Monetary Economics: Macro Aspects, 1/3 2004
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Plan for today:

1. Optimal taxation and seigniorage
2. Robustness of the Friedman rule?

Literature: Walsh (Chapter 4, pp. 172-187; pp. 192-195)

3. Plan for next lectures

Introductory remarks

From last lecture:

- Monetary and fiscal policy are linked through the budget constraint
- Ignoring this, may be valid if governments have access to lump-sum taxation and follow policies that fully back interest-bearing debt with taxes
- Otherwise, important channels from monetary policy to fiscal policy and vice versa may be overlooked, as the financing properties of inflation is ignored
- Also, it is important to stress that an observed change in monetary policy may or may not be due to fiscal considerations, and therefore have different implications for the real economy depending on the source of the change
- While a potential financing tool, one must be aware of the dangers of hyperinflation associated with reliance on seigniorage as a means of financing public expenditures

Now:

- *If* inflation is used as a tax What should its optimal value be?
- Is the Friedman rule robust, even under public finance considerations?
- Are there (other) circumstances under which inflation can be harmful when taxation is considered?

Optimal taxation and seigniorage

- Basic idea goes back to Phelps (1972): If inflation is a tax, then it should be used along "conventional" taxes in an optimal tax structure
- Optimal tax policies trade off the distortionary effects of various taxes (on savings, labour supply, etc.). So seigniorage should be part of that "optimal tax structure problem"! And this may call for the optimality of positive inflation to achieve seigniorage (so as to reduce the distortions from other taxes)
- This idea is examined in a simple partial equilibrium model due to Mankiw (1987)
- Assume exogenous stream of expenditures. Government issues debt, collects taxes and seigniorage (real interest rate is assumed constant)
- Government flow budget constraint:

$$g + Rb_{t-1} = \tau_t + s_t + b_t \qquad (4.41')$$

- Government's intertemporal budget constraint (as $\lim_{i\to\infty} R^{-i} b_{t+i} = 0$ is imposed: "No Ponzi-Games"):

$$Rb_{t-1} + \frac{R}{R-1} g = \mathrm{E}_t \left[\sum_{i=0}^{\infty} R^{-i} \left(\tau_{t+i} + s_{t+i} \right) \right] \qquad (4.43')$$

Debt liability plus interest and present value of current and future spending equals (expected) present value of current and future taxes and seigniorage

- Government choice: Set taxes and seigniorage (commit to a whole path for them) given the path of g and initial debt, and the intertemporal budget constraint
- Government's objective? An *ad hoc* specification of preferences: Government wants to **minimize** present value of the **distortions** arising from taxes and seigniorage
- These distortions are assumed to be stochastic and quadratic in taxes and seigniorage:
  - Per-period loss from tax distortions:

    $\frac{1}{2} \left(\tau_t + \phi_t \right)^2, \quad \phi_t$ is capturing stochastic shifts in tax distortions
  - Per-period loss from seigniorage distortions:

    $\frac{1}{2} \left(s_t + \varepsilon_t \right)^2, \quad \varepsilon_t$ is capturing stochastic shifts in seign. distortions
- Hence, objective is to minimize

$$\frac{1}{2} \sum_{i=0}^{\infty} R^{-i} \mathrm{E}_t \left[\left(\tau_t + \phi_t \right)^2 + \left(s_t + \varepsilon_t \right)^2 \right]$$

- Let λ be multiplier on intertemporal budget constraint. First order conditions become:

$$\mathrm{E}_t \left(\tau_{t+i} + \phi_{t+i} \right) = \lambda, \quad i \geq 0,$$
$$\mathrm{E}_t \left(s_{t+i} + \varepsilon_{t+i} \right) = \lambda, \quad i \geq 0,$$

