Optimal Taxation of Multinational Enterprises: A Ramsey Approach

Sebastian Dyrda Guangbin Hong Joseph B. Steinberg

University of Toronto

100th Carnegie-Rochester-NYU Conference on Public Policy:

“International Policy Coordination and Competition”

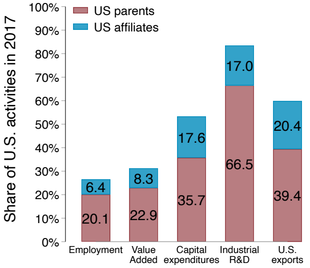
April 28–29, 2023

How should the international tax system be designed?

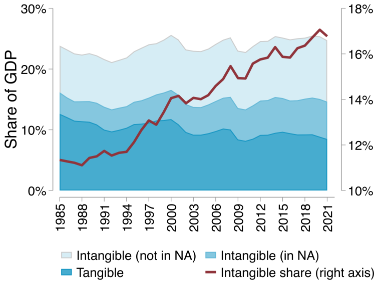
Classic macro public finance question: Feldstein, Hartman (1979), Gordon (1986), Keen and Wildasin (2004), Costinot and Werning (2018), Chari, Nicolini, Teles (2022)

We revisit this question by emphasizing 3 key features of modern global economy:

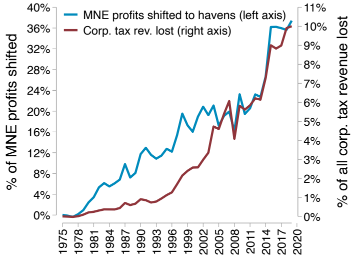
(a) Importance of MNEs



(b) Rise of intangible capital



(c) Rise of profit shifting



How should multinational enterprises' profits be taxed?

Current corporate tax paradigm: harmonizing corporate taxes across countries and shutting down profit shifting would benefit global economy

- October 2021: 136 countries signed on to OECD/G20 proposal of 15% global minimum tax
- December 2022: EU passed resolution requiring implementation by end of 2023

Our view: profit shifting has benefits as well as costs

- Dyrda et al. 2022 (positive): Increases return on intangible investment. MNEs would respond to OECD/G20 plan by doing less of this investment. Global economy would shrink.
- **This paper (normative):** Creates opening for corporate taxes to make cross-country allocation of intangible investment more efficient. Optimal to allow MNEs to shift profits.

What we do

1. **Theory:** Optimal taxation of corporate income in multi-country neoclassical growth model with three ingredients designed to capture key features of modern global economy:
   - MNEs and nonrival intangible capital
   - International technology spillovers through FDI
   - Profit shifting via transfer pricing of intangible income
2. **Quantification:** Ramsey problems in calibrated model with three additional ingredients:
   - Asymmetric countries
   - Heterogeneous firms
   - Selection into exporting, multinational activity, and profit shifting

What we find

1. **Theory**
   - No profit shifting: Spillover externality prevents planner from using corporate taxes to achieve efficient allocation of intangible investment
   - With profit shifting: Planner can use corporate income taxes to fully internalize externality
   - Caveat: Corporate taxes create intertemporal distortions. Planner needs to offset with capital income taxes to achieve Pareto optimality. Chamley-Judd no longer holds.
2. **Quantification**
   - No restrictions: Adverse intertemporal effects dominate. Large corporate tax cuts in high-tax rich countries, eliminate profit shifting.
   - Restricted to Pareto improvements: Smaller tax cuts, profit shifting similar to status quo

Outline

1. Theory

- Preferences and technology
- Pareto frontier
- Competitive equilibrium with transfer pricing and profit shifting
- Implications of spillovers and profit shifting for Ramsey planner
- Implementing a Pareto-optimal allocation

2. Quantification

- Overview of firm heterogeneity and selection margins
- Calibration overview
- Ramsey policies

THEORY

Environment overview

- Multi-country BKK with distortionary taxation as in Chari, Nicolini, Teles (2022)
  - Representative consumers with standard preferences
  - Nontradable final goods
  - Country-specific intermediate goods
  - Governments that finance public consumption using distortionary taxes
- Add multinationals and intangible capital as in McGrattan and Prescott (2009,2010)
- Add spillover externality in intangible capital production
- Add transfer pricing and profit shifting as in Dyrda et al. (2022)

Preferences and final goods

- Preferences

$$U^i = \sum_{t=0}^{\infty} \beta^t u^i \left(c_{it}, h_{it}\right).$$

- Nontradable final goods produced according to CRS technology:

$$q_{it} = G^i\big(\underbrace{q_{1it}, \ldots, q_{Iit}}_{\substack{\text{Domestic} \\ \text{or imported}}}, \; \underbrace{\hat{q}_{1it}, \ldots, \hat{q}_{Iit}}_{\substack{\text{Foreign goods} \\ \text{produced locally}}}\big).$$

