Week 8: Fiscal policy in the New Keynesian Model

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1 Fiscal Policy in a New Keynesian Model

1.1 Positive analysis: the effect of fiscal shocks

- How do fiscal shocks affect inflation?
- See Summers & Calvo discussion (blog FT.com)
- UK potential fiscal stimulus.
- "Fiscal Policy should be used when constrained Monetary Policy cannot react to fall in activity"
- "Treasury fiscal stimulus would prevent central bank to lower rates"
• Can fiscal policy be used as an instrument to boost economic activity?
• What are the implications for inflation?
1.2 Positive analysis: the effect of government expenditure shocks

- Suppose that government consumption is financed by lump sum taxes
- Household aggregate budget constraint (in real terms):

\[ Y_t = C_t + T_t \]

where \( T_t \) denotes lump sum taxes

- Government resource constraint:

\[ G_t = T_t \]

- So economy-wide market clearing
\[ Y_t = C_t + G_t \]

- The economy-wide resource constraint is given by

\[ \hat{y}_t = (1 - s_g) \hat{c}_t + s_g \hat{g}_t \]

where \( s_g = G/Y \). (slightly different specification than in previous lectures)

- If one wants to allow for zero steady-state government consumption - define

\[ \tilde{g}_t = (G_t - G)/Y = G_t/Y \] - then obtain

\[ \hat{y}_t = \hat{c}_t + \tilde{g}_t \]
**The supply side effect**

- For any given level of output, fiscal policy crowds out private consumption
- Lower consumption implies higher marginal utility of consumption
  \[ -\sigma \hat{c}_t = -\sigma \hat{y}_t + \sigma \tilde{g}_t \]
- Higher marginal utility implies higher labour supply and lower real marginal cost
  - Total cost (constant returns \( Y_t = N_t \))
    \[ W_t N_t = W_t Y_t \]
  - Marginal cost is \( W_t \), so real marginal cost, in log terms
    \[
    \hat{mc}_t = \hat{w}_t - \hat{p}_t = \sigma \hat{c}_t + \varphi \hat{n}_t \\
    = (\sigma + \varphi) \hat{y}_t - \sigma \tilde{g}_t
    \]
higher labour supply/lower marginal cost implies higher potential output
- With flexible prices, marginal cost is constant

\[ \tilde{y}_t^n = \frac{\sigma}{\sigma + \varphi} \tilde{g}_t \]

With sticky prices, the Phillips curve would be given by the usual equation

\[ \pi_t = \kappa \tilde{y}_t + \beta E_t \pi_{t+1} \]
The demand side effect

- As we have seen

\[
\hat{y}_t = \hat{c}_t + \tilde{g}_t
\]

- The Euler equation

\[
\hat{c}_t = E_t\hat{c}_{t+1} - \sigma^{-1}(\hat{i}_t - E_t\pi_{t+1})
\]

becomes

\[
\hat{y}_t - \tilde{g}_t = E_t(\hat{y}_{t+1} - \tilde{g}_{t+1}) - \sigma^{-1}(\hat{i}_t - E_t\pi_{t+1})
\]

or

\[
\tilde{y}_t = E_t\tilde{y}_{t+1} - \sigma^{-1}(\hat{i}_t - E_t\pi_{t+1} - \tilde{r}_t^n)
\]

where \( \tilde{r}_t^n = -\frac{\sigma\varphi}{\sigma + \varphi}E_t\Delta\tilde{g}_{t+1} \)
• So, a fiscal shock ($\tilde{g}_t$) increases the natural interest rate.

• Fiscal shock increases aggregate demand.

• ...But it also increases supply.

• The net effect on inflation depends on the central bank response.
  
  – Can you already infer the policy prescription of a central bank that wants to maintain price stability?
  
  – This is given by $\hat{r}^n_t$: the interest rate that is consistent with constant prices increases after an increase in g.exp. $\Rightarrow$ so, the central bank that wants to maintain inflation has to raise interest rates to contain the increase in demand and inflationary pressures.
- Taylor rule that responds to the output gap and inflation with $\phi_y = 1$ and $\phi_\pi = 1.5$ : Real rate increase by less than the natural rate $\rightarrow$ shock is inflationary
Exercise:

(A) Assume that the shock is iid.
   - A.1) Derive the reduce form solution for interest rates and inflation as
         a function of the shock
   - A.2) How does this interest rate rule compared with one which guar-
         antees price stability?
   - A.3) Show that the larger $\phi_\pi$ the larger is the interest rate response to
         the shock and the lower is the inflation level.

