t-1})$	$(\mathbf{M}_t - \mathbf{M}_{t-1})/\mathbf{P}_t$
Sep 2006	3.5×10^{10}	83	-	-	-
Nov 2007	6.7×10^{13}	642	565%	6.70E+13	1.04E+11
Dec 2007	1.0×10^{14}	1000	20298%	3.30E+13	3.30E+10
Mar 2008	2.5×10^{16}	8260	465401%	2.49E+16	3.01E+12
Jun 2008	1.0×10^{18}	442000	819915006%	9.75E+17	2.21E+12

when inflation exceeded half a million percent at an annualized rate. (4 points)