  - First I elements are domestically-produced intermediates (which are imported when $j \neq i$)
  - Last $I - 1$ elements are foreign intermediates produced locally in country i

- Resource constraint

$$q_{it} = c_{it} + g_i + k_{it+1} - (1-\delta)k_{it}$$

Intermediate goods and rival production factors

- Country i's intermediate produced in country j according to DRS technology:

$$y_{ijt} = F^{ij}\left(z_{it}, k_{ijt}, l_{ijt}\right),$$

  - z_{it}: Nonrival intangible capital produced in home country i
  - k_{ijt}, ℓ_{ijt}: Rival local factors from country j

- Resource constraints for intermediate goods

$$y_{iit} = q_{iit} + \sum_{j \neq i} q_{ijt}$$

$$y_{ijt} = \hat{q}_{ijt} \quad \forall_{j \neq i}$$

- Resource constraints for factors of production

$$k_{it} = \sum_{j=1}^{I} k_{jit}, \quad h_{it} = \sum_{j=1}^{I} \ell_{jit} + \ell_{it}^{z}.$$

Nonrival intangible capital

- Intangible capital z_{it} produced using domestic R&D labor ℓ_{it}^{z}:

$$z_{it} = H^{i}(\ell_{it}^{z}; \{\ell_{jt}^{z}\}_{j \neq i})$$

- Spillover effect: foreign countries' R&D efforts enhance productivity of ℓ_{it}^{z}
- $H_{j}^{i} := \partial H^{i} / \partial l_{jt}^{z}$: marginal product of an additional unit of research labor in country j in producing intangible capital in country i
- $H_{j}^{i} > 0$ for $j \neq i$: the spillover effect is positive
- Simple way to capture technology transfer via FDI
  - e.g. Javorcik (2004) and Bitzer, Kerekes (2008)

Pareto frontier

- Standard static and intertemporal conditions from Chari, Nicolini, Teles (2022)
- New condition for optimal level of intangible investment:

$$\frac{F_{\ell}^{ii}}{F_{z,t}^{ii} H_i^i} = 1 + \underbrace{\sum_{j \neq i} \frac{u_c^j G_{\hat{i},t}^j F_z^{ij}}{u_c^i G_i^i F_z^{ii}}}_{\text{Nonrivalry effect}} + \underbrace{\sum_{j \neq i} \left[\frac{H_i^j}{H_i^i} \left(\frac{G_{\hat{j}}^i F_z^{ji}}{G_i^i F_z^{ii}} + \frac{u_c^j G_j^j F_z^{jj}}{u_c^i G_i^i F_z^{ii}} \right) + \sum_{k \neq i,j} \frac{H_i^k}{H_i^i} \frac{u_c^j G_{\hat{k}}^j F_z^{kj}}{u_i^c G_i^i F^i i_z} \right]}_{\text{Spillover effect}}$$

  - Left side: Marginal rate of technical substitution between production labor and R&D labor in home country
  - Nonrivalry effect: worldwide gains from higher output of *i*'s intermediate good in all countries
  - Spillover effect: worldwide gains from higher output of other countries' intermediates due to increased R&D productivity

Market arrangements and competitive equilibrium

- Consumers and final-good producers as in BKK
- Governments finance spending using distortionary taxes τ_{it}^{p} on corporate income
- Intermediate-good MNEs maximize global after-tax profits
- Transfer pricing and profit shifting work as in Dyrda et al. (2022)
  - Each division pays per-unit intangible capital licensing fee $\vartheta_{ijt} = MRP_{zt}^{ij}$
  - Market value of intangible capital = sum of licensing fees: $\boldsymbol{\vartheta}_i = \sum_{j=1}^{I} \vartheta_{ijt}$
  - By default, domestic parent owns intangible capital and collects fees from foreign affiliates
  - Can sell fraction λ of licensing rights to tax haven with tax rate τ_{TH}^{p}
  - Sale occurs at markdown $\varphi < 1$ below market value. Incurs convex cost $\mathcal{C}(\lambda)$.
  - For now, no economic activity takes place in tax haven. Relax in quantification.

MNE's problem – second stage

- Given intangible capital z_{it}, choose how must to produce in each location to maximize profits
- Domestic parent division that produces y_{ii}:

$$\pi_{ii}(z_i) = \max_{\{\ell_{ii}, k_{ii}, q_{ij}\}_{j=1}^{I}} (1 - \tau_i^p) \left[p_{ii} q_{ii} + \sum_{j \neq i} p_{ij} q_{ij} - w_i \ell_{ii} - \delta p_i k_{ii} \right] - r_i k_{ii}$$

- Foreign affiliates that produce y_{ij}, $j \neq i$:

$$\pi_{ij}(z_i) = \max_{\ell_{ij}, k_{ij}, \hat{q}_{ij}} \left(1 - \tau_j^p\right) \left[\hat{p}_{ij} \hat{q}_{ij} - w_j \ell_{ij} - \delta p_j k_{ij}\right] - r_j k_{ij}$$

- Note: tangible capital costs other than depreciation is <u>not tax-deductable</u>, which means that increasing τ_j^p reduces k_{ij}.

