

Ramsey Taxation in the Global Economy

V. V. Chari¹, Juan Pablo Nicolini² & Pedro Teles³

September 2019

¹ University of Minnesota & Federal Reserve Bank of Minneapolis

² Federal Reserve Bank of Minneapolis & Universidad Torcuato Di Tella

³ Catolica-Lisbon School of Business and Economics & Banco de Portugal

Revisit Ramsey Taxation in the global economy

- Is free trade in goods and services optimal?
- Is free capital mobility optimal?
- Are border adjustments desirable?

Revisit Ramsey Taxation in the global economy

- Is free trade in goods and services optimal? YES
- Is free capital mobility optimal? YES
- Are border adjustments desirable? YES

Revisit Ramsey Taxation in the global economy

- Is free trade in goods and services optimal? YES
- Is free capital mobility optimal? YES
 - Many think answers to these two are obvious:
 - Well known paper in AER (2004) argues the answer is NO
- Bhagwati and Johnson argue free trade is not optimal with distortions
 - If taxes not optimal, free trade not optimal
 - If taxes optimal, free trade optimal

Revisit Ramsey Taxation in the global economy

- Are border adjustments desirable? YES
 - Public finance economists say YES
 - International trade economists say IRRELEVANT (Lerner symmetry)

Model sheds light on current policy debates

- Examples:
 - Should every good have the same tax rate in every country?
(Tax harmonization)
 - Should trade agreements also have fiscal policy agreements?

Model sheds light on current policy debates

- Examples:
 - Should every good have the same tax rate in every country? NO
 - Should trade agreements also have fiscal policy agreements? YES

Model sheds light on current policy debates

- Other questions:
 - Should goods be taxed based on origin or destination?
 - Is the residence principle for asset income taxation optimal?
 - Should capital income be taxed?

Model sheds light on current policy debates

- Other questions:
 - Should goods be taxed based on origin or destination? DESTINATION
 - Is the residence principle for asset income taxation optimal? YES
 - Should capital income be taxed? NO WITH STANDARD MACRO PREFERENCES

Recent Literature

- Costinot - Werning, Hosseini - Shourideh argue free trade not optimal with distorting taxes
- Use Naito's framework
- Why do results differ?
- No hidden trade in this paper
- Albrecht, De, Eslami, Chari argue results differ because of hidden trade

Ramsey Approach: Tax Instruments Given

- We assume rich tax system: taxes commonly used worldwide
- Focus on cooperative Ramsey equilibrium
- Ramsey approach yields wedges
 - Taxes not necessarily pinned down
 - Multiple implementations
- Need to take stand on initial policies or promises
 - Assume value of wealth cannot be below benchmark level

Two-Country BKK Model

Preferences and Technology

- Preferences

$$U^i = \sum_{t=0}^{\infty} \beta^t u^i(c_{it}, n_{it})$$

- Intermediate goods (only traded goods)

$$y_{i1t} + y_{i2t} = y_{it} = F^i(k_{it}, n_{it})$$

y_{ijt} : amount of good i used in country j

- Final goods

$$c_{it} + g_{it} + x_{it} \leq G^i(y_{1it}, y_{2it})$$

$$x_{it} = k_{it+1} - (1 - \delta) k_{it}$$

Efficiency Conditions with Lump-Sum Taxes

- No labor wedge:

$$-\frac{u_{c,t}^i}{u_{n,t}^i} = \frac{1}{G_{i,t}^i F_{n,t}^i}$$

- No investment wedge:

$$\frac{u_{c,t}^i}{\beta u_{c,t+1}^i} = G_{i,t+1}^i F_{k,t+1}^i + 1 - \delta$$

- Static production efficiency:

$$\frac{G_{2,t}^1}{G_{1,t}^1} = \frac{G_{2,t}^2}{G_{1,t}^2}$$

- Dynamic production efficiency:

$$\frac{G_{j,t}^1 \left[G_{1,t+1}^1 F_{k,t+1}^1 + 1 - \delta \right]}{G_{j,t+1}^1} = \frac{G_{j,t}^2 \left[G_{2,t+1}^2 F_{k,t+1}^2 + 1 - \delta \right]}{G_{j,t+1}^2}$$

Benchmark Tax System

- Consumption tax: τ_{it}^c
- Labor income tax: τ_{it}^n
- Taxes on imports and exports: τ_{ijt}^m and τ_{ijt}^x
- Tax on initial wealth: l_{i0}
- Transfers to government i : T_{i0}
 - $T_{10} + T_{20} = 0$
 - Can be interpreted as relabeling initial claims

