Optimal Capital Taxation Revisited

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How Should Capital Be Taxed?

- Influential results on taxation of capital: Chamley-Judd (1985-86)
  - The capital income tax is zero in the steady state
  - But there is a transition in that capital income is fully taxed
- Presumption that capital taxes ought to be high for some time
- The presumption could be reinforced by more recent literature: Basseto and Benhabib (2006) and Straub and Werning (2015)
  - Capital income is fully taxed forever
- Ramsey problem comparing a labor income tax with a particular tax on capital income

How Should Capital Be Taxed?

- Follow the Ramsey tradition: Tax system is exogenously given
- Our choice of system: Taxes used in practice by developed economies
- Allow for a rich tax system that includes taxes on labor and capital income, consumption, dividends, and wealth

Taxes and Wedges

- Many tax policies yield the same wedges
- The theory pins down wedges, not taxes

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Taxes and Wedges

- Many tax policies yield the same wedges
- The theory pins down wedges, not taxes
- Key question: Does the Ramsey policy have intertemporal distortions?
- If yes, we say future capital is taxed
- If no, we say future capital is not taxed

Findings

- With a rich tax system:
  - With general preferences, capital should not be taxed asymptotically
  - Along the transition capital may be taxed or subsidized
  - With standard macro preferences, future capital should never be taxed
- Results remain in heterogeneous agent economies, with capital-rich and poor agents
- Results differ from literature because we consider a rich tax system and the literature considers a restricted system

Literature

- Setting up optimal taxation problems:
  - Ramsey (1927), Diamond and Mirrlees (1972), Lucas and Stokey (1983)
- Optimal taxation in growth models with restricted tax systems
  - Chamley (1986), Judd (1985), Straub and Werning (2015)
- Optimal taxation in growth models with rich tax systems
  - Chari and Kehoe (1999), Zhu (1992), Werning (2007)

Plan

1. Results for growth model with representative agent
2. Initial confiscation
3. Results for growth model with heterogeneous agents
4. Relate results to production efficiency

Point of the Paper

- Bring together well known results in a unified framework
- Clarify relationships among results
- Relate to uniform commodity taxation literature

Representative Agent Growth Model

Representative Agent Growth Model

- Preferences

$$U = \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right)$$

- Resource constraints:

$$c_t + g_t + k_{t+1} - \left(1 - \delta\right) k_t \leq F\left(k_t, n_t\right)$$

F is constant returns to scale

Government Policies

- Exogenous public consumption and initial debt financed with
  - τ_t^n: labour income tax
  - τ_t^k: capital income tax
  - τ_t^c: consumption tax
  - τ_t^d: dividend tax
  - l_0: tax on initial wealth

Competitive Equilibrium

- Allocations, prices, policies, such that
  - Household maximizes utility subject to

$$\sum_{t=0}^{\infty} q_t \left[\left(1+\tau_t^c\right) c_t - \left(1-\tau_t^n\right) w_t n_t \right] = \left(1-l_0\right) \left[b_0 + \sum_{t=0}^{\infty} q_t \left(1-\tau_t^d\right) d_t \right]$$

  - A representative firm maximizes

$$\sum_{t=0}^{\infty} q_t \left(1-\tau_t^d\right) d_t$$

  with

$$d_t = F(k_t, n_t) - w_t n_t - \tau_t^k \left[F(k_t, n_t) - w_t n_t - \delta k_t \right] - \left[k_{t+1} - (1-\delta) k_t \right]$$

- τ_t^d is the tax in Abel (2007)

Competitive Equilibrium Wedges

$$-\frac{u_c(t)}{u_n(t)} = \frac{(1+\tau_t^c)}{(1-\tau_t^n)} \frac{1}{F_n(t)}$$

$$\frac{u_c(t)}{\beta u_c(t+1)} = \frac{(1+\tau_t^c)\left(1-\tau_{t+1}^d\right)}{\left(1+\tau_{t+1}^c\right)\left(1-\tau_t^d\right)} \left[1+\left(1-\tau_{t+1}^k\right)(F_k(t+1)-\delta)\right]$$

$$\frac{u_n(t)}{\beta u_n(t+1)} = \frac{(1-\tau_t^n)\left(1-\tau_{t+1}^d\right)}{\left(1-\tau_{t+1}^n\right)\left(1-\tau_t^d\right)} \frac{F_n(t)\left[1+\left(1-\tau_{t+1}^k\right)(F_k(t+1)-\delta)\right]}{F_n(t+1)}$$

