Optimal Fiscal and Monetary Policy

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Friedman-Phelps Debate

- Money Demand:

\[ \frac{M}{P} = \exp[-\alpha R] \]

- Friedman:
  
  (a) Efforts to Economize Cash Balances when $R$ High is Socially Wasteful
  
  (b) Set $R$ as Low As Possible: $R = 1$.
  
  (c) Since $R = 1 + r + \pi$, Friedman Recommends $\pi = -r$.

  (i) $r \sim$ exogenous (net) real interest rate
  
  (ii) $\pi \sim$ inflation rate, $\pi = (P - P_{-1})/P_{-1}$
Phelps:

(a) Inflation Acts Like a Tax on Cash Balances -

\[
\text{Seignorage} = \frac{M_t - M_{t-1}}{P_t} = \frac{M_t}{P_t} - \frac{P_{t-1}M_{t-1}}{P_t P_{t-1}} \\
\approx \frac{M \pi}{P (1 + \pi)}
\]

(b) Use of Inflation Tax Permits Reducing Some Other Tax Rate

(c) Extra Distortion in Economizing Cash Balances Compensated by Reduced Distortion Elsewhere.

(d) With Distortions a Convex Function of Tax Rates, Would Always Want to Tax All Goods (Including Money) At Least A Little.

(e) Inflation Tax Particularly Attractive if Interest Elasticity of Money Demand Low.
Question: Who is Right, Friedman or Phelps?

- Answer: Friedman Right Surprisingly Often
- Depends on Income Elasticity of Demand for Money
- Will Address the Issue From a Straight Public Finance Perspective, In the Spirit of Phelps.
- Easy to Develop an Answer, Exploiting a Basic Insight From Public Finance.
Some Basic Ideas from Ramsey Theory

- **Policy**, \( \pi \), Belonging to the Set of ‘Budget Feasible’ Policies, \( A \).

- **Private Sector Equilibrium Allocations**, Equilibrium Allocations, \( x \), Associated with a Given \( \pi \); \( x \in B \).

- **Private Sector Allocation Rule**, mapping from \( \pi \) to \( x \) (i.e., \( \pi : A \to B \)).

- **Ramsey Problem**: Maximize, w.r.t. \( \pi \), \( U(x(\pi)) \).

- **Ramsey Equilibrium**: \( \pi^* \in A \) and \( x^* \), such that \( \pi^* \) solves Ramsey Problem and \( x^* = x(\pi^*) \). ‘Best Private Sector Equilibrium’.
• **Ramsey Allocation Problem**: Solve, \( \tilde{x} = \arg \max U(x) \) for \( x \in B \)

• **Alternative Strategy for Solving the Ramsey Problem**:
  
  (a) Solve Ramsey Allocation Problem, to Find \( \tilde{x} \).
  
  (b) Execute the Inverse Mapping, \( \tilde{\pi} = x^{-1}(\tilde{x}) \).
  
  (c) \( \tilde{\pi} \) and \( \tilde{x} \) Represent a Ramsey Equilibrium.

• **Implementability Constraint**: Equations that Summarize Restrictions on Achievable Allocations, \( B \), Due to Distortionary Tax System.
Policy, $\pi$

Set, $A$, of Budget-Feasible Policies

Private sector Allocation Rule, $x(\pi)$

Private Sector Equilibrium Allocations, $x$

Set, $B$, of Private Sector Allocations Achievable by Some Budget-Feasible Policy

Utility
Example

- Households:

\[
\max_{c,l} u(c, l) \\
\text{subject to}: \quad c \leq z(1 - \tau)l, \\
z \sim \text{wage rate} \\
\tau \sim \text{labor tax rate}
\]
Household Problem Implies Private Sector Allocation Rules, \( l(\tau), c(\tau) \), defined by:

\[
u_c z (1 - l) + u_l = 0, \quad c = (1 - \tau)zl
\]

Private Sector Allocation Rules:

\( l(\tau), \quad c(\tau) = z(1-\tau)l \)
• Ramsey Problem:

$$\max_{\tau} u(c(\tau), l(\tau))$$
subject to $g \leq zl(\tau)\tau$

• Ramsey Equilibrium: $\tau^*, c^*, l^*$ such that

(a) $c^* = c(\tau^*), l^* = l(\tau^*)$
   ‘Private Sector Allocations are a Private Sector Equilibrium’

(b) $\tau^*$ Solves Ramsey Problem
   ‘Best Private Sector Equilibrium’
Analysis of Ramsey Equilibrium

• Simple Utility Specification:

\[ u(c, l) = c - \frac{1}{2}l^2 \]