Competitive Equilibrium

- CE is allocation (c, n, y) , prices (p, q, w, Q) , policies (τ, T_0) such that
 - Households maximize
 - Firms maximize
 - Government budget constraint satisfied
 - Markets clear
 - In particular, balance of payments condition is met:

$$\sum_{t=0}^{\infty} Q_t [p_{it}Y_{ijt} - p_{jt}Y_{jit}] = - (1 + r_0^f) f_{i,0} - T_{i,0}$$

$f_{i,0}$ is initial claims of country i on country j

p_{it} obtained from firm and household first order conditions

Wedges in Competitive Equilibrium

- Labor wedge:

$$-\frac{u_{c,t}^i}{u_{n,t}^i} = \frac{(1 + \tau_{it}^c)}{(1 - \tau_{it}^n) G_{i,t}^i F_{n,t}^i}$$

- Investment wedge:

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

Wedges in Competitive Equilibrium

- Static wedge (static production inefficiency):

$$\frac{G_{2t}^1}{G_{1t}^1} = \frac{(1 + \tau_{21t}^m)(1 + \tau_{12t}^m)}{(1 - \tau_{21t}^x)(1 - \tau_{12t}^x)} \frac{G_{2t}^2}{G_{1t}^2}$$

- Dynamic wedge (dynamic production inefficiency):

$$\begin{aligned} \frac{(1 + \tau_{12t}^m) / (1 - \tau_{12t}^x)}{(1 + \tau_{12t+1}^m) / (1 - \tau_{12t+1}^x)} \frac{G_{1t}^1}{G_{1t+1}^1} [G_{1t+1}^1 F_{kt+1}^1 + 1 - \delta] \\ = \frac{G_{1t}^2}{G_{1t+1}^2} [G_{2t+1}^2 F_{kt+1}^2 + 1 - \delta] \end{aligned}$$

Implementable Set Used for Characterization Theorem

- Implementability constraint

$$\sum_{t=0}^{\infty} [\beta^t u_{c,t}^i c_{it} + \beta^t u_{n,t}^i n_{it}] = \mathcal{W}_{i0},$$

where

$$\mathcal{W}_{i0} = \frac{(1 - l_{i0}) u_{c,0}^i}{(1 + \tau_{i0}^c)} \left[(1 - \delta + G_{i,0}^i F_{k,0}^i) k_{i0} + Q_{-1} b_{i0} + (1 + r_0^f) \frac{f_{i,0}}{q_{i,0}} \right]$$

- Resource constraints
- Balance of payments condition

Necessary and Sufficient Conditions

- **Proposition 1:** Allocation and period zero policies implementable as competitive equilibrium if and only if they satisfy
 - Implementability condition
 - Resource constraints
 - Balance of payments condition

Cooperative Ramsey Equilibrium

- Maximize

$$\lambda U^1 + (1 - \lambda) U^2$$

over the implementable set

- Without restrictions on initial policies: Lump-sum tax allocation
- We impose wealth restriction in utility terms: $\mathcal{W}_{i0} \geq \bar{\mathcal{W}}_i$, where

$$\mathcal{W}_{i0} = \frac{(1 - l_{i0}) u_{c,0}^i}{(1 + \tau_{i0}^c)} \left[(1 - \delta + G_{i,0}^i F_{k,0}^i) k_{i0} + Q_{-1} b_{i0} + (1 + r_0^f) \frac{f_{i,0}}{q_{i,0}} \right]$$

- Can be implemented as Markov equilibrium with one-period commitment (Chari, Nicolini & Teles, 2016)

Analog of Second Welfare Theorem

- For any λ , there exists transfers T_0 such that the Ramsey allocation has static and dynamic production efficiency
 - Free trade optimal: One implementation sets tariffs to zero
 - Tax rates on consumption and labor income in general different across countries (tax harmonization not optimal)
 - Free capital mobility optimal
 - Tax system allows distortions to capital mobility by letting tariffs change over time. But it is not optimal to use these distortions
 - Can allow for taxes on capital income. Implementable set unchanged. One implementation sets these taxes to zero