Characterization Theorem:

- Allocations and period 0 policies are part of an equilibrium iff
    - Implementability constraint

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t\right] = W_0$$

with $W_0 = u_{c,0} \frac{(1-l_0)}{\left(1+\tau_0^c\right)} \left[b_0 + \left(1 - \tau_0^d\right) \left[1 + \left(1 - \tau_0^k\right) \left(F_{k,0} - \delta\right)\right] k_0\right]$

-
    - Resource constraints
- If tax system is restricted, additional restrictions must be imposed

Necessity Proof

- Present value of dividends = value of initial capital stock
- Substitute prices and policies into

$$\sum_{t=0}^{\infty} q_t \left[\left(1+\tau_t^c\right) c_t - \left(1-\tau_t^n\right) w_t n_t\right]$$
$$= \left(1-l_0\right)\left[b_0 + \left(1-\tau_0^d\right)\left[k_0 + \left(1-\tau_0^k\right)\left(F_{k,0}-\delta\right) k_0\right]\right]$$

to obtain implementability constraint

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t\right] = W_0$$

Sufficiency Proof or Implementation:

- Construct prices and policies to satisfy other equilibrium conditions:

$$-\frac{u_{c,t}}{u_{n,t}} = \frac{\left(1+\tau_t^c\right)}{\left(1-\tau_t^n\right)} \frac{1}{F_{n,t}}$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \frac{\left(1+\tau_t^c\right)\left(1-\tau_{t+1}^d\right)}{\left(1+\tau_{t+1}^c\right)\left(1-\tau_t^d\right)} \left[1+\left(1-\tau_{t+1}^k\right)\left(F_{k,t+1}-\delta\right)\right]$$

- Can implement with τ_t^n, $t \geq 0$, and τ_t^d, $t \geq 1$, alone
- Can impose a 100% upper bound on dividend taxes: Never binding here
- Many possible implementations

Capital Income Taxes Are Redundant

- So, restrictions like $\tau_t^k \leq 1$ are irrelevant
- One implementation sets $\tau_t^k = 0$ for $t \geq 0$
- What does it mean that future capital should not be taxed?
- Not taxing future capital means no intertemporal wedges on either goods consumption or leisure consumption

Taking a Stand on Period 0 Policies

$$W_0 = u_{c,0} \frac{(1 - l_0)}{(1 + \tau_0^c)} \left[b_0 + \left(1 - \tau_0^d\right) \left[1 + \left(1 - \tau_0^k\right) \left(F_{k,0} - \delta\right) \right] k_0 \right]$$

- Standard assumption: Initial policies are given
  - Incentives to choose future policies to affect value of initial wealth
- We assume that W_0 is fixed (Armenter, 2008)
  - Abstract from valuation effects, for now
  - Will return to this later

Ramsey Problem

- Choose allocations to maximize utility subject to

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t\right] = W_0$$

and

$$c_t + g_t + k_{t+1} - (1-\delta) k_t \leq F(k_t, n_t)$$

Ramsey Marginal Conditions

$$-\frac{u_{c,t}}{u_{n,t}} = \frac{1+\varphi\left[1+\sigma_t^n - \sigma_t^{nc}\right]}{1+\varphi\left[1-\sigma_t + \sigma_t^{cn}\right]}\frac{1}{F_{n,t}} \text{ for all } t \geq 0$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \frac{1+\varphi\left[1-\sigma_{t+1} + \sigma_{t+1}^{cn}\right]}{1+\varphi\left[1-\sigma_t + \sigma_t^{cn}\right]}\left[1+F_{k,t+1}-\delta\right] \text{ for all } t \geq 0$$

where elasticities are given by

$$\sigma_t = -\frac{u_{cc,t}c_t}{u_{c,t}}, \sigma_t^n = \frac{u_{nn,t}n_t}{u_{n,t}}, \sigma_t^{nc} = -\frac{u_{nc,t}c_t}{u_{n,t}}, \sigma_t^{cn} = \frac{u_{cn,t}n_t}{u_{c,t}}$$