(B) Assume that the shock is an AR(1) with coefficient $\rho = 0.9$ and code
    the model in Dynare or Matlab
   - Is it still the case that the larger $\phi_\pi$ the larger the nominal interest rate
     response? What about inflation?
   - Can you explain this result?
1.3 Positive analysis: the effect of income tax shocks

• What are the effects of income taxes?

• Suppose that the government taxes income and redistribute in lump sum transfers
  – Government budget constraint:
    \[ \tau_t^l Y_t = T_t \]
    where \( \tau_t^l \) denote income taxes
  – Aggregate household budget constraint:
    \[ (1 - \tau_t^l)Y_t + T_t = C_t \]
  – Aggregate resource constrain in log linear terms:
    \[ Y_t = C_t \text{ and } \hat{y}_t = \hat{c}_t \]
• Taxes will affect agent’s labour leisure decision

\[
\max U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[ \frac{C_s^{1-\sigma}}{1-\sigma} - \frac{N_s^{1+\varphi}}{1+\varphi} \right],
\]

subject to

\[
\int_{0}^{1} C_t(j) P_t(j) \, dj + Q_t B_t \leq B_{t-1} + (1 - \tau_t^l) W_t N_t - T_t
\]

• it decreases the supply of labour for each unit of real wage

\[
- \frac{U_n(C_t; N_t)}{U_c(C_t; N_t)} = (1 - \tau_t^l) \frac{W_t}{P_t}
\]

– This, ceteris paribus, increases real marginal cost

\[
\tilde{m}c_t = \tilde{w}_t - \tilde{p}_t = \sigma \tilde{c}_t + \varphi \tilde{n}_t + \tau_t^l
\]

for simplicity we also assumed that taxes are zero in steady state
Thus:

\[ \hat{y}_t^n = \frac{-1}{\sigma + \varphi} \tau_t \]

An increase in taxes works as a negative supply shock and does not have any effect on demand.
1.4 Positive analysis: fiscal policy

- What are the effects of government spending finance by income taxes?
  - Government budget constraint:
    \[ \tau_t^l Y_t = G_t \]
    maintaining the zero-state assumptions
    \[ \tau_t^l = \tilde{g}_t \]
  - Aggregate household budget constraint:
    \[ (1 - \tau_t^i)Y_t = C_t \]
  - So economy-wide market clearing in log linear terms
    \[ \hat{y}_t = \hat{c}_t + \tilde{g}_t \]
– Marginal cost

\[
\hat{mc}_t = \hat{w}_t - \hat{p}_t = \sigma \hat{c}_t + \varphi \hat{n}_t + \tau^l_t
\]

\[
= (\sigma + \varphi)\hat{y}_t - \sigma \tilde{g}_t + \tau^l_t
\]

\[
= (\sigma + \varphi)\hat{y}_t + (1 - \sigma)\tilde{g}_t
\]

– Potential output

\[
\hat{y}^n_t = \frac{(1 - \sigma)}{\sigma + \varphi} \tilde{g}_t
\]

– This fiscal policy has a dubious effect on supply and a positive effect on demand.
1.5 Normative analysis: Fiscal Policy and Welfare

- Policy instruments: Public spending, Lump-sum taxes, Income taxes, Inflation tax

- Inflation may be viewed as a tax from different points of view
  - government can finance their expenditure via seigniorage
  - or inflation can deflate the real value of public debt, improving its financing conditions

- But which tax is more costly? Inflation tax, income tax, etc.

- Income taxes are costly because they affect agents labour leisure decision (distort the incentives of agents to work an extra hour)

- Lump sum transfers are not costly, but are they feasible? Are they equitable?

- In an NK model, inflation is costly due to nominal rigidities
1.6 Normative analysis: Fiscal Policy and Welfare

1.6.1 What have we learned?

- Production Subsidy can improve welfare (Steady-state analysis)

- Efficient allocation

\[- \frac{U_n}{U_c} = MPN_t\]

- We know that monopolistic competition may lead to lower production (suboptimal employment):

\[P = \mathcal{M} \frac{W}{MPN}\]

\[- \frac{U_n}{U_c} = \frac{W}{P} = \frac{MPN}{\mathcal{M}}\]
• Production subsidy $\tau^s$ can increase production towards efficient level

$$\frac{U_n}{U_c} = \frac{W}{P} = \frac{MPN}{(1 - \tau^s)M}$$

• An income subsidy can increase labour supply towards it’s efficient level
1.7 Normative analysis: Fiscal Policy and Welfare

1.7.1 What have we learned?

- Apart from the steady state analysis: changes in government spending may introduce a trade-off between output and inflation when steady state is inefficient