Optimal wedges

$$-\frac{u'_{c,t}}{u'_{n,t}} \frac{\left[1 + \frac{\varphi^i}{\lambda^i} [1 - \sigma_t^i - \sigma_t^{cni}]\right]}{\left[1 + \frac{\varphi^i}{\lambda^i} [1 + \sigma_t^{ni} - \sigma_t^{nci}]\right]} = \frac{1}{G_{i,t}^i F_{n,t}^i},$$

$$\frac{u'_{c,t}}{\beta u'_{c,t+1}} \frac{\left[1 + \frac{\varphi^i}{\lambda^i} [1 - \sigma_t^i - \sigma_t^{cni}]\right]}{\left[1 + \frac{\varphi^i}{\lambda^i} [1 - \sigma_{t+1}^i - \sigma_{t+1}^{cni}]\right]} = 1 - \delta + G_{i,t+1}^i F_{kt+1}^i$$

$$\frac{G_{2,t}^1}{G_{1,t}^1} = \frac{G_{2,t}^2}{G_{1,t}^2}$$

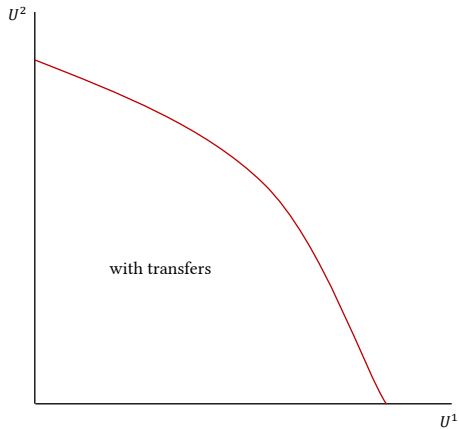
$$\frac{G_{j,t}^1 \left[G_{1,t+1}^1 F_{k,t+1}^1 + 1 - \delta \right]}{G_{j,t+1}^1} = \frac{G_{j,t}^2 \left[G_{2,t+1}^2 F_{k,t+1}^2 + 1 - \delta \right]}{G_{j,t+1}^2}$$

where σ 's are own and cross elasticities

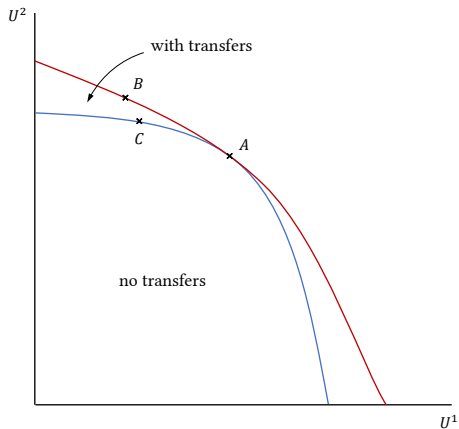
Analogue of First Welfare Theorem

- There exists a $\lambda \in (0, 1)$ such that transfers are zero in the Ramsey allocation
 - Implies that even if planner cannot make transfers, there exists a Ramsey equilibrium that cannot be Pareto improved

Utility Possibility Set



Utility Possibility Set



A: Analogue of first welfare theorem

B: Given initial endowment, need transfers to implement B

C: Given welfare weights, without transfers planner implements C

No Government-to-Government Transfers

- Consider relaxed problem:

$$\max \lambda U^1 + (1 - \lambda) U^2$$

subject to

- implementability constraint
 - resource constraint
- Let

$$s_i(\lambda) = \sum_{t=0}^{\infty} Q_t [p_{it}y_{ijt} - p_{jt}y_{jit}]$$

where Q , p , y are all functions of λ

- Walras' law implies

$$\sum_i s_i(\lambda) = 0$$

No Government-to-Government Transfers

- Negishi argument:
 - Define $g_i(\lambda) : \text{unit simplex} \rightarrow \text{unit simplex}$

$$g_i(\lambda) = \frac{\max\{\lambda_i, \lambda_i + s_i(\lambda)\}}{\sum_i \max\{\lambda_i, \lambda_i + s_i(\lambda)\}}$$

- Apply Brouwer's fixed point theorem:

$$g(\lambda^*) = \lambda^*$$

- If $s_1((0, 1)) > 0$ and $s_2((1, 0)) > 0$, then fixed point exists with $s_i(\lambda^*) = 0$ for all i
- There exist Pareto weights such that free trade is optimal

Alternative Implementations

Value Added Taxes with Border Adjustment

- τ_{it}^V : value added taxes
- τ_{it}^N : labor income tax
- No tax on exports, cannot deduct imports
- Turns out to be equivalent to a consumption tax

Value Added Taxes with Border Adjustment

- Intermediate good firm in country 1 maximizes

$$\sum_{t=0}^{\infty} Q_t [(p_{11t}y_{11t} + p_{2t}y_{12t}) - w_{1t}n_{1t} - q_{1t}x_{1t}] - \sum_{t=0}^{\infty} Q_t \tau_{1t}^v [p_{1t}y_{11t} - q_{1t}x_{1t}]$$

