OPTIMAL FISCAL POLICY

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Basics of Ramsey Analysis

- **Maintained assumptions**
  - **Lack of lump-sum taxes (the starting point of Ramsey 1927!)**
  - **Completeness of set of proportional tax instruments**
  - **Completeness of government debt markets**
    - **Fully state-contingent set of government bonds issued in *t*, only one yields return depending on realized state in *t*+1**

- **Completeness of tax instruments?**
  - **Suppose three distinct goods, each with proportional tax rate**
  - **Household optimality conditions**

$$\frac{u_1(c_1,c_2,c_3)}{u_2(c_1,c_2,c_3)}=\frac{(1-\tau_1)\cdot p_1}{(1-\tau_2)\cdot p_2} \qquad \frac{u_2(c_1,c_2,c_3)}{u_3(c_1,c_2,c_3)}=\frac{(1-\tau_2)\cdot p_2}{(1-\tau_3)\cdot p_3}$$

  - **Completeness of tax instruments exists if, given a Ramsey allocation**
    - **There is ≥ one tax rate on each MRS = price ratio condition and…**
    - **…there is a unique mapping from the Ramsey allocation to a set of tax rates**

BASICS OF RAMSEY MACRO FISCAL POLICY

- Ramsey problem

$$\max_{\{c_t, n_t, k_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h(n_t) \right] \quad \text{s.t.}$$

$$c_t + g_t + k_{t+1} - (1-\delta)k_t = z_t f\left(k_t, n_t\right)$$

<u>Sequence</u> of Lagrange multipliers $\beta^t \lambda_t$

Present-value implementability constraint (PVIC)

$$E_0 \sum_{t=0}^{\infty} \beta^t \underbrace{\left[u'(c_t) \cdot c_t - h'(n_t) \cdot n_t \right]}_{\text{Define as } W(c_t,\, n_t)} = A_0$$

<u>Single</u> Lagrange multiplier μ

- Ramsey FOCs (for $t > 0$, which sidesteps thorny issue of taxation of initial capital stock and other assets, of which A_0 is a function)

$$u'(c_t^{RP}) - \lambda_t^{RP} + \mu \cdot W_c(c_t^{RP}, n_t^{RP}) = 0$$

$$-h'(n_t^{RP}) + \lambda_t^{RP} z_t f_n\left(k_t^{RP}, n_t^{RP}\right) + \mu \cdot W_n(c_t^{RP}, n_t^{RP}) = 0$$

$$-\lambda_t^{RP} + \beta E_t \left\{ \lambda_{t+1}^{RP} \left[z_{t+1} f_k(k_{t+1}^{RP}, n_{t+1}^{RP}) + 1 - \delta \right] \right\} = 0$$

Basics of Ramsey Macro Fiscal Policy

- **Ramsey FOCs (for $t > 0$, which sidesteps thorny issue of taxation of initial capital stock and other assets, of which A_0 is a function)**

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- **Social Planner FOCs**

$$u'(c_t^{SP}) - \lambda_t^{SP} = 0$$

$$-h'(n_t^{SP}) + \lambda_t^{SP} z_t f_n\left(k_t^{SP}, n_t^{SP}\right) = 0$$

$$-\lambda_t^{SP} + \beta E_t\left\{\lambda_{t+1}^{SP}\left[z_{t+1} f_k(k_{t+1}^{SP}, n_{t+1}^{SP}) + 1 - \delta\right]\right\} = 0$$

Evaluate at deterministic steady states

Basics of Ramsey Macro Fiscal Policy

- **Ramsey FOCs (for *t* > 0) at deterministic steady state**

$$u'(c^{RP}) - \lambda^{RP} + \mu \cdot W_c(c^{RP}, n^{RP}) = 0$$

$$-h'(n^{RP}) + \lambda^{RP} z \cdot f_n\left(k^{RP}, n^{RP}\right) + \mu \cdot W_n(c^{RP}, n^{RP}) = 0$$

$$-\lambda^{RP} + \beta\lambda^{RP}\left[z \cdot f_k(k^{RP}, n^{RP}) + 1 - \delta\right] = 0$$

- **Social Planner FOCs at deterministic steady state**

$$u'(c^{SP}) - \lambda^{SP} = 0$$

$$-h'(n^{SP}) + \lambda^{SP} z \cdot f_n\left(k^{SP}, n^{SP}\right) = 0$$

$$-\lambda^{SP} + \beta \cdot \lambda^{SP}\left[z \cdot f_k(k^{SP}, n^{SP}) + 1 - \delta\right] = 0$$