- φ is the multiplier on the implementability condition

Intertemporal Distortions

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \frac{1+\varphi\left[1-\sigma_{t+1}+\sigma_{t+1}^{cn}\right]}{1+\varphi\left[1-\sigma_t+\sigma_t^{cn}\right]}\left[1+F_{k,t+1}-\delta\right]$$

$$\frac{u_{n,t}}{\beta u_{n,t+1}} = \frac{1+\varphi\left(1+\sigma_{t+1}^{n}-\sigma_{t+1}^{nc}\right)}{1+\varphi\left(1+\sigma_t^{n}-\sigma_t^{nc}\right)}\frac{F_{n,t}\left[1+F_{k,t+1}-\delta\right]}{F_{n,t+1}}$$

- If elasticities are constant, no intertemporal wedges on both margins

Intertemporal Distortions in the Steady State

- In the steady state, elasticities are constant
  - No intertemporal distortions in the steady state
- Along the transition may want to tax or subsidize capital
- No presumption that capital should be taxed at high rates

Future Capital Taxes with Standard Preferences

- Standard preferences:

$$U = \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\sigma} - 1}{1-\sigma} - \eta n_t^{\psi} \right]$$

Future Capital Taxes with Standard Preferences

- Standard preferences:

$$U = \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\sigma} - 1}{1 - \sigma} - \eta n_t^{\psi} \right]$$

- **Proposition 1** With standard macro preferences, no intertemporal distortions ever

- Reason: Elasticities are constant

Future Capital Taxes with Standard Preferences

$$-\frac{u_c(t)}{u_n(t)} = \frac{(1+\tau_t^c)}{(1-\tau_t^n)} \frac{1}{F_n(t)}$$

$$\frac{u_c(t)}{\beta u_c(t+1)} = \frac{(1+\tau_t^c)\left(1-\tau_{t+1}^d\right)}{(1+\tau_{t+1}^c)\left(1-\tau_t^d\right)} \left[1 + \left(1-\tau_{t+1}^k\right)\left(F_k(t+1)-\delta\right)\right]$$

$$\frac{u_n(t)}{\beta u_n(t+1)} = \frac{(1-\tau_t^n)\left(1-\tau_{t+1}^d\right)}{(1-\tau_{t+1}^n)\left(1-\tau_t^d\right)} \frac{F_n(t)\left[1 + (1-\tau_{t+1}^k)(F_k(t+1)-\delta)\right]}{F_n(t+1)}$$

- Implementation:
    - Constant taxes on consumption and/or labor
    - Zero taxes on capital
    - Constant tax on dividends (and appropriate tax on wealth)

Capital Taxation in Restricted Tax Systems

- Suppose only capital and labor could be taxed and $\tau_t^k \leq 1$
- Proposition 1 still holds
  - Additional restrictions are satisfied with
    - constant tax rates on labor
    - zero tax on capital
- Key reason: Have restricted utility value of initial wealth
- Suppose period zero policies are restricted instead
  - Proposition 1 will not hold

Initial Confiscation

The Initial Confiscation: Valuation Effects

- With representative agent must impose period zero restrictions to avoid lump sum tax outcomes
- Direct confiscation

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t\right]$$
$$= u_{c,0} \frac{(1 - l_0)}{(1 + \tau_0^c)} \left[b_0 + \left(1 - \tau_0^d\right) \left[1 + \left(1 - \tau_0^k\right) \left(F_{k,0} - \delta\right)\right] k_0\right]$$

Alternative Period Zero Restrictions in Rich Tax Systems

- Rather than restricting the value of initial wealth, suppose we fix l_0, τ_0^c, τ_0^d, τ_0^k

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t \right] = u_{c,0} \mathcal{W}_0$$

$$\mathcal{W}_0 = \frac{(1 - l_0)}{(1 + \tau_0^c)} \left[b_0 + \left(1 - \tau_0^d\right) \left[1 + \left(1 - \tau_0^k\right) \left(F_{k,0} - \delta\right) \right] k_0 \right]$$