- Final good firm in country 1 maximizes

$$\sum_{t=0}^{\infty} Q_t [q_{1t}G^1(y_{11t}, y_{21t}) - p_{1t}y_{11t} - p_{2t}y_{21t}] - \sum_{t=0}^{\infty} Q_t \tau_{1t}^v [q_{1t}G^1(y_{11t}, y_{21t}) - p_{1t}y_{11t}]$$

- **Proposition:** VAT equivalent to consumption tax with

$$1 - \tau_{it}^v = \frac{1}{(1 + \tau_{it}^c)}$$

Value Added Taxes without Border Adjustment

- τ_{ijt}^m : tariff levied by j on imports from i
- Intermediate good firms in country 1 maximize

$$\sum_{t=0}^{\infty} Q_t [(1 - \tau_{1t}^v)(p_{11t}y_{11t} + (1 - \tau_{12t}^e)p_{12t}y_{12t} - q_{1t}x_{1t}) - w_{1t}n_{1t}]$$

- Final good firms in country 1 maximize

$$\sum_{t=0}^{\infty} Q_t (1 - \tau_{1t}^v) [q_{1t}G^1(y_{11t}, y_{21t}) - p_{11t}y_{11t} - (1 + \tau_{21t}^m)p_{21t}y_{21t}]$$

and similarly in country 2

Value Added Taxes without Border Adjustment

- First order conditions:

$$\frac{(1 + \tau_{21t}^m) G_{2,t}^2}{(1 - \tau_{21t}^e) G_{2,t}^1} = \frac{(1 - \tau_{12t}^e) G_{1,t}^2}{(1 + \tau_{12t}^m) G_{1,t}^1}$$

and

$$\begin{aligned} \frac{1 - \tau_{1t+1}^v}{1 - \tau_{1t}^v} \frac{(1 + \tau_{12t}^m)}{(1 - \tau_{12t}^e)} \frac{(1 - \tau_{12t+1}^e)}{(1 + \tau_{12t+1}^m)} \frac{G_{1,t}^1}{G_{1,t+1}^1} [G_{1,t+1}^1 F_{k,t+1}^1 + 1 - \delta] \\ = \frac{1 - \tau_{2t+1}^v}{1 - \tau_{2t}^v} \frac{G_{1,t}^2}{G_{1,t+1}^2} [G_{2,t+1}^2 F_{k,t+1}^2 + 1 - \delta] \end{aligned}$$

- In general cannot implement Ramsey equilibrium with zero tariffs

Bottomline of Border Adjustment Issue

- Ramsey allocations implementable with border adjustment
- Ramsey allocations not implementable without border adjustment and zero tariffs
- Border adjustment seems like a tax on imports
- No border adjustment seems like a tax on exports
- Lerner symmetry says these should be equivalent
- What's going on?

Connection with Lerner Symmetry

- Lerner symmetry theorem: taxes on imports equivalent to taxes on exports
 - Pf: With one import good and one export good only relative price matters. Transfers take care of the effect of tariffs on the balance of payments condition
- With multiple import goods and multiple export goods, each with different tax rates, cannot replace taxes on imports by taxes on exports
 - Pf: Such a tax change alters prices of imported goods relative to each other
- Can interpret dynamic model as static model with multiple import and export goods
- Lerner symmetry typically fails in dynamic models

Residence Based Taxation of income

- τ_{it}^k : tax rate on firms' capital income
- τ_{it} : tax rate on households' asset income
- τ_{it}^n : tax rate on labor income
- Note: No consumption taxes

Intermediate Goods Firms' Problem

- Intermediate good firm maximizes present value of dividends

$$\sum_{t=0}^{\infty} Q_t d_{it}$$

where

$$d_{it} = p_{it} F(k_{it}, n_{it}) - w_{it} n_{it} \\ - \tau_{it}^k [p_{it} F(k_{it}, n_{it}) - w_{it} n_{it} - q_{it} \delta k_{it}] - q_{it} [k_{it+1} - (1 - \delta) k_{it}]$$