MNE's problem – first stage

- Choose intangible investment and profit shifting to maximize global profits:

$$d_i = \max_{z_i, \lambda_i} \Bigg\{ \overbrace{\pi_{ii}(z_i) - (1-\tau_i^p) w_i \ell_i^z}^{\substack{\text{Domestic parent profits} \\ \text{inclusive of R\&D cost}}} + \overbrace{\sum_{j \neq i} [\pi_{ij}(z_i) - (1-\tau_j^p)\vartheta_{ij} z_i]}^{\substack{\text{Foreign affiliate profits} \\ \text{inclusive of licensing fees}}}$$

$$+ \underbrace{(1-\tau_i^p) \left[(1-\lambda_i) \sum_{j \neq i} \vartheta_{ij} + \lambda_i (\varphi_i - \mathcal{C}(\lambda_i)) \boldsymbol{\vartheta}_i - \lambda_i \vartheta_{ii} \right] z_i}_{\text{Parent licensing income net of profit shifting costs}} + \underbrace{(1-\tau_{TH}^p)(1-\varphi_i)\lambda_i \boldsymbol{\vartheta}_i z_i}_{\substack{\text{Tax-haven} \\ \text{affiliate profits}}} \Bigg\}$$

- Note: R&D labor <u>is tax-deductable</u>, which means that increasing τ_i^p does not reduce z_i
- Instead, reduces foreign affiliates' tax rates rate relative to rate at which R&D costs are deducted, which increases z_i

Intangible investment wedge – without profit shifting

$$\frac{F_\ell^{ii}}{H_\ell^i F_z^{ii}} = 1 + \sum_{j \neq i} \frac{(1-\tau_j^p) p_{ij} F_z^{ij}}{(1-\tau_i^p) p_{ii} F_{iiz}} = 1 + \sum_{j \neq i} \left(\frac{u_c^j}{u_c^i} \frac{G_{\hat{i}}^j}{G_i^i} \frac{F_z^{ij}}{F_z^{ii}} \right) \left(\frac{1-\tau_j^p}{1-\tau_i^p} \right)$$

Proposition

Without profit shifting, Ramsey planner cannot achieve efficient allocation of intangible investment.

Intuition:

- $(1-\tau_j^p)/(1-\tau_i^p)$ has to be > 1 for some countries but < 1 for others, but spillover effect strictly positive for all countries
- Still holds with transfer pricing but no profit shifting. Corporate taxes do not show up at all, so planner has no ability whatsoever to affect allocation of intangible investment.

Intangible investment wedge – with profit shifting

$$\frac{F_{\ell}^{ii}}{H_{\ell}^{i} F_{z}^{ii}} = \left[1 + \sum_{j \neq i} \left(\frac{u_c^j}{u_c^i} \frac{G_{\hat{i}}^j}{G_i^i} \frac{F_z^{ij}}{F_z^{ii}} \right) \right] \underbrace{\left\{ 1 - \mathcal{C}\left(\lambda_i\right) + \frac{\lambda_i \left(1-\varphi\right) \left(\tau_i^p - \tau_{TH}^p\right)}{\left(1-\tau_i^p\right)} \right\}}_{\mathcal{P}(\tau_{it}^p) \geq 1, \ \nearrow \text{in} \tau_i^p}$$

Proposition

In baseline model with transfer pricing and profit shifting, Ramsey planner can achieve efficient allocation of intangible investment.

Intuition:

- After-tax return on intangible investment can be driven arbitrarily high by increasing τ_i^p due to tax-deductability of RD costs
- The higher τ_i^p, the more RD costs can be deducted while earning same profit on licensing fees taxed booked in tax haven

Intangible investment wedge – no spillovers

Without spillovers, only nonrivalry effect operates. Pareto-efficient allocation satisfies

$$\frac{F_\ell^{ii}}{F_z^{ii} H_i^i} = 1 + \sum_{j \neq i} \frac{u_c^j G_{\hat{i}}^j F_z^{ij}}{u_c^i G_i^i F_z^{ii}}$$

Proposition

Without spillovers, planner <u>can</u> achieve efficient allocation of intangible investment by setting corporate income taxes to zero in all countries, both with and without profit shifting.