- **Intra**temporal optimality: $E_t(\tau_{t+i} + \phi_{t+i}) = E_t(s_{t+i} + \varepsilon_{t+i}) = \lambda$
  - Marginal losses of distortions are *equalized* within each period
- Implication: If financing needs go up (e.g., g or b_{t-1} go up causing λ to go up), taxes and seigniorage move in *similar direction*
- **Inter**temporal optimality: $E_t(\tau_{t+i} + \phi_{t+i}) = E_t(\tau_{t+i+1} + \phi_{t+i+1})$ and $E_t(s_{t+i} + \varepsilon_{t+i}) = E_t(s_{t+i+1} + \varepsilon_{t+i+1})$
  - Marginal losses of each instrument equalized across periods. "Tax smoothing"
  - If $E_t\varepsilon_{t+1} = \varepsilon_t$, future seigniorage is unpredictable; i.e., follows a "random walk"
- Empirical evidence of Mankiw model mixed....
  - For some countries the positive relationship between taxes and seigniorage are present, for some not (in particular industrialized countries)
  - For some countries the (near) random walk behavior of inflation is observed in data; however, this could have other explanations
  - For U.S., seigniorage are linked to deficit rather than taxes
- Model is based on *ad hoc* government loss function; no explicit formulation of money demand, and thereby how distortions arise.....
  - A fully formulated model may provide more "restrictions" on optimal inflation; e.g., through its interaction with consumption changes

- Optimal seigniorage with temporary changes in financing needs?
- In model, taxes and seigniorage are linked to permanent changes in expenditures
- If extended to include temporary variation in expenditures, it will be optimal that these are met with changes in deficits (as these have no distortionary costs)
- But why would there be costs of temporary, unanticipated, seigniorage??
  - In MIU and CIA models, all distortions from inflation came from *anticipated* inflation (as this affected nominal interest rates)
  - Unanticipated inflation will just have income effects (through the budget); hence, non-distortionary
- Indeed, it can be shown in micro-founded model that optimal behavior has seigniorage responding temporarily to temporary changes in financing needs (in contrast with Mankiw's model). This is in accordance with the data from the US
  - ....(and shows importance of micro-founded models)

Robustness of the Friedman rule?

- Will public finance considerations render the Friedman rule invalid, as positive inflation necessarily will involve a positive nominal interest rate?
- The answer is "**maybe**," but surprisingly the Friedman rule may still be optimal in some circumstances
- To analyze the issue, one must move beyond the *ad hoc* model of optimal seigniorage with postulated distortions (in that type of model, positive seigniorage is optimal by definition!)
- Here focus is on the optimal inflation tax in a CIA and a MIU model

The Friedman rule in a CIA model

- Two consumption goods. A "cash" good (i.e., subject to a CIA constraint) and a "credit" good.
- Taxes on labor income and consumption goods (commodity taxes)
- For simplicity, no capital and a linear production technology
- Per-period utility function:

$$U\left(c_{1,t}, c_{2,t}, l_t\right)$$

$c_{1,t}$ is cash good and $c_{2,t}$ is credit good; l_t is leisure

- Budget constraint in nominal terms:

$$\begin{aligned} & \left(1+\tau^c\right) Q_t \left(c_{1,t}+c_{2,t}\right)+M_t+B_t \\ = & \left(1-\tau^h\right) Q_t \left(1-l_t\right)+\left(1+i_{t-1}\right) B_{t-1}+M_{t-1} \end{aligned}$$

τ^c is the commodity tax (*uniform* = identical on both goods); τ^h is wage tax; Q_t is producer price

- Let $P_t = \left(1+\tau^c\right) Q_t$ be consumer prices
- Let $w_t = \left(M_t + B_t\right)/P_t = m_t + b_t$ be total real wealth
- Budget constraint becomes:

$$\begin{aligned} c_{1,t}+c_{2,t}+w_t &= (1-\tau)\left(1-l_t\right)+\left(1+r_{t-1}\right) w_{t-1}-\frac{i_{t-1}}{1+\pi_t} m_{t-1} \\ (1-\tau) &\equiv \frac{\left(1-\tau^h\right)}{\left(1+\tau^c\right)} \end{aligned}$$

Note last term is seigniorage definition $\overline{s}$, relevant with this wealth definition

- CIA constraint is $c_{1,t} \leq \left(1+\pi_t\right)^{-1} m_{t-1}$
- Optimality condition guiding relative demand between the two consumption goods:

$$\frac{U_1\left(c_{1,t}, c_{2,t}, l_t\right)}{U_2\left(c_{1,t}, c_{2,t}, l_t\right)} = 1 + i_t$$

As in CIA model of Chapter 3, the CIA constraint is a tax on the "cash" good relative to the credit good