Households' Problem

- Flow of funds

$$\begin{aligned} b_{it+1} + V_{it} s_{it+1} + f_{it+1} &= \frac{Q_{t-1}}{Q_t} b_{it} + (V_{it} + d_{it}) s_{it} \\ &\quad - \tau_{it} \left(V_{it} - V_{it-1} + d_{it} - \frac{(q_{it} - q_{it-1}) V_{it-1}}{q_{it-1}} \right) s_{it} \\ &\quad + (1 + r_t^f) f_{it} - \tau_{it} \left(r_t^f - \frac{q_{it} - q_{it-1}}{q_{it-1}} \right) f_{it} \\ &\quad + (1 - \tau_{it}^n) w_{it} n_{it} - (1 + \tau_{it}^c) q_{it} c_{it} \end{aligned}$$

where f_{it} is holdings of foreign assets

- Note income defined net of valuation changes

- Static production efficiency met

$$\frac{G_{1,t}^2}{G_{2,t}^2} = \frac{G_{1,t}^1}{G_{2,t}^1}$$

- Intertemporal production efficiency not necessarily met

$$\begin{aligned} \frac{G_{j,t}^1}{G_{j,t+1}^1} [1 + (1 - \tau_{1,t+1}^k) (G_{1,t+1}^1 F_{k,t+1}^1 - \delta)] \\ = \frac{G_{j,t}^2}{G_{j,t+1}^2} [1 + (1 - \tau_{2,t+1}^k) (G_{2,t+1}^2 F_{k,t+1}^2 - \delta)] \end{aligned}$$

Ramsey Allocation

- Must set $\tau_{1t+1}^k = \tau_{2t+1}^k = 0$ or set

$$\begin{aligned} & \tau_{1t+1}^k (G_{1,t+1}^1 F_{k,t+1}^1 - \delta) \\ & = \tau_{2t+1}^k \left(G_{1,t+1}^1 F_{k,t+1}^1 - \delta - \left(\frac{G_{j,t+1}^1 / G_{j,t+1}^2}{G_{j,t}^1 / G_{j,t}^2} - 1 \right) \right) \end{aligned}$$

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

- Joint distortion from taxes on asset income and firm's profits
- **Proposition:** In Ramsey equilibrium, set τ_{it+1} and τ_{it+1}^n appropriately
- **Proposition:** With standard macro preferences set taxes to 0
- Residence based taxation implements Ramsey outcome

Mirrlees Taxation and Production Efficiency

- Household k in country i indexed by parameter θ_i^k
- Type- θ_i^k household supplies $l_t = \theta_i^k n_t$ units of *effective* labor
- Distribution of types $H_i(\theta_i^k)$

Cooperative Planner

- **observes**
 - consumption of each type
 - effective labor of each type
- does **not observe**
 - household type

Mirrlees Taxation and Production Efficiency

An **allocation** consists of household allocations $\{c_t(\theta_i^k), l_t(\theta_i^k)\}$ and aggregate allocations $\{y_{ijt}, k_{it+1}, x_{it}\}$ for each country. Allocation is:

- *feasible* if resource constraints are met:

$$y_{i1t} + y_{i2t} = y_{it} = F^i \left(k_{it}, \int l_t(\theta_i^k) dH_i(\theta_i^k) \right),$$

$$\int c_t(\theta_i^k) dH_i(\theta_i^k) + g_{it} + x_{it} \leq G^i(y_{1it}, y_{2it});$$

- *incentive compatible* if for all $\theta_i^k, \hat{\theta}_i^k$

$$\sum_{t=0}^{\infty} \beta^t u^i(c_t(\theta_i^k), l_t(\theta_i^k)/\theta_i^k) \geq \sum_{t=0}^{\infty} \beta^t u^i(c_t(\hat{\theta}_i^k), l_t(\hat{\theta}_i^k)/\theta_i^k).$$

Households rank allocations according to

$$U^i(\theta_i^k) = \sum_{t=0}^{\infty} \left[u^i \left(c_t(\theta_i^k), \frac{l_t(\theta_i^k)}{\theta_i^k} \right) + h^i(g_{it}) \right].$$

Mirrlees Problem

A **cooperative Mirrlees outcome** is an allocation, which is a solution to:

$$\omega^1 \int U^1(\theta_1^k) dJ_1(\theta_1^k) + \omega_2 \int U^2(\theta_2^k) dJ_2(\theta_2^k) \rightarrow \max$$

subject to

- incentive compatibility,
- resource feasibility.

Proposition:

- Mirrleesian outcome satisfies production efficiency so that free trade and unrestricted capital mobility are optimal,
- if preferences are separable, then it is optimal to have no intertemporal distortions.

Summary

- Production efficiency optimal in Ramsey and Mirrleesian outcomes with widely used taxes
- Border tax adjustments desirable
- Residence based taxation optimal

When is it optimal to deviate from Production efficiency

- Results that production efficiency not optimal often comes from unrealistic restrictions on tax systems
- Private information? NOT BY ITSELF
- Private and information and hidden trading? YES
(See Albrecht, Chari, De & Eslami, *forthcoming*)