Tension between static and dynamic efficiency

- Efficient intangible investment requires $\tau_i^p > 0$. Implies wedge in tangible Euler equation:

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

- Corporate taxes reduce tangible investment due to non-deductability of depreciation. Overall effect on intangible investment ambiguous:

$$z_i = \left\{ \left[\underbrace{\left(1 - \tau_i^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_i^p\right)}_{\text{(i): } \searrow \text{ in } \tau_i^p} \Lambda_i + \underbrace{\sum_{j \neq i} \left(1 - \tau_j^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_j^p\right) \Lambda_j}_{\text{unaffected by } \tau_i^p,\ \searrow \text{ in } \tau_j^p} \right] \underbrace{\mathcal{P}\left(\tau_i^p\right)}_{\text{(ii): } \nearrow \text{ in } \tau_i^p} \right\}^{\frac{1-\gamma-\alpha}{1-\phi-\alpha-\gamma}}$$

  - If (i) is stronger than (ii), raising corporate taxes in attempt to correct externality backfires. Stronger spillover amplifies this effect.

- Planner cannot implement Pareto-optimal allocation using corporate income taxes alone

Implementing a Pareto-optimal allocation

Proposition

Suppose planner also has access to tangible capital income taxes τ_{it}^{k}. Then:

- *With spillovers and profit shifting, planner can implement Pareto-optimal allocation by setting τ_{it}^{p} so that $P(\tau_{it}^{p})$ corrects externality, and $\tau_{it}^{k} = -\tau_{it}^{p}$ to eliminate intertemporal wedge.*
- *With spillovers but no profit shifting, planner can never implement a Pareto-optimal allocation.*
- *Without spillovers, setting $\tau_{it}^{p} = \tau_{it}^{k} = 0$ always implements Pareto-optimal allocation.*

- With spillovers, Chamley-Judd doesn't hold. Need non-zero capital income taxes to eliminate intertemporal wedge.
- Other instruments that implement Pareto-optimal allocations: R&D subsidies; bilateral taxes on MNE profits,...

QUANTIFICATION

Overview

- Quantitative version of model accounts for importance of firm heterogeneity in MNE activity, R&D, and profit shifting
  - Firms are heterogeneous in productivity
  - Exporting and establishing foreign affiliates require fixed costs
  - In terms of #: non-exporters > exporters > MNEs > profit-shifting MNEs
  - In terms or size: non-exporters < exporters < MNEs < profit-shifting MNEs
- Calibrate model to match salient facts about production, trade, intangible investment, MNE activity, and profit shifting under current international tax regime
- Solve for cooperative global Ramsey planner's optimal corporate tax system

Firms in quantitative model

- Productivity heterogeneity and monopolistic competition as in Chaney (2008)
- Choices of firm based in region i:
  - $J_X \subseteq I$: set of export destinations, subject to fixed cost κ_{ij}^X
  - $J_F \subseteq I$: set of foreign affiliate locations, subject to fixed cost κ_{ij}^F
  - z: Intangible investment technology on next slide
  - ℓ_j, k_j: rival local factors for $j \in J_F \cup \{i\}$
  - λ: share of intangible capital to shift
- Allow simultaneous exporting and FDI ($J_X \cap J_F \neq \emptyset$) as in Garetto et al. (2019) and McGrattan and Waddle (2020)
- Interdependence between z and (J_F, λ) makes MNEs (especially those that shift profits) more intangible-intensive, but also makes for complex combinatorial optimization problem

Spillovers in quantitative model

- Parameterize R&D technology as

$$z_i(\omega) = A_i \times \ell_i^z(\omega) \times \tilde{Z}_i^{\upsilon}, \text{ where } \tilde{Z}_i = \sum_{j \neq i} \int_{\Omega_{ji}} z_i(\omega') \, \mathrm{d}\omega'$$

  - $\tilde{Z}_i$ = intangible capital of foreign MNEs with affiliates in i
  - υ governs strength of spillover effect. No spillovers when $\upsilon = 0$.

- Fixed-point problem. Each firm's choice needs to be consistent with all other firms' choices:

$$z_i(\omega) = F\left(\{z_j(\omega')\}_{\substack{j \neq i \\ \omega' \in \Omega_j}} \right)$$

Calibration overview

- Aggregation
  - High-tax regions: North America (NA), Europe (EU), Rest of the World (RW)
  - Low tax region (LT): Belgium, Switzerland, Netherlands, Ireland, etc.
  - Tax haven (TH): Antigua, Aruba, the Bahamas, Barbados, etc.
  - Firms from high-tax regions can shift profits to either LT and/or TH
- Identification of key parameters
  - TFP and prod. dispersion: GDP and firm size dist.
  - Intangible share: foreign MNEs' intangible share
  - Trade costs: num. exporters, trade flows
  - FDI costs: num. MNEs, foreign MNEs' VA shares
  - Profit shifting costs: Tørsløv et al. (2022) country-level estimates of lost profits
- Spillover υ hard to calibrate. Compare model with $\upsilon = 0$ vs. $\upsilon > 0$.