• Two Ways to Compute the Ramsey Equilibrium

  (a) Direct Way: Solve Ramsey Problem (In Practice, Hard)

  (b) Indirect Way: Solve Ramsey Allocation Problem (Can Be Easy)
Direct Approach

- Private Sector Allocation Rules:

\[ u_c z(1 - \tau) + u_l = 0, \quad c = (1 - \tau) z l \]

\[ \Rightarrow z(1 - \tau) = l(\tau) \]

\[ \Rightarrow c(\tau) = z(1 - \tau) l(\tau) = z^2 (1 - \tau)^2 \]
• Ramsey Problem:

\[
\max_{\tau} \frac{1}{2}z^2(1 - \tau)^2
\]

subject to:

\[
g \leq \tau z^2 l(\tau) = \tau z^2(1 - \tau).
\]

\[
\tau^* = \tau_1 = \frac{1}{2} - \frac{1}{2}\left[1 - 4\frac{g}{z^2}\right]^{\frac{1}{2}} \quad \tau_2 = \frac{1}{2} + \frac{1}{2}\left[1 - 4\frac{g}{z^2}\right]^{\frac{1}{2}}
\]

\[
l(\tau^*) = \frac{1}{2}\left\{z + \left[z^2 - 4\frac{g}{z^2}\right]^{\frac{1}{2}}\right\}
\]
Indirect Approach

- Approach: Solve Ramsey Allocation Problem, Then ‘Inverse Map’ Back into Policies

- Problem: Would Like a Characterization of $B$ that Only Has $(c, l)$, Not the Policies

\[
B = \{ c, l : \exists \tau, \text{ with } u_c z (1 - \tau) + u_l = 0, \\
\quad c = (1 - \tau) z l, \ g \leq \tau z l \} 
\]
Solution: Rearrange Equations in $B$, So That Only $(c, l)$ Appears

(a) Multiply Household Budget Equation by $u_c$:

$$u_cc - u_c(1 - \tau)zl = 0$$

(b) Substitute out for $u_c(1 - \tau)z$ From Labor First Order Condition:

$$(*) u_cc + u_il = 0.$$  

(c) Combine Household Budget Equation With Government Budget Constraint:

$$(**) c + g \leqzl.$$
• Previous Manipulations Suggest Candidate Alternative Representation of $B$:

\[
D = \left\{ (c, l) : \begin{array}{l}
\text{resource constraint} \\
(\underbrace{c + g \leq zl}, \quad \underbrace{u_c c + u_l l = 0}) \\
\text{implementability constraint}
\end{array}\right\}
\]

• Want, $D = B$,

  (a) Have Shown $(c, l) \in B \rightarrow (c, l) \in D$

  (b) Still Need to Verify $(c, l) \in D \rightarrow (c, l) \in B$
Proof that \((c, l) \in D \implies (c, l) \in B\)

- Suppose \((c, l) \in D\), i.e., \(u_c c + u_l l = 0\), \(c + g \leq zl\)
- Need to show:

  \[\exists \tau \text{ s.t. } (i) \ u_c (1-\tau)z + u_l = 0, \ (ii) \ c = (1-\tau)zl, \ (iii) \ g \leq \tau zl\]

- Set \(\tau\) so that

  \[1 - \tau = \frac{-u_l}{u_c z}, \ \text{so (i) holds.}\]

- Multiply Both Sides by \(lz\) and rewrite:

  \[(1 - \tau)lz = \frac{-u_l l}{u_c} = c, \ \text{so (ii) holds.}\]

- \((iii)\) follows (ii) and \(c + g \leq zl\).
• Conclude:

\[ B = D \]

• Express Ramsey Allocation Problem:

\[
\max_{c,l} u(c, l) \\
\text{s.t. } u_c c + u_l l = 0, \ c + g \leq zl \\
\]

or

\[
\max_{l} l^2 \\
\text{s.t. } l^2 + g \leq zl \\
\]
Ramsey Allocation Problem:

Max $\frac{1}{2}l^2$
Subject to $l^2 + g \leq zl$

Solution:

$l_2 = \frac{1}{2}\{ z + [ z^2 - 4g ]^{\frac{1}{2}} \}$

Same Result as Before!
Lucas-Stokey Cash-Credit Good Model

- Households
- Firms
- Government
Households

- Household Preferences:

\[ \sum_{t=0}^{\infty} \beta^t u(c_{1t}, c_{2t}, l_t), \]

\( c_{1t} \sim \) cash goods, \( c_{2t} \sim \) credit goods, \( l_t \sim \) labor