Basics of Ramsey Macro Fiscal Policy

- **Ramsey FOCs (for *t* > 0) at deterministic steady state**

$$u'(c^{RP}) - \lambda^{RP} + \mu \cdot W_c(c^{RP}, n^{RP}) = 0 \qquad (1)$$

$$-h'(n^{RP}) + \lambda^{RP} z \cdot f_n\left(k^{RP}, n^{RP}\right) + \mu \cdot W_n(c^{RP}, n^{RP}) = 0 \qquad (2)$$

$$-\cancel{\lambda^{RP}} + \beta \cancel{\lambda^{RP}}\left[z \cdot f_k(k^{RP}, n^{RP}) + 1 - \delta\right] = 0 \qquad (3)$$

- **Social Planner FOCs at deterministic steady state**

$$u'(c^{SP}) - \lambda^{SP} = 0 \qquad (4)$$

$$-h'(n^{SP}) + \lambda^{SP} z \cdot f_n\left(k^{SP}, n^{SP}\right) = 0 \qquad (5)$$

$$-\cancel{\lambda^{SP}} + \beta \cdot \cancel{\lambda^{SP}}\left[z \cdot f_k(k^{SP}, n^{SP}) + 1 - \delta\right] = 0 \qquad (6)$$

- **(3) and (6) imply Ramsey-optimal *k* / *n* ratio = efficient *k* / *n* ratio**
  - **(Given maintained assumption of CRS production *f*(.))**
  - **A crucial result!**
  - **Second-best *k* / *n* ratio = first-best *k* / *n* ratio**
  - **Chamley (1986 *ECTA*), Judd (1985 *JPub*) seminal references**

ZERO CAPITAL INCOME TAX

- What does this imply for Ramsey-optimal tax rates?
- Recall household optimization
  - With labor income tax and capital income tax (and no lump-sum taxes)

$$\max_{\{c_t, n_t, k_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h(n_t) \right] \quad \text{s.t.} \quad c_t + k_{t+1} = (1-\tau_t^n) w_t n_t + \left[1 + (1-\tau_t^k)(r_t - \delta) \right] k_t$$

  - Steady-state consumption-labor optimality (labor supply condition)

$$\frac{h'(n)}{u'(c)} = (1-\tau^n) \underbrace{z \cdot f_n(k,n)}_{= w \text{ in equilibrium}}$$

  - Steady-state consumption-savings optimality (capital Euler condition)

$$\cancel{u'(c)} = \beta \cancel{u'(c)} \left(1 + (1-\tau^k)(\overbrace{z \cdot f_k(k,n)}^{= r \text{ in equilibrium}} - \delta) \right)$$

  - **Ramsey-optimal capital income tax rate = 0!**
  - Don't tax intertemporal margin at all in the long run…
  - …even though Ramsey government has to raise revenue through distortionary taxes

POSITIVE LABOR INCOME TAX

- **What does this imply for Ramsey-optimal tax rates?**
  - **Steady-state consumption-labor optimality (labor supply condition)**

$$\frac{h'(n)}{u'(c)} = (1-\tau^n)z \cdot f_n(k,n)$$

  - **Steady-state consumption-savings optimality (capital Euler condition)**

$$u'(\cancel{c}) = \beta \cancel{u'}(c)\left(1+(1-\tau^k)(z \cdot f_k(k,n)-\delta)\right)$$

  - **Ramsey-optimal capital income tax rate = 0!**
  - **Don't tax intertemporal margin at all in the long run…**
  - **…even though Ramsey government has to raise revenue through distortionary taxes**

- **All revenue must be raised through positive labor income tax**

- **Two central Ramsey macro fiscal policy results**

Dynamics of Tax Rates

- **Outside the steady state?**
- **Focus on labor income tax rate (simple to consider)**

  - **Consumption-labor optimality (labor supply condition)**

$$\underbrace{\frac{h'(n_t)}{u'(c_t)}}_{=\ \mathrm{MRS}_t} = \underbrace{(1-\tau_t^n)z_t f_n(k_t, n_t)}_{=\ \mathrm{MPN}_t}$$

$$\rightarrow MRS_t = (1-\tau_t^n) MPN_t$$

- **Labor income tax is a wedge between labor supply and labor demand**

- **Along the business cycle?**
  - **Consider utility form** $u(c_t) - h(n_t) = \ln c_t - \frac{\kappa}{1+1/\iota} n_t^{1+1/\iota}$

ι is labor supply elasticity with respect to real wage

DYNAMICS OF TAX RATES

- Along the business cycle?
  - Consider utility form $u(c_t) - h(n_t) = \ln c_t - \frac{\kappa}{1+1/\iota} n_t^{1+1/\iota}$

ι is labor supply elasticity with respect to real wage

- Compute first and second derivatives of *u*(.) and *h*(.)…
  - …which are needed to compute W_c(.) and W_n(.)