Ramsey problem and key tradeoffs

- Objective: population-weighted welfare in long-run steady state
- Instruments: $\{\tau_i^p\}_{i=1}^I$. Labor taxes adjust to restore fiscal balance. No other instruments.
- Many competing effects of raising CIT:
  - With spillovers, fixes externality through profit shifting channel as in theory
  - Reduces tangible investment via intertemporal wedge. May also reduce intangible investment if this effect is stronger than profit shifting channel.
  - Raises CIT revenues, which allows reduces intratemporal wedge by lowering labor income taxes
  - Affects profit shifting
    - $i \neq LT$: increases profit shifting, reduces domestic revenues but increases LT's revenues
    - $i = LT$: reduces profit shifting, reduces domestic revenues but increases other countries' revenues

Ramsey policy – Not constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	16.0	5.7	18.8	18.7
Corp. tax (p.p. chg.)	-6.5	-11.6	7.4	1.3
Welfare (% chg.)	0.07	-0.28	-1.13	0.11
Intang. cap. (% chg.)	4.6	7.6	-2.9	-0.4
Lost profits (bench.=100)	38.6	3.4	0.0	90.3
(b) Spillovers				
Corp tax (%)	11.8	2.0	18.5	18.4
Corp. tax (p.p. chg.)	-10.7	-15.3	7.1	1.0
Welfare (% chg.)	-0.07	-0.54	-1.09	0.18
Intang. cap. (% chg.)	7.6	10.2	-2.2	0.3
Lost profits (bench.=100)	20.2	0.0	0.0	87.6

Ramsey policy – Not constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	16.0	5.7	18.8	18.7
Corp. tax (p.p. chg.)	-6.5	-11.6	7.4	1.3
Welfare (% chg.)	0.07	-0.28	-1.13	0.11
Intang. cap. (% chg.)	4.6	7.6	-2.9	-0.4
Lost profits (bench.=100)	38.6	3.4	0.0	90.3
(b) Spillovers				
Corp tax (%)	11.8	2.0	18.5	18.4
Corp. tax (p.p. chg.)	-10.7	-15.3	7.1	1.0
Welfare (% chg.)	-0.07	-0.54	-1.09	0.18
Intang. cap. (% chg.)	7.6	10.2	-2.2	0.3
Lost profits (bench.=100)	20.2	0.0	0.0	87.6

- Primary objective: restructure tax system to benefit RW, which is larger and poorer than other regions

Ramsey policy – Not constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	16.0	5.7	18.8	18.7
Corp. tax (p.p. chg.)	-6.5	-11.6	7.4	1.3
Welfare (% chg.)	0.07	-0.28	-1.13	0.11
Intang. cap. (% chg.)	4.6	7.6	-2.9	-0.4
Lost profits (bench.=100)	38.6	3.4	0.0	90.3
(b) Spillovers				
Corp tax (%)	11.8	2.0	18.5	18.4
Corp. tax (p.p. chg.)	-10.7	-15.3	7.1	1.0
Welfare (% chg.)	-0.07	-0.54	-1.09	0.18
Intang. cap. (% chg.)	7.6	10.2	-2.2	0.3
Lost profits (bench.=100)	20.2	0.0	0.0	87.6

- Primary objective: restructure tax system to benefit RW, which is larger and poorer than other regions
- Spillovers allow planner to increase RW's welfare by 60% more. But also hurts high-tax rich countries more.

Ramsey policy – Not constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	16.0	5.7	18.8	18.7
Corp. tax (p.p. chg.)	-6.5	-11.6	7.4	1.3
Welfare (% chg.)	0.07	-0.28	-1.13	0.11
Intang. cap. (% chg.)	4.6	7.6	-2.9	-0.4
Lost profits (bench.=100)	38.6	3.4	0.0	90.3
(b) Spillovers				
Corp tax (%)	11.8	2.0	18.5	18.4
Corp. tax (p.p. chg.)	-10.7	-15.3	7.1	1.0
Welfare (% chg.)	-0.07	-0.54	-1.09	0.18
Intang. cap. (% chg.)	7.6	10.2	-2.2	0.3
Lost profits (bench.=100)	20.2	0.0	0.0	87.6

- Primary objective: restructure tax system to benefit RW, which is larger and poorer than other regions
- Spillovers allow planner to increase RW's welfare by 60% more. But also hurts high-tax rich countries more.
- Lowering CIT increases intangible investment. Intertemporal distortion channel stronger than profit shifting.

Ramsey policy – Not constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	16.0	5.7	18.8	18.7
Corp. tax (p.p. chg.)	-6.5	-11.6	7.4	1.3
Welfare (% chg.)	0.07	-0.28	-1.13	0.11
Intang. cap. (% chg.)	4.6	7.6	-2.9	-0.4
Lost profits (bench.=100)	38.6	3.4	0.0	90.3
(b) Spillovers				
Corp tax (%)	11.8	2.0	18.5	18.4
Corp. tax (p.p. chg.)	-10.7	-15.3	7.1	1.0
Welfare (% chg.)	-0.07	-0.54	-1.09	0.18
Intang. cap. (% chg.)	7.6	10.2	-2.2	0.3
Lost profits (bench.=100)	20.2	0.0	0.0	87.6

- Primary objective: restructure tax system to benefit RW, which is larger and poorer than other regions
- Spillovers allow planner to increase RW's welfare by 60% more. But also hurts high-tax rich countries more.
- Lowering CIT increases intangible investment. Intertemporal distortion channel stronger than profit shifting.
- Optimal to shut down profit shifting as much as possible. Even with spillovers, negative effect on tax revenues dominates externality.