- Distinction Between Cash and Credit Goods:
  - All Goods Paid With Cash At the Same Time, After Goods Market, in Asset Market
  - Cash Good: Must Carry Cash In Pocket Before Consuming It

\[ M_t \geq P_t c_{1t} \]

- Credit Good: No Need to Carry Cash Before Purchase.
Household Participation in Asset and Good Markets


- Goods Market: Second Half of Period, Goods are Consumed, Labor Effort is Applied, Production Occurs.
Sources of Cash for Household:
- $M_{t-1}^d - P_{t-1}c_{1,t-1} - P_{t-1}c_{2,t-1}$
- $R_{t-1}B_{t-1}^d$
- $(1 - \tau_{t-1})z_{t-1}$

Uses of Cash
- Bonds, $B_t^d$
- Cash, $M_t^d$

- Constraint On Households in Asset Market (Budget Constraint)

\[
M_t^d + B_t^d \\
\leq M_{t-1}^d - P_{t-1}c_{1,t-1} - P_{t-1}c_{2,t-1} \\
+ R_{t-1}B_{t-1}^d + (1 - \tau_{t-1})z_{t-1}
\]
Household First Order Conditions

- Cash versus Credit Goods:
  \[
  \frac{u_{1t}}{u_{2t}} = R_t
  \]

- Cash Goods Today versus Cash Goods Tomorrow:
  \[
  u_{1t} = \beta u_{1t+1} R_t \frac{P_t}{P_{t+1}}
  \]

- Credit Goods versus Leisure:
  \[
  u_{3t} + (1 - \tau_t) z u_{2t} = 0.
  \]
Firms

- Technology: \( y = zl \)
- Competition Guarantees Real Wage = \( z \).
Government

- Inflows and Outflows in Asset Market (Budget Constraint):

\[
M_t^s - M_{t-1}^s + B_t^s \geq R_{t-1}B_{t-1}^s + P_{t-1}g_{t-1} - P_{t-1}\tau_{t-1}z_{t-1}l_{t-1}
\]

Sources of Funds \hspace{1cm} Uses of Funds

- Policy:

\[
\pi = (M_0^s, M_1^s, ..., B_0^s, B_1^s, ..., \tau_0, \tau_1, ...)
\]
Ramsey Equilibrium

- Private Sector Allocation Rule:

For each policy, $\pi \in A$, there is a Private Sector Equilibrium:

$$x = (\{c_{1t}\}, \{c_{2t}\}, \{l_t\}, \{M_t\}, \{B_t\})$$

$$p = (\{P_t\}, \{R_t\})$$

$$M_t = M_t^s = M_t^d$$

$$B_t = B_t^s = B_t^d$$

$$R_t \geq 1 \text{ (i.e., } u_{1t}/u_{2t} \geq 1)$$

- Ramsey Problem:

$$\max_{\pi \in A} U(x(\pi))$$

- Ramsey Equilibrium:

$$\pi^*, x(\pi^*), p(\pi^*),$$

Such that $\pi^*$ Solves Ramsey Problem.
Finding The Ramsey Equilibrium By Solving the Ramsey Allocation Problem

$$\max_{\{c_{1t},c_{2t},l_t\} \in D} \sum_{t=0}^{\infty} \beta^t u(c_{1t}, c_{2t}, l_t),$$

where $D$ is the set of allocations, $c_{1t}, c_{2t}, l_t$, $t = 0, 1, 2, \ldots$, such that

$$\sum_{t=0}^{\infty} \beta^t [u_{1t}c_{1t} + u_{2t}c_{2t} + u_{3t}l_t] = u_{2,0}a_0,$$

$$c_{1t} + c_{2t} + g \leq zl_t, \quad \frac{u_{1t}}{u_{2t}} \geq 1,$$

$$a_0 = \frac{R_{-1}B_{-1}}{P_0} \sim \text{real value of initial government debt}$$

Assumption: $B_{-1} = 0.$
Lagrangian Representation of Ramsey Allocation Problem:

- There is a $\lambda \geq 0$, Such that the Solution to the RA Problem and the Following Problem Coincide:

$$\max_{\{c_{1t},c_{2t},l_t\}} \sum_{t=0}^{\infty} \beta^t W(c_{1t}, c_{2t}, l_t; \lambda)$$

subject to :  $c_{1t} + c_{2t} + g \leq z_l, \frac{u_{1t}}{u_{2t}} \geq 1,$

$W(c_{1t}, c_{2t}, l_t; \lambda) = u(c_{1t}, c_{2t}, l_t) + \lambda [u_{1t}c_{1t} + u_{2t}c_{2t} + u_{3t}l_t].$