Alternative Period Zero Restrictions in Rich Tax Systems

- Ramsey solution (with standard preferences)

$$\frac{u_c(0)}{\beta u_c(1)} = \frac{1+\varphi(1-\sigma)}{1+\varphi\left(1-\sigma+\frac{\sigma \mathcal{W}_0}{c_0}\right)}\left[1-\delta+F_k(1)\right]$$

- Subsidize consumption at time 0, relative to all later periods

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \frac{\left(1+\tau_t^c\right)\left(1-\tau_{t+1}^d\right)}{\left(1+\tau_{t+1}^c\right)\left(1-\tau_t^d\right)}\left[1+\left(1-\tau_{t+1}^k\right)\left(F_{k,t+1}-\delta\right)\right]$$

- Implement with the dividend tax in period 1: τ_t^d taxes the gross return on capital

Alternative Period Zero Restrictions in Rich Tax Systems

- Dividend tax is higher in period one and remains constant
- Valuation effects are dealt with in one period
- Intertemporal distortions for one period only

Restricted Tax Systems

- Only labor and capital income taxes (with $\tau_t^k \leq 1$)
- Additional constraints on the Ramsey problem:

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = 1 + \left(1 - \tau_{t+1}^k\right)\left(F_{k,t+1} - \delta\right) \text{ with } \tau_t^k \leq 1$$

- These additional constraints will bind for a while, or even forever as in Straub-Werning

Restricted Tax Systems

$$\sum_{t=0}^{\infty} \beta^t \left[u_{c,t} c_t + u_{n,t} n_t\right] = u_{c,0} \mathcal{W}_0$$

- Strong incentive to make $u_{c,0}$ small
- But must respect intertemporal conditions

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = 1 + \left(1 - \tau_{t+1}^k\right)\left(F_{k,t+1} - \delta\right)$$

  - Fixing $u_{c,1}$ have incentives to make τ_1^k large to reduce $u_{c,0}$
  - If bound on τ_1^k is hit, have incentives to make $u_{c,1}$ small to reduce $u_{c,0}$
  - Fixing $u_{c,2}$ have incentives to make τ_2^k large to reduce $u_{c,1}$
  - If bound on τ_2^k is hit, have incentives to make $u_{c,2}$ small to reduce $u_{c,1}$

Restricted Tax Systems

- This may last forever as in Straub-Werning
- Get $u_{c,0}$ to be low by using the whole term structure
- This problem does not show up with rich tax systems because gross returns can be taxed

Heterogeneous Agent Growth Model

Heterogeneous Agent Growth Model

- Focus on wealth heterogeneity
- For simplicity, two types of agents, 1 and 2
- Social welfare function: $\theta U^1 + (1-\theta) U^2$
- Standard preferences, same for both types
- Resource constraint: $c_t^1 + c_t^2 + g_t + k_{t+1} - (1-\delta) k_t \leq F\left(n_t^1 + n_t^2, k_t\right)$
- Initial endowments: Possibly different
- Policies:
  - Same as before. The tax rates are the same for all agents
  - No restrictions on initial policies: Can confiscate initial wealth

Ramsey Problem

- Maximize welfare subject to
  - Implementability constraints

$$\sum_{t=0}^{\infty} \beta^t \left[u^1_{c,t} c^1_t + u^1_{n,t} n^1_t\right] = u^1_{c,0} \left(1 - l_0\right) V^1_0,$$

and

$$\sum_{t=0}^{\infty} \beta^t \left[u^2_{c,t} c^2_t + u^2_{n,t} n^2_t\right] = u^2_{c,0} \left(1 - l_0\right) V^2_0,$$

with $V^i_0 = \frac{1}{\left(1+\tau^c_0\right)} \left[b^i_0 + \left(1 - \tau^d_0\right) \left[1 + \left(1 - \tau^k_0\right) \left(F_{k,0} - \delta\right)\right] k^i_0\right]$