Ramsey policy – Constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	18.6	16.0	10.1	18.2
Corp. tax (p.p. chg.)	-3.9	-1.3	-1.3	0.8
Welfare (% chg.)	0.04	0.00	0.00	0.01
Intang. cap. (% chg.)	2.6	1.1	1.3	-0.3
Lost profits (bench.=100)	70.2	97.5	113.6	118.2
(b) Spillovers				
Corp tax (%)	16.0	16.0	9.3	17.9
Corp. tax (p.p. chg.)	-6.5	-1.3	-2.1	0.5
Welfare (% chg.)	0.02	0.00	0.00	0.03
Intang. cap. (% chg.)	4.4	1.2	1.9	0.0
Lost profits (bench.=100)	52.2	105.0	120.3	117.5

Ramsey policy – Constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	18.6	16.0	10.1	18.2
Corp. tax (p.p. chg.)	-3.9	-1.3	-1.3	0.8
Welfare (% chg.)	0.04	0.00	0.00	0.01
Intang. cap. (% chg.)	2.6	1.1	1.3	-0.3
Lost profits (bench.=100)	70.2	97.5	113.6	118.2
(b) Spillovers				
Corp tax (%)	16.0	16.0	9.3	17.9
Corp. tax (p.p. chg.)	-6.5	-1.3	-2.1	0.5
Welfare (% chg.)	0.02	0.00	0.00	0.03
Intang. cap. (% chg.)	4.4	1.2	1.9	0.0
Lost profits (bench.=100)	52.2	105.0	120.3	117.5

- Smaller tax cuts in NA and EU required to satisfy promise-keeping

Ramsey policy – Constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	18.6	16.0	10.1	18.2
Corp. tax (p.p. chg.)	-3.9	-1.3	-1.3	0.8
Welfare (% chg.)	0.04	0.00	0.00	0.01
Intang. cap. (% chg.)	2.6	1.1	1.3	-0.3
Lost profits (bench.=100)	70.2	97.5	113.6	118.2
(b) Spillovers				
Corp tax (%)	16.0	16.0	9.3	17.9
Corp. tax (p.p. chg.)	-6.5	-1.3	-2.1	0.5
Welfare (% chg.)	0.02	0.00	0.00	0.03
Intang. cap. (% chg.)	4.4	1.2	1.9	0.0
Lost profits (bench.=100)	52.2	105.0	120.3	117.5

- Smaller tax cuts in NA and EU required to satisfy promise-keeping
- Spillovers help design system that still primarily benefits RW. Without spillovers, NA benefits most.

Ramsey policy – Constrained to Pareto improvements

	NA	EU	LT	RW
(a) No spillovers				
Corp tax (%)	18.6	16.0	10.1	18.2
Corp. tax (p.p. chg.)	-3.9	-1.3	-1.3	0.8
Welfare (% chg.)	0.04	0.00	0.00	0.01
Intang. cap. (% chg.)	2.6	1.1	1.3	-0.3
Lost profits (bench.=100)	70.2	97.5	113.6	118.2
(b) Spillovers				
Corp tax (%)	16.0	16.0	9.3	17.9
Corp. tax (p.p. chg.)	-6.5	-1.3	-2.1	0.5
Welfare (% chg.)	0.02	0.00	0.00	0.03
Intang. cap. (% chg.)	4.4	1.2	1.9	0.0
Lost profits (bench.=100)	52.2	105.0	120.3	117.5

- Smaller tax cuts in NA and EU required to satisfy promise-keeping
- Spillovers help design system that still primarily benefits RW. Without spillovers, NA benefits most.
- Allow profit shifting to continue. More profits shifted to LT than under status quo.

Ramsey policy – Constrained, planner also chooses τ^p_{TH}

	NA	EU	LT	RW	TH
(a) No spillovers					
Corp tax (%)	19.9	16.8	11.4	18.7	5.9
Corp. tax (p.p. chg.)	-2.6	-0.5	0.0	1.3	2.6
Welfare (% chg.)	0.09	0.02	0.00	0.04	–
Intang. cap. (% chg.)	1.7	0.4	0.4	-0.8	–
Lost profits (bench.=100)	65.4	85.4	105.5	100.0	–
(b) Spillovers					
Corp tax (%)	14.6	16.2	9.6	18.2	7.0
Corp. tax (p.p. chg.)	-7.9	-1.1	-1.8	0.8	3.7
Welfare (% chg.)	0.01	0.04	0.00	0.07	–
Intang. cap. (% chg.)	5.2	1.1	1.8	-0.2	–
Lost profits (bench.=100)	27.9	90.4	117.4	93.6	–