- Note that If You Could Ignore $\frac{u_{1t}}{u_{2t}} \geq 1,$ Optimization Implies

$$\frac{W_{1t}}{W_{2t}} = 1$$
Restricting the Utility Function

- Utility Function:

\[ u(c_1, c_2, l) = h(c_1, c_2)v(l), \]
\[ h \sim \text{homogeneous of degree } k \]
\[ v \sim \text{strictly decreasing}. \]

- Then, \( u_1c_1 + u_2c_2 + u_3l = h[kv + v'], \) so

\[ W(c_1, c_2, l; \lambda) = hv + \lambda h[kv + v'] \]
\[ = h(c_1, c_2)Q(l, \lambda). \]

- Conclude - Homogeneity and Separability Imply:

\[ \frac{W_1(c_1, c_2, l; \lambda)}{W_2(c_1, c_2, l; \lambda)} = \frac{u_1(c_1, c_2, l)}{u_2(c_1, c_2, l)}. \]
Surprising Result: Friedman is Right More Often Than You Might Expect

• Suppose You Can Ignore $u_{1t}/u_{2t} \geq 1$ Constraint. Then, Necessary Condition of Solution to Ramsey Allocation Problem:

\[
\frac{W_1(c_1, c_2, l; \lambda)}{W_2(c_1, c_2, l; \lambda)} = 1.
\]

• This, In Conjunction with Homogeneity and Separability, Implies:

\[
\frac{u_1(c_1, c_2, l)}{u_2(c_1, c_2, l)} = 1.
\]

• Note: $u_{1t}/u_{2t} \geq 1$ is Satisfied, So Restriction is Redundant Under Homogeneity and Separability.

• Conclude: $R = 1$, So Friedman Right!
Generality of the Result

- Result is True for the Following More General Class of Utility Functions:

\[ u(c_1, c_2, l) = V(h(c_1, c_2), l), \]

where \( h \) is homothetic.


- Actually, strict homotheticity and separability are not necessary.
Interpretation of the Result

• ‘Looking Beyond the Monetary Veil’ - The Connection Between The $R = 1$ Result and the Uniform Taxation Result for Non-Monetary Economies
• The Importance of Homotheticity
• The Link Between Homotheticity and Separability, and The Consumption Elasticity of Money Demand.
Uniform Taxation Result from Public Finance For Non-Monetary Economies

- Households:

\[
\max_{c_1, c_2, l} u(c_1, c_2, l) \\
\text{s.t. } zl \geq c_1(1 + \tau_1) + c_2(1 + \tau_2) \\
\Rightarrow c_1 = c_1(\tau_1, \tau_2), \ c_2 = c_2(\tau_1, \tau_2), \ l = l(\tau_1, \tau_2).
\]

- Ramsey Problem:

\[
\max_{\tau_1, \tau_2} u(c_1(\tau_1, \tau_2), c_2(\tau_1, \tau_2), l(\tau_1, \tau_2)) \\
\text{s.t. } g \geq c_1(\tau_1, \tau_2)\tau_1 + c_2(\tau_1, \tau_2)\tau_2
\]

- Uniform Taxation Result:

if \( u = V(h(c_1, c_2), l), \ h \sim \text{homothetic} \)

then \( \tau_1 = \tau_2 \).

Proof: trivial! (just study Ramsey Allocation Problem)
Similarities to Monetary Economy

- Rewrite Budget Constraint:
  \[
  \frac{zl}{1 + \tau_2} \geq c_1 \frac{1 + \tau_1}{1 + \tau_2} + c_2.
  \]

- Similarities:
  \[
  \frac{1}{1 + \tau_2} \sim 1 - \tau, \quad \frac{1 + \tau_1}{1 + \tau_2} \sim R.
  \]

- Positive Interest Rate ‘Looks’ Like a Differential Tax Rate on Cash and Credit Goods.

- Have the Same Ramsey Allocation Problem, Except Monetary Economy Also Has:
  \[
  \frac{u_1}{u_2} \geq 1.
  \]
What Happens if You Don’t Have Homotheticity?