- the policymaker’s problem:

$$\min E_0 \sum_{k=0}^{\infty} \beta^k \left[ \varepsilon (\pi_t)^2 + \kappa (\tilde{y}_t)^2 \right]$$

s.t

$$\pi_t = \kappa \tilde{y}_t + \beta E_t \pi_{t+1}$$
but the welfare relevant output gap is $\tilde{y}_t^w = y_t - y_t^t$, where

$$y_t^t = \frac{d\sigma g_t}{(\varphi + \sigma)} \neq y_t^n$$

(1)

Intuition: fiscal shock can reduce monopolist distortion (because, as we’ve seen, it increases potential output)
1.8 Normative analysis: Fiscal Policy and Welfare

1.8.1 Optimal fiscal policy

- Up to now we have looked at fiscal policy either in steady-state or as a shock.
- What about formulating an endogenous feedback rule for the fiscal instrument: i.e., how should taxes respond to shocks?
- What fiscal instrument: lump-sum taxes not realistic.
- State contingent income taxes?
- But income taxes are discretionary.
- The neoclassical literature on optimal fiscal policy has suggested that, when taxes are discretionary, welfare would be maximized if taxes are smoothed.
over time and across states of nature (see Barro, 1979 and Lucas and Stokey, 1983).

- In these models, if possible, taxes would be essentially invariant (see Lucas and Stokey, 1983 and Chari, Christiano and Kehoe, 1991)

- or would follow a random walk (see Barro, 1979, Aiyagari et al. 2002) when the fiscal authority is forced to move taxes to adjust its public finances
1.9 Normative analysis: Fiscal Policy and Welfare

1.9.1 Benigno and Woodford (2003): Optimal fiscal and monetary policy in a NK model

*The fiscal authority controls income taxes, issues nominal bonds (and one can also assume that the government faces exogenous expenditure streams)*

**Households - as before**

\[
\max U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[ \frac{C_s^{1-\sigma}}{1-\sigma} - \frac{N_s^{1+\varphi}}{1+\varphi} \right],
\]

where:

\[
C_t = \left[ \int_0^1 C_t(j) \frac{\epsilon-1}{\epsilon} dj \right] \frac{\epsilon}{\epsilon-1}
\]
subject to

\[
\int_0^1 C_t(j) P_t(j) \, dj + B_t \leq B_{t-1}(1 + i_{t-1}) + (1 - \tau_t)W_t N_t - T_t
\]

1. Optimal allocation of expenditures

\[
c_t(j) = \left( \frac{p_t(j)}{P_t} \right)^{-\varepsilon} C_t
\]

2. Labour leisure decision

\[
\frac{U_n(C_t; N_t)}{U_c(C_t; N_t)} = (1 - \tau_t) \frac{W_t}{P_t}
\]

3. Intertemporal decision

\[
Q_t = \beta E_t \left( \frac{U_{c,t+1}}{U_{c,t}} \frac{P_t}{P_{t+1}} \right)
\]
Firms— as before

- Optimal Price Setting

\[ \sum_{k} E_t \theta^k Q_{t.t+k} Y_{t+k,t} \left[ P_t^* - M \psi_{t+k,t} \right] = 0 \]

- Aggregate price dynamics

\[ P_t = \left[ \theta (P_{t-1})^{1-\varepsilon} + (1 - \theta) P_t^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \]
1.10 Government budget constraint

- the government issues one period nominal risk free bonds
- and collects taxes
- Government debt $D_t^n$, expressed in nominal terms, follows the law of motion:

$$D_t = D_{t-1}(1 + i_{t-1}) - P_t \tau_t^i Y_t$$

Or, we can define

$$d_t \equiv \frac{D_t(1 + i_t)}{P_t},$$

in order to rewrite the government budget constraint as

$$d_t = d_{t-1} \frac{(1 + i_t)}{\Pi_t} - \tau_t^i Y_t (1 + i_t)$$

- Inflation reduces the real value of government debt
2 A log-linear representation of the model

- Phillips Curve

\[ \pi_t = \kappa (\sigma \hat{c}_t + \varphi \hat{y}_t + \omega \hat{\tau}_t^l - (1 + \varphi)\hat{a}_t) + \beta E_t \pi_{t+1} \]

- as in the case of income taxes we’ve talked about, but here we allow for non-zero steady state taxes, so \( \omega = \bar{\tau}/(1 - \bar{\tau}) \)

- Resource constraint

\[ \hat{y}_t = \hat{c}_t \]