- Optimal tax structure?
- Famous result from public finance literature (Atkinson and Stiglitz, 1972): **Uniform commodity taxes are optimal when preferences are homothetic and weakly separable in leisure**
  - Homothetic utility: Any monotonic function of a function that is homogeneous of degree one in its arguments
  - Weakly separability implies that ratios of marginal utilities of everything but leisure, are independent of leisure
  - Example: $U(c_{1,t}, c_{2,t}, l_t) \equiv V[\varphi(c_{1,t}, c_{2,t}), l_t]$ where $\varphi(c_{1,t}, c_{2,t})$ is homogeneous of degree one in $c_{1,t}, c_{2,t}$
- Why does result hold? And why is it interesting here?
  - **Why does it hold:**
    * When utility is homogeneous of degree one, marginal utility is homogeneous of degree zero
    * Hence

$$\frac{\varphi_{c_1}(c_{1,t}, c_{2,t})}{\varphi_{c_2}(c_{1,t}, c_{2,t})} = \frac{\varphi_{c_1}(c_{1,t}/c_{2,t}, 1)}{\varphi_{c_2}(c_{1,t}/c_{2,t}, 1)} = f\left(\frac{c_{1,t}}{c_{2,t}}\right)$$

    * Hence the marginal rate of substitution between the goods determines the *ratio* of the goods, and this will be *independent of* leisure, and thus *income*!
    * Optimal to have the marginal rate of substitution equal to the relative price of goods = 1; hence producer prices should not be distorted by different commodity taxes — irrespective of the distortions taxes may have on income

  - **Why is this interesting here?**
    * Irrespective of the labour supply distortions or other income distortions caused by the tax system, optimality requires:

$$\frac{U_1(c_{1,t}, c_{2,t}, l_t)}{U_2(c_{1,t}, c_{2,t}, l_t)} = \frac{V_1[\varphi(c_{1,t}, c_{2,t}), l_t]\,\varphi_{c_1}(c_{1,t}, c_{2,t})}{V_1[\varphi(c_{1,t}, c_{2,t}), l_t]\,\varphi_{c_2}(c_{1,t}, c_{2,t})} = \frac{\varphi_{c_1}(c_{1,t}, c_{2,t})}{\varphi_{c_2}(c_{1,t}, c_{2,t})} = 1$$

    * We had before

$$\frac{U_1(c_{1,t}, c_{2,t}, l_t)}{U_2(c_{1,t}, c_{2,t}, l_t)} = 1 + i_t,$$

    and therefore $i_t = 0$ is the optimal monetary policy. The Friedman rule again!
    * No seigniorage will be optimal in the optimal tax mix under the assumptions about the utility function
    * It only distorts the demand away from cash goods

- Note: If there were no credit good, the result is even more general:
  - A positive nominal interest rate distorts the consumption-leisure trade-off
  - ...but government already has a (conventional) labor tax
  - ...so no need to use seigniorage as an "additional labor tax"

The Friedman rule in a MIU model

- Same procedure, and usual first-order condition guiding money versus consumption:

$$\frac{U_m(c_t, m_t, l_t)}{U_c(c_t, m_t, l_t)} = \frac{i_t}{1+i_t}$$

- So if utility is homothetic in c and m and weakly separable in l, then we have again that the social optimum is one where the marginal rate of substitution between money and consumption should equal the relative social price, **which is zero**

- Hence, $i_t = 0$ is optimal again under these restrictions on the utility function. The Friedman rule again.

- So, both in MIU and CIA models, one can restore the Friedman rule, albeit under some restrictions on the utility function (**note, however, that the specific utility functions typically used in quantitative models indeed satisfy these restrictions!**)

Inflation and an unindexed tax system: An example of negative consequences of inflation

- Usually, taxes are levied on nominal interest income on bonds and nominal capital gains on capital. Inflation can then **distort** the savings decision.

- In absence of taxes, budget constraint in nominal terms is

$$\begin{aligned} & P_t f(k_{t-1}) + (1+i_{t-1}) B_{t-1} + P_t T_t + P_t (1-\delta) k_{t-1} \\ = \; & P_t c_t + P_t k_t + B_t \end{aligned}$$

Nominal resources equal nominal outlays

- Reformulate left-hand side to be nominal current income *flow*:

$$\begin{aligned} & P_t f(k_{t-1}) + i_{t-1} B_{t-1} + P_t T_t + (P_t - P_{t-1})(1-\delta) k_{t-1} \\ = \; & P_t c_t + P_t k_t - P_{t-1}(1-\delta) k_{t-1} + B_t - B_{t-1} \end{aligned}$$