Ramsey policy – Constrained, planner also chooses τ^p_{TH}

	NA	EU	LT	RW	TH
(a) No spillovers					
Corp tax (%)	19.9	16.8	11.4	18.7	5.9
Corp. tax (p.p. chg.)	-2.6	-0.5	0.0	1.3	2.6
Welfare (% chg.)	0.09	0.02	0.00	0.04	–
Intang. cap. (% chg.)	1.7	0.4	0.4	-0.8	–
Lost profits (bench.=100)	65.4	85.4	105.5	100.0	–
(b) Spillovers					
Corp tax (%)	14.6	16.2	9.6	18.2	7.0
Corp. tax (p.p. chg.)	-7.9	-1.1	-1.8	0.8	3.7
Welfare (% chg.)	0.01	0.04	0.00	0.07	–
Intang. cap. (% chg.)	5.2	1.1	1.8	-0.2	–
Lost profits (bench.=100)	27.9	90.4	117.4	93.6	–

- If planner can choose tax haven's tax rate as well, raise it only slightly
- Do not shut down profit shifting to TH even though planner puts no weight on it
- Optimal tax rate in TH far less than 15% minimum proposed by OECD/G20

CONCLUSION

Conclusion

- Conventional view: multinational profit shifting bad for global economy
- Our theory: profit shifting has benefits as well as costs
  - Higher corporate taxes mean greater returns to profit shifting and more intangible investment
  - Provides planner with means to correct externality from FDI spillovers
- Our quantification: Optimal Pareto-improving corporate tax system would have similar amount of profit shifting to status quo

Thank you!

APPENDIX

Pareto frontier - CNT

- No intratemporal wedges condition:

$$-\frac{u^i_{c,t}}{u^i_{h,t}} = \frac{1}{G^i_{i,t}F^{ii}_{l,t}} = \frac{1}{G^i_{\hat{j},t}F^{ji}_{l,t}} \quad \forall_i, \forall_{j\neq i}$$

- No intertemporal wedges:

$$\frac{u^i_{c,t}}{\beta u^i_{c,t+1}} = (1-\delta) + G^i_{i,t+1}F^{ii}_{k,t+1} = (1-\delta) + G^i_{\hat{j},t+1}F^{ji}_{k,t+1} \qquad \forall_i, \forall_{j\neq i}$$

- Static production efficiency

$$\frac{G^i_{n,t}}{G^i_{m,t}} = \frac{G^n_{n,t}u^n_{c,t}}{G^m_{m,t}u^m_{c,t}} \qquad \forall_i, \forall_{m,n\neq i}$$

- Dynamic production efficiency

$$\frac{G^i_{j,t}}{G^i_{j,t+1}}\left((1-\delta) + G^i_{i,t+1}F^{ii}_{k,t+1}\right) = \left(\frac{G^j_{j,t}u^j_{c,t}}{G^j_{j,t+1}\beta u^j_{c,t+1}}\right) \qquad \forall_i, \forall_{j\neq i}$$

Wedges in Competitive Equilibrium

1. Labor wedge

$$-\frac{u^i_{c,t}}{u^i_{h,t}} = \frac{(1+\tau^c_{it})}{\left(1-\tau^h_{it}\right)} \frac{1}{G^i_{i,t} F^{ii}_{l,t}} = \frac{(1+\tau^c_{it})}{\left(1-\tau^h_{it}\right)} \frac{1}{G^i_{\hat{j},t} F^{ji}_{l,t}} \quad \forall_i, \forall_{j \neq i},$$

2. Investment wedge

$$\begin{aligned}\frac{u^i_{c,t}}{\beta u^i_{c,t+1}} &= \frac{(1+\tau^c_{it})}{\left(1+\tau^c_{it+1}\right)} \left[1 + \left(1-\tau^p_{it+1}\right)\left(G^i_{i,t} F^{ii}_{k,t+1} - \delta\right)\right] \\ &= \frac{(1+\tau^c_{it})}{\left(1+\tau^c_{it+1}\right)} \left[1 + \left(1-\tau^p_{it+1}\right)\left(G^i_{\hat{j},t} F^{ji}_{k,t+1} - \delta\right)\right] \quad \forall_i, \forall_{j \neq i}.\end{aligned}$$

Wedges in Competitive Equilibrium

3. Static wedge (static production inefficiency)

$$\frac{(1-\tau^x_{nit})\,(1+\tau^m_{mit})}{\left(1+\tau^m_{nit}\right)\,\left(1-\tau^x_{mit}\right)}\frac{G^i_{n,t}}{G^i_{m,t}}=\frac{p_{nt}}{p_{mt}}\frac{G^n_{n,t}}{G^m_{m,t}}\quad \forall_i,\forall_{m,n\neq i},$$

