Optimal Capital Taxation Revisited

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Conference in Honor of Robert E. Lucas Jr.

October 2016

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In 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: Bassetto 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
Many tax policies yield the same wedges

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

The theory pins down wedges, not taxes

Key question: Does the Ramsey policy have intertemporal distortions?
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
Setting up optimal taxation problems:
- Ramsey (1927), Diamond and Mirrlees (1972), Lucas and Stokey (1983)

Optimal taxation in growth models with restricted tax systems

Optimal taxation in growth models with rich tax systems
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
Preferences

\[ U = \sum_{t=0}^{\infty} \beta^t u(c_t, n_t) \]

Resource constraints:

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

\( F \) is constant returns to scale
Exogenous public consumption and initial debt financed with

- $\tau^n_t$: labour income tax
- $\tau^k_t$: capital income tax
- $\tau^c_t$: consumption tax
- $\tau^d_t$: dividend tax
- $l_0$: tax on initial wealth
Competitive Equilibrium

- Allocations, prices, policies, such that
  - Household maximizes utility subject to
    $$\sum_{t=0}^{\infty} q_t \left[ (1 + \tau_t^c) c_t - (1 - \tau_t^n) w_t n_t \right] = (1 - l_0) \left[ b_0 + \sum_{t=0}^{\infty} q_t \left( 1 - \tau_t^d \right) d_t \right]$$
  - A representative firm maximizes
    $$\sum_{t=0}^{\infty} q_t \left( 1 - \tau_t^d \right) d_t$$
    with
    $$d_t = F(k_t, n_t) - w_t n_t - \tau_t^k \left[ F(k_t, n_t) - w_t n_t - \delta k_t \right] - \left[ k_{t+1} - (1 - \delta) k_t \right]$$
- $\tau_t^d$ is the tax in Abel (2007)
\[
\frac{-u_c(t)}{u_n(t)} = \frac{(1 + \tau^c_t)}{(1 - \tau^n_t) F_n(t)} \frac{1}{(1 + \tau^c_{t+1}) (1 - \tau^d_t)} [1 + (1 - \tau^k_{t+1})(F_k(t+1) - \delta)]
\]

\[
\frac{u_c(t)}{\beta u_c(t+1)} = \frac{(1 + \tau^c_t)(1 - \tau^d_{t+1})}{(1 + \tau^c_{t+1})(1 - \tau^d_t)} [1 + (1 - \tau^k_{t+1})(F_k(t+1) - \delta)]
\]

\[
\frac{u_n(t)}{\beta u_n(t+1)} = \frac{(1 - \tau^n_t)(1 - \tau^d_{t+1})}{(1 - \tau^n_{t+1})(1 - \tau^d_t)} F_n(t) \frac{1}{(1 + \tau^c_{t+1}) (1 - \tau^d_t)} F_n(t+1)
\]
Characterization Theorem:

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

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

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

- 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

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

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

to obtain implementability constraint

$$\sum_{t=0}^{\infty} \beta^t [u_{c,t} c_t + u_{n,t} n_t] = W_0$$
Sufficiency Proof or Implementation:

- Construct prices and policies to satisfy other equilibrium conditions:

\[
- \frac{u_{c,t}}{u_{n,t}} = \frac{(1 + \tau^c_t)}{(1 - \tau^n_t)} \frac{1}{F_{n,t}}
\]

\[
\frac{u_{c,t}}{\beta u_{c,t+1}} = \frac{(1 + \tau^c_t)(1 - \tau^d_{t+1})}{(1 + \tau^c_{t+1})(1 - \tau^d_t)} \left[ 1 + (1 - \tau^k_{t+1})(F_{k,t+1} - \delta) \right]
\]

- Can implement with \( \tau^n_t, t \geq 0 \), and \( \tau^d_t, t \geq 1 \), alone

- Can impose a 100\% upper bound on dividend taxes: Never binding here

- Many possible implementations
Capital Income Taxes Are Redundant

- So, restrictions like $\tau^k_t \leq 1$ are irrelevant

- One implementation sets $\tau^k_t = 0$ 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


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

- 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

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**Taking a Stand on Period 0 Policies**

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Optimal Capital Taxation Revisited
Choose allocations to maximize utility subject to

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

and

\[ c_t + g_t + k_{t+1} - (1 - \delta) k_t \leq F(k_t, n_t) \]
Ramsey Marginal Conditions

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

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

where elasticities are given by

\[\sigma_t = -\frac{u_{cc,t}c_t}{u_{c,t}}, \quad \sigma^n_t = \frac{u_{nn,t}n_t}{u_{n,t}}, \quad \sigma^{nc}_t = -\frac{u_{nc,t}c_t}{u_{n,t}}, \quad \sigma^{cn}_t = \frac{u_{cn,t}n_t}{u_{c,t}}\]