- Do some algebra combining the Ramsey FOCs …

$$\underbrace{\kappa \cdot n_t^{1/\iota} \cdot c_t}_{=\ \text{MRS}_t} = \underbrace{\left[1 + \mu\left(\frac{1+\iota}{\iota}\right)\right]^{-1}}_{=\ \text{wedge between MRS}_t\ \text{and MPN}_t} \cdot \underbrace{z_t f_n(k_t, n_t)}_{=\ \text{MPN}_t}$$

- **Wedge is a (endogenous…) constant between MRS and MPN in every time period**
  - μ = 0 (the case of lump-sum taxes) ➔ wedge = 0
  - μ > 0 (the Ramsey case) ➔ wedge ≠ 0

DYNAMICS OF TAX RATES

- Along the business cycle?
- Wedge is a (endogenous…) constant between MRS and MPN in every time period…

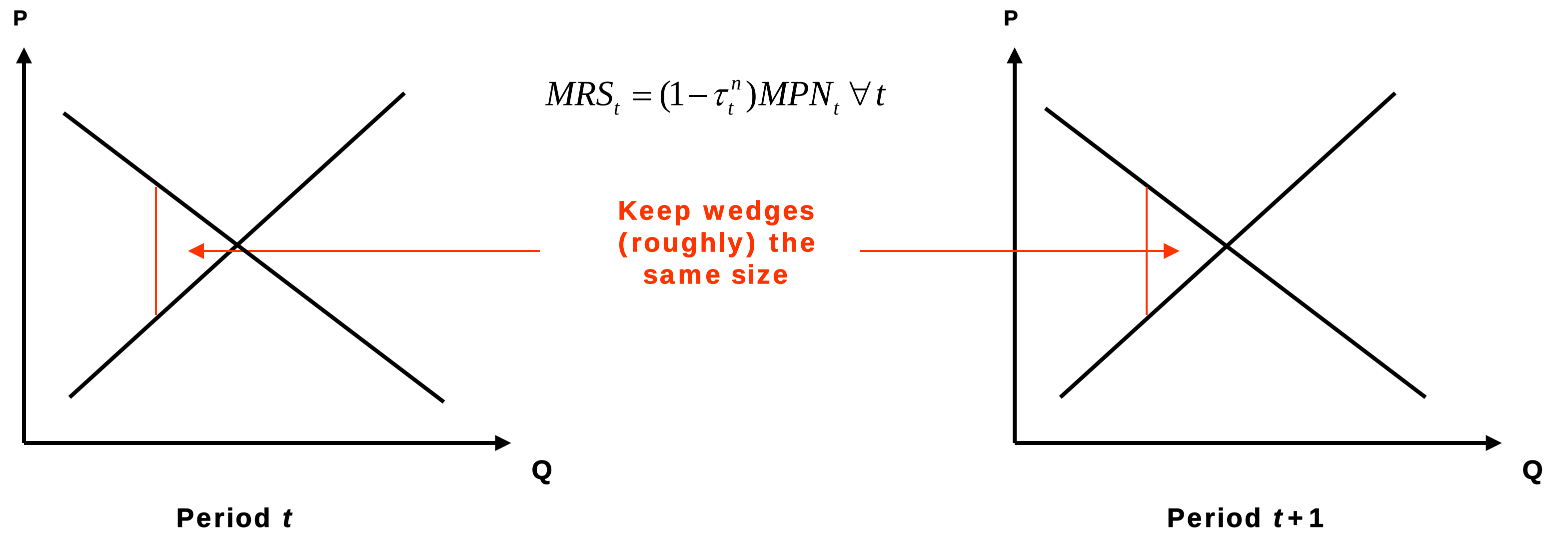
$$\underbrace{\kappa \cdot n_t^{1/\iota} \cdot c_t}_{=\ \mathrm{MRS}_t} = \underbrace{\left[1+\mu\left(\frac{1+\iota}{\iota}\right)\right]^{-1}}_{=\ \text{wedge between } \mathrm{MRS}_t \text{ and } \mathrm{MPN}_t} \cdot \underbrace{z_t f_n(k_t, n_t)}_{=\ \mathrm{MPN}_t}$$

- …thus labor income tax rate is constant over time (for this utility form)
  - Nearly constant if move to slightly different $h(n)$ function

- **Labor income tax smoothing**
  - Key Ramsey macro fiscal policy result
  - Keep deadweight losses constant across markets over time

TAX SMOOTHING

$$MRS_t = (1-\tau_t^n)MPN_t \;\forall t$$



- Ramsey wants to keep these wedges constant
- Result and intuition depend on neoclassical view of labor markets
  - Labor tax is the only wedge → tax-smoothing is wedge-smoothing