  - Common tax rate constraints

$$\frac{u^1_{c,t}}{u^2_{c,t}} = \frac{u^1_{c,t+1}}{u^2_{c,t+1}} \quad \text{and} \quad \frac{u^1_{c,t}}{u^2_{c,t}} = \frac{u^1_{n,t}}{u^2_{n,t}}$$

which imply

$$u^1_{c,t} = \gamma u^2_{c,t} \quad \text{and} \quad u^1_{n,t} = \gamma u^2_{n,t}$$

  - Resource constraints

Future Capital Should Never Be Taxed

- **Proposition 2** With (identical) standard macro preferences, no intertemporal distortions ever
- Future capital should not be taxed for any weights and endowments
- Holds for all periods: No need to impose restrictions on initial policies, as in Werning (2007)

Why No Need to Impose Restrictions on Initial Policies?

$$\sum_{t=0}^{\infty} \beta^t \left[u^i_{c,t} c^i_t + u^i_{n,t} n^i_t \right] = u^i_{c,0} \left(1 - l_0\right) V^i_0$$

- Because of the common tax assumption, marginal utilities are proportionate
- Whatever can be done with $u^1_{c,0} = \gamma u^2_{c,0}$, can be done with l_0 with a gain
- No valuation effects here
    - No initial wealth terms in Ramsey FOC
    - As with the exogeneity assumption on the value of initial wealth in the representative agent economy

Production Efficiency

Capital Taxation and Production Efficiency

- Standard macro preferences are separable and homothetic
- With separable and homothetic preferences, uniform taxation is optimal
- Uniform taxation is optimal because production efficiency is optimal
- We map the growth economy into an intermediate goods economy

The Map

- Composite final goods are produced with constant returns to scale technologies

$$U = \frac{\left(C^i\right)^{1-\sigma} - \frac{1}{1-\beta}}{1-\sigma} - \eta \left(N^i\right)^{\psi}$$

- Intermediate goods technologies

$$C = \mathcal{C}(c_0, c_1, ...) = \left[\sum_{t=0}^{\infty} \beta^t c_t^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

$$N = \mathcal{N}(n_0, n_1, ...) = \left[\sum_{t=0}^{\infty} \beta^t n_t^{\psi}\right]^{\frac{1}{\psi}}$$

Intermediate Good Economy: Competitive Equilibrium

- Households: Maximize utility subject to

$$p(1+\tau^C)C^i - w(1-\tau^N)N^i \leq (1-l_0)\, V^i$$

- Consumption firm: Maximize

$$pC - \sum_{t=0}^{\infty} q_t(1+\tau_t^c)c_t$$

subject to consumption intermediate good technology

- Labor firm: Maximize

$$\sum_{t=0}^{\infty} q_t(1-\tau_t^n)w_t n_t - wN$$

subject to labor intermediate good technology

- Capital accumulation firm: Same as in the growth model
- Market clearing:

$$C^1 + C^2 = C,\ N^1 + N^2 = N$$

Ramsey Outcomes in Intermediate Goods Economy

- Can apply production efficiency theorem
- Production efficiency means outcomes are at the boundary of the production set
- Thus optimal not to distort use of intermediate goods
- Can implement with a tax on final goods and zero tax on intermediate goods
- Need to extend Diamond and Mirrlees with endogenous l_0.
- Do so in paper

Allowing for Heterogeneity in Preferences

- Suppose consumption elasticities are different so that

$$C^i = \mathcal{C}^i(c_0^i, c_1^i, ...) = \left[\sum_{t=0}^{\infty} \beta^t \left(c_t^i\right)^{1-\sigma_i}\right]^{\frac{1}{1-\sigma_i}}$$

- Map growth model into intermediate good economy with two types of final composite goods
- To apply production efficiency theorem need to be able to tax the different goods at different rates
- If tax rates are forced to be the same for the two final goods, production efficiency does not necessarily hold
- It may be optimal to have intertemporal distortions, unless different agents can be taxed at different rates

Conclusion

- With rich tax systems, for standard macro preferences, future capital should never be taxed
- With more general preferences capital should not be taxed in the steady state
  - No presumption that capital should be taxed heavily for some period of time
- If the initial capital is to be confiscated, should do so directly
  - Not by taxing future capital