\(\varphi\) is the multiplier on the implementability condition
If elasticities are constant, no intertemporal wedges on both margins.
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:

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

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

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

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

**Implementation:**

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

\[
\sum_{t=0}^{\infty} \beta^t \left[ u_{c,t} c_t + u_{n,t} n_t \right] = u_{c,0} \frac{(1 - l_0)}{(1 + \tau_0^c)} \left[ b_0 + (1 - \tau_0^d) \left[ 1 + (1 - \tau_0^k) (F_{k,0} - \delta) \right] k_0 \right]
\]
Rather than restricting the value of initial wealth, suppose we fix $l_0$, $\tau_0^c$, $\tau_0^d$, $\tau_0^k$

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

$$\mathcal{W}_0 = \frac{(1 - l_0)}{(1 + \tau_0^c)} \left[ b_0 + (1 - \tau_0^d) \left[ 1 + (1 - \tau_0^k) (F_{k,0} - \delta) \right] k_0 \right]$$
Alternative Period Zero Restrictions in Rich Tax Systems

- Ramsey solution (with standard preferences)

\[
\frac{u_c(0)}{\beta u_c(1)} = \frac{1 + \varphi (1 - \sigma)}{1 + \varphi \left(1 - \sigma + \frac{\sigma W_0}{c_0}\right)} \left[1 - \delta + F_k(1)\right]
\]

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

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

- Implement with the dividend tax in period 1: \(\tau_t^d\) taxes the gross return on capital
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:

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

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

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

- Strong incentive to make \( u_{c,0} \) small

- But must respect intertemporal conditions

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

- Fixing \( u_{c,1} \) have incentives to make \( \tau_1^k \) large to reduce \( u_{c,0} \)

- If bound on \( \tau_1^k \) is hit, have incentives to make \( u_{c,1} \) small to reduce \( u_{c,0} \)

- Fixing \( u_{c,2} \) have incentives to make \( \tau_2^k \) large to reduce \( u_{c,1} \)

- If bound on \( \tau_2^k \) is hit, have incentives to make \( u_{c,2} \) small to reduce \( u_{c,1} \)
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
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: 
\[
c^1_t + c^2_t + g_t + k_{t+1} - (1 - \delta) k_t \leq F \left( n^1_t + n^2_t, k_t \right)
\]

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
    \[
    \sum_{t=0}^{\infty} \beta^t \left[ u_{c,t}^1 c_t + u_{n,t}^1 n_t \right] = u_{c,0}^1 (1 - l_0) V_{0,0}^1,
    \]
    and
    \[
    \sum_{t=0}^{\infty} \beta^t \left[ u_{c,t}^2 c_t + u_{n,t}^2 n_t \right] = u_{c,0}^2 (1 - l_0) V_{0,0}^2,
    \]
    with \( V_{0,0}^i = \frac{1}{(1 + \tau_0^c)} \left[ b_0^i + (1 - \tau_0^d) \left[ 1 + (1 - \tau_0^k) (F_{k,0} - \delta) \right] k_0^i \right] \)
  - Common tax rate constraints
    \[
    \frac{u_{c,t}^1}{u_{c,t}^2} = \frac{u_{c,t+1}^1}{u_{c,t+1}^2} \quad \text{and} \quad \frac{u_{c,t}^1}{u_{n,t}^1} = \frac{u_{n,t}^1}{u_{n,t}^2},
    \]
    which imply
    \[
    u_{c,t}^1 = \gamma u_{c,t}^2 \quad \text{and} \quad u_{n,t}^1 = \gamma u_{n,t}^2,
    \]
  - 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?

$$\sum_{t=0}^{\infty} \beta^t \left[ u_{c,t}^i c_t^i + u_{n,t}^i n_t^i \right] = u_{c,0}^i (1 - l_0) V_0^i$$

- Because of the common tax assumption, marginal utilities are proportionate.
- Whatever can be done with $u_{c,0}^1 = \gamma u_{c,0}^2$, 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
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
Composite final goods are produced with constant returns to scale technologies

\[ U = \frac{(C^i)^{1-\sigma} - \frac{1}{1-\beta}}{1-\sigma} - \eta (N^i) ^\psi \]

Intermediate goods technologies

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

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

\[ pC - \sum_{t=0}^{\infty} q_t(1 + \tau^c_t)c_t \]
subject to consumption intermediate good technology

Labor firm: Maximize

\[ \sum_{t=0}^{\infty} q_t(1 - \tau^n_t)w_t n_t - wN \]
subject to labor intermediate good technology

Capital accumulation firm: Same as in the growth model

Market clearing:

\[ C^1 + C^2 = C, \quad N^1 + N^2 = N \]
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

\[ C^i = C^i(c^i_0, c^i_1, \ldots) = \left[ \sum_{t=0}^{\infty} \beta^t (c^i_t)^{1-\sigma_i} \right]^{\frac{1}{1-\sigma_i}} \]

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
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