- IS curve

\[ \hat{c}_t = E_t \hat{c}_{t+1} - \sigma^{-1}(\hat{\tau}_t - E_t \pi_{t+1}) \]

- Government budget constraint (defining \( \tilde{d}_t \equiv (d_t - d)/Y \) and \( d_{ss} = d/Y \))

\[ \tilde{d}_t \beta = \tilde{d}_{t-1} - d_{ss} \pi_t + d_{ss} \beta \hat{i}_t - \tau (\hat{\tau}_t + \hat{y}_t) \]
3 Optimal Policy

First, exploring the policy implication of discretionary taxation (ignoring the sticky price distortion)

3.1 The case of Flexible Prices

When prices are flexible (that is, $\theta = 0$), the loss function derived in the previous section simplifies to:

$$\min U_c \tilde{C} E_{t0} \sum \beta^t \left[ \frac{1}{2} \Phi_Y \tilde{y}_t^w \right] + t.i.p.$$
Alternatively, using the relationship between discretionary taxes and output dictated by the Phillips curve, it is possible to rewrite the objective function as

$$\min U_c \tilde{C} E_t \sum \beta^t \left[ \frac{1}{2} \Phi_\tau \tilde{\tau}^2 + t.i.p + O(||\xi||^3) \right],$$

where $\Phi_\tau = -\frac{\omega}{\varphi + \rho} \Phi_Y$

- Under this specification, domestic producer inflation is not costly (the assumption that $\theta = 0$ implies that $\Phi_\pi = 0$), and policymakers’ incentives are only affected by tax distortions.

- The constraints of the policy problem are given by the equilibrium conditions presented before.

- Thus, the first order conditions implies that

$$\tilde{y}_t = \tilde{\tau}_t = 0.$$
• Since inflation is not costly, optimal policy can induce unexpected variations in domestic prices in order to restore fiscal equilibrium.

• This result is consistent with the findings of Bohn (1990), Chari, Christiano and Kehoe (1991) and Benigno and Woodford (2003).
• Show that if debt is zero in steady state, i.e. $d_{ss} = 0$ the government cannot fully stabilize taxes

• Taxes vary across states but they remain constant after the shock hits the economy.

• The best policy available entails a "jump" in the tax rate in order to adjust the level of primary surplus after the shock.

• Subsequently, taxes are kept constant as to minimize distortions in the consumption/leisure trade-off. That is, the optimal plan implies

$$E_t \Delta \tilde{y}_{t+1} = E_t \Delta \tilde{\tau}_t^{lw} = 0.$$  

(a similar rule would hold if $d_{ss} \neq 0$ but the government issued real bonds)

• Result consistent with Barro (1979)
3.2 The case of sticky prices

The policy problem

$$\min U_c \bar{C}E_{t_0} \sum \beta^t \left[ \frac{1}{2} \phi_\tau \widetilde{y}_t^{\nu w^2} + \phi_\pi \pi_t^2 \right] + t.i.p + O(||\xi||^3),$$

- Do not want to use inflation to adjust the fiscal conditions because inflation is costly
- Although there are two policy incentives and two policy instruments - that is, an active fiscal and monetary policy - the first best cannot be achieved.
- It’s not possible to keep simultaneously inflation and taxes constant across states and over time.
- Nor is it possible, as in the flexible price case, to move tax rates permanently (and smooth them in subsequent periods).
• By inspection of the Phillips curve we note that, when prices are sticky, a permanent change in taxes would imply a non stationary process for inflation (and an explosive path for the domestic price level).

• If we further assume that debt is zero in steady state, i.e. \( d_{ss} = 0 \), the optimal plan implies

\[
\omega E_t \Delta \tilde{\tau}_t^{iw} + k^{-1} \Phi \pi \pi_t = 0.
\]
3.3 Open economy

Introduce another distortion... optimize the use of instruments...

\[ L_{to}^i = U_c C E_t \beta \sum \beta^t \left[ \frac{1}{2} \Phi_Y \tilde{y}_t^2 + \frac{1}{2} \Phi_{RS} \tilde{s}_t^2 + \frac{1}{2} \Phi_\pi (\tilde{\pi}_t^H)^2 \right] + t.i.p, \quad (2) \]

If we further assume that debt is zero in steady state, i.e. \( d_{ss} = 0 \), the optimal plan implies

\[ \Phi_{rs} E_t \Delta \tilde{s}_{t+1}^w + \frac{(1 + l)}{\sigma(1 - \lambda)} \Phi_Y E_t \Delta \tilde{y}_{t+1}^w = 0, \]

and

\[ E_t \tilde{\pi}_{t+1}^H = 0 \]