- Utility Function:

\[ u(c_1, c_2, l) = \frac{c_1^{1-\sigma}}{1 - \sigma} + \frac{c_2^{1-\delta}}{1 - \delta} + v(l) \]

- ‘Utility Function’ in Ramsey Allocation Problem:

\[ W(c_1, c_2, l) = [1 + (1 - \sigma)\lambda] \frac{c_1^{1-\sigma}}{1 - \sigma} \]

\[ + [1 + (1 - \delta)\lambda] \frac{c_2^{1-\delta}}{1 - \delta} + v(l) + \lambda v'(l)l \]
• Marginal Rate of Substitution in Ramsey Allocation Problem That Ignores \( \frac{u_1}{u_2} \geq 1 \) Condition:

\[
1 = \frac{W_1(c_1, c_2, l; \lambda)}{W_2(c_1, c_2, l; \lambda)} = \frac{1 + (1 - \sigma)\lambda}{1 + (1 - \delta)\lambda} \times \frac{u_1}{u_2},
\]

or, since \( \frac{u_1}{u_2} = R \):

\[
R = \frac{1 + (1 - \delta)\lambda}{1 + (1 - \sigma)\lambda}
\]

• Finding:

\[
\delta = \sigma \Rightarrow R = 1 \text{ (homotheticity case)}
\]

\[
\delta > \sigma \Rightarrow R \geq 1 \text{ Binds, so } R = 1
\]

\[
\delta < \sigma \Rightarrow R > 1.
\]

Note: Friedman Right More Often Than Uniform Taxation Result, Because \( \frac{u_1}{u_2} \geq 1 \) is a Restriction on the Monetary Economy, Not the Barter Economy.
Consumption Elasticity of Demand

- Homotheticity and Separability Correspond to Unit Consumption Elasticity of Money Demand.

- Money Demand:

\[ R = \frac{u_1}{u_2} = \frac{h_1}{h_2} = f \left( \frac{c_2}{c_1} \right) \]

\[ = f \left( \frac{c - \frac{M}{P}}{\frac{M}{P}} \right) \]

\[ = \tilde{f} \left( \frac{c}{\frac{M}{P}} \right). \]

- Note: Holding \( R \) Fixed, Doubling \( c \) Implies Doubling \( \frac{M}{P} \)
Elasticity of Money Demand and Failure of Homotheticity

- Money Demand:

\[ R = \frac{u_1}{u_2} = \frac{c_1^{-\sigma}}{c_2^{-\delta}} = \frac{(\frac{M}{P})^{-\sigma}}{(c - \frac{M}{P})^{-\delta}} \]

- Taylor Series Approximation About Steady State (\( m \equiv M/P \) in steady state):

\[ \hat{m} = \frac{1}{m} \left( \frac{c}{\delta} \right) \times \hat{c} \quad - \quad \frac{1}{\delta \frac{m}{c-m} + \sigma} \times \hat{R} \]

\( \hat{c} \) Consumption Money Demand Elasticity, \( \varepsilon_M \)

\( \hat{R} \) Interest Elasticity

- Can Verify:

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<th>Monetary Economy</th>
</tr>
</thead>
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Bottom Line:

- Friedman is Right ($R = 1$) When Consumption Elasticity of Money Demand is Unity or Greater
- Implicitly, High Interest Rates Tax Some Goods More Heavily than Others. Under Homotheticity and Separability Conditions, Want to Tax Goods at Same Rate.
- What is Consumption Elasticity in the Data?
What To Do, When $g, \ z$ Are Random?

- Ramsey Principle: Minimize Tax Distortions
- If There is A Low Elasticity Item, Tax It
- If a Bad Shock Hits: Tax Capital (i.e., hit things that reflect past decisions like physical capital)
- Important ..... If a Good Shock Hits: Subsidize Capital (that minimizes ex ante distortions to capital accumulation)
- Movements in $P$ May Be Best Thing (see Simulations)
  This Conclusion Will Be Dependent on Degree of Price Stickiness
TABLE 3

Properties of the Monetary Models

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<td>Baseline</td>
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Labor Tax

Inflation

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Money Growth

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Financing War: Barro versus Ramsey

When War (or Other Large Financing Need) Suddenly Strikes:

- Barro:
  - Raise Labor and Other Tax Rates a Small Amount So That When Held Constant at That Level, Expected Value of War is Financed
  - This Minimizes Intertemporal Substitution Distortions
  - Involves a Big *Increase* in Debt in Short Run
  - Prediction for Labor Tax Rate: Random Walk.
• Ramsey:
  – Tax Existing Capital Assets (Human, Physical, etc) For Full Amount of Expected Value of War. Do This at the First Sign of War.
  – This Minimizes Intertemporal and Intratemporal Distortions (Don’t Change Tax Rates on Income at all).
  – Example:
    * Suppose War is Expected to Last Two Periods, Cost: $1 Per Period
    * Suppose Gross Rate of Interest is 1.05 (i.e., 5%)
    * Tax Capital $1 + 1/1.05 = 1.95 Right Away.
    * Debt Falls $0.95 in Period When War Strikes.
  – Involves a Reduction of Outstanding Debt in Short Run.
  – Prediction for Labor Tax Rate: Roughly Constant.