- Assume this nominal income is taxed by τ; constraint then becomes:

$$\begin{aligned} & (1-\tau)\left[P_t f(k_{t-1}) + i_{t-1} B_{t-1} + P_t T_t + (P_t - P_{t-1})(1-\delta) k_{t-1}\right] \\ = \; & P_t c_t + P_t k_t - P_{t-1}(1-\delta) k_{t-1} + B_t - B_{t-1} \end{aligned}$$

(note mistake in Walsh p. 192: he has $P_t(1-\delta) k_{t-1}$ on right-hand side instead of $P_{t-1}(1-\delta) k_{t-1}$)

- In real terms (deflate by P_t):

$$\begin{aligned} & (1-\tau)\left[f(k_{t-1}) + \frac{i_{t-1}}{1+\pi_t} b_{t-1} + T_t + \frac{\pi_t}{1+\pi_t}(1-\delta) k_{t-1}\right] \\ = \; & c_t + k_t - \frac{1}{1+\pi_t}(1-\delta) k_{t-1} + b_t - \frac{1}{1+\pi_t} b_{t-1} \end{aligned}$$

- Isolate the part involving capital gains (on physical capital):

$$\begin{aligned}(1-\tau)\left[f(k_{t-1})+\frac{i_{t-1}}{1+\pi_t}b_{t-1}+T_t\right]-\tau\frac{\pi_t}{1+\pi_t}(1-\delta)k_{t-1}\\ = c_t+k_t-(1-\delta)k_{t-1}+b_t-\frac{1}{1+\pi_t}b_{t-1}\end{aligned}$$

With $\tau > 0$, inflation involves a *reduction* in real income available for consumption, physical investment and bond accumulation

- Household optimization can be characterized by

$$V(k_{t-1}, b_{t-1}) = \max\{u(c_t)+\beta V(k_t, b_t)\}$$

- First-order condition for k_{t-1} (using envelope theorem):

$$V_k(k_{t-1}, b_{t-1}) = \beta V_k(k_t, b_t)\left[(1-\tau)f_k(k_t)+\left(1-\tau\frac{\pi_{t+1}}{1+\pi_{t+1}}\right)(1-\delta)\right]$$

Marginal value of k_{t-1} equals the discounted future marginal value of k_t, taking into account $\partial k_t/\partial k_{t-1}$. Note: higher π_{t+1} reduces the after-tax return on k_{t-1}

- Steady state:

$$(1-\tau)f_k(k^{ss})+\left(1-\tau\frac{\pi^{ss}}{1+\pi^{ss}}\right)(1-\delta)=\frac{1}{\beta}$$

$$\tau > 0 \Longrightarrow \frac{\partial k^{ss}}{\partial \pi^{ss}} < 0$$

- The reduction in real after-tax return on capital accumulation results in lower steady-state capital stock
  - Example of distortion of a tax on nominal return distorting the after tax real return

- Generally, the real after-tax return is, when nominal return is taxed:

$$\begin{aligned}r_a &= (1-\tau)i-\pi\\ &= (1-\tau)r-\pi+(1-\tau)\pi\\ &= (1-\tau)r-\tau\pi\end{aligned}$$

- Hence, with $\tau > 0$, inflation reduces the real after-tax return. Result: Higher pre-tax return, r, in equilibrium $\Longleftrightarrow$ lower k
- With indexed, or with real taxation, $r^a = (1-\tau)r$, inflation has no independent role for the after-tax return

- The distortionary effects of inflation in an unindexed tax system can be **severe** (cf. Feldstein's, 1996, computations of the welfare gains of reducing inflation from 2% to zero ≈ 1 % permanent raise in GDP)
- A strong argument against using inflation as a source of revenue

Summary

- Optimal seigniorage may be a tax that helps equating marginal costs of all tax distortions within and across periods (Mankiw)
- In fully specified, micro-founded models with distortionary taxes, however, the Friedman rule may still hold (under some restrictions on utility unctions)
- Inflation may have negative effects in a non-indexed tax system

- So, although monetary and fiscal policy **is** linked through the public budget constraint, the case for using inflation as a tax is not clear

Plan for next lectures

Wednesday, March 3

1. Money in the short run: Incomplete nominal adjustment (I)
2. Flexible prices and asymmetric information

Literature: Walsh (Chapter 5, pp. 199-211 — plus relevant appendix)

Monday, March 8

1. Money in the short run: Incomplete nominal adjustment (II)
2. Sticky Prices and Wages

Literature: Walsh (Chapter 5, pp. 211-223 — plus relevant appendix)