4. Dynamic wedge (dynamic production inefficiency)

$$\frac{\left(1+\tau^m_{jit+1}\right)}{\left(1-\tau^x_{jit+1}\right)}\frac{\left(1-\tau^x_{jit}\right)}{\left(1+\tau^m_{jit}\right)}\frac{G^i_{j,t}}{G^i_{j,t+1}}\left[1+\left(1-\tau^p_{it+1}\right)\left(G^i_{i,t+1}F^{ii}_{k,t+1}-\delta\right)\right]=$$

$$\frac{G^j_{j,t}}{G^j_{j,t+1}}\left[1+\left(1-\tau^p_{jt+1}\right)\left(G^j_{j,t+1}F^{jj}_{k,t+1}-\delta\right)\right].$$

Theory details: solution for z_i – free transfer

- Assume $F^{ij}(z,k,\ell) = A_j z^{\phi} k^{\alpha} \ell^{\gamma}$ as in McGrattan and Prescott (2009,2010)
- Without transfer pricing or profit shifting (i.e. $\vartheta_{ij} = 0$) MNE's intangible capital given by

$$z_i = \left(\underbrace{\left(1-\tau_i^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_i^p\right)}_{\text{(i): } \searrow \text{ in } \tau_i^p} \Lambda_i + \underbrace{\frac{\left(1-\tau_j^p\right)^{\frac{1-\gamma}{1-\gamma-\alpha}}}{\left(1-\tau_i^p\right)} \hat{r}\left(\tau_j^p\right)}_{\text{(ii): } \nearrow \text{ in } \tau_i^p,\ \searrow \text{ in } \tau_j^p} \Lambda_j \right)^{\frac{1-\gamma-\alpha}{1-\gamma-\alpha-\phi}}$$

where $\hat{r}\left(\tau_i^p\right) = \left(\frac{r_i + p_i\delta}{r_i + \left(1-\tau_i^p\right) p_i \delta}\right)^{\alpha} \nearrow$ in τ_i^p and Λ_i, Λ_j are constant in partial equilibrium

(i) Partial non-deductability of tangible investment $\Rightarrow k_{ii} \searrow$ in τ_i^p

(ii) Full deductability of intangible investment $\Rightarrow$ higher τ_i^p makes τ_j^p "feel" lower

Theory details: solution for z_i – transfer pricing

- With transfer pricing but no profit shifting (i.e., assume $\lambda_i = 0$), solution becomes

$$z_i = \left(\underbrace{\left(1-\tau_i^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_i^p\right)}_{\text{(i): } \searrow \text{ in } \tau_i^p} \Lambda_i + \underbrace{\left(1-\tau_j^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_j^p\right)}_{\text{unaffected by } \tau_i^p,\ \searrow \text{ in } \tau_j^p} \Lambda_j \right)^{\frac{1-\gamma-\alpha}{1-\gamma-\alpha-\phi}}$$

- Intangible income in j now flows back to (and is taxed by) i. Term (ii) no longer operates.
- $z_i \searrow$ unambiguously with both τ_i^p and τ_j^p

Theory details: solution for z_i – profit shifting

- In baseline model with profit shifting, solution is

$$z_i = \left[\left(\underbrace{\left(1-\tau_i^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_i^p\right)}_{\text{(i): } \searrow \text{ in } \tau_i^p} \Lambda_i + \underbrace{\left(1-\tau_j^p\right)^{\frac{\alpha}{1-\gamma-\alpha}} \hat{r}\left(\tau_j^p\right)}_{\text{unaffected by } \tau_i^p,\ \searrow \text{ in } \tau_j^p} \Lambda_j \right) \underbrace{\left(1-\mathcal{C}\left(\lambda_i\right)+\frac{\lambda_i\left(1-\varphi\right)\left(\tau_i^p-\tau_{TH}^p\right)}{\left(1-\tau_i^p\right)}\right)}_{\text{(ii): } \nearrow \text{ in } \tau_i^p} \right]^{\frac{1-\gamma-\alpha}{1-\phi-\alpha-\gamma}}$$

- Profit shifting increases intangible investment as in Dyrda et al. (2022)
- Effect of τ_i^p on z_i now ambiguous again

Quantitative model details: final goods producer

The final goods producer of region i combines intermediate goods with a CES technology:

$$Q_j = \left[\sum_{i=1}^{J} \int_{\Omega_{ji}} q_{ji}(\omega)^{\frac{\varrho-1}{\varrho}} \, d\omega \right]^{\frac{\varrho}{\varrho-1}}$$

- Ω_{ji}: the set of goods from i available in j.
- q_{ji}: quantity of inputs
- ϱ: elas. of sub. between varieties

Demand curves:

$$p_{ji}(\omega) = P_i Q_i^{\frac{1}{\varrho}} q_{iji}(\omega)^{-\frac{1}{\varrho}}, \tag{1}$$

The price index is :

$$P_j = \left[\sum_{i=1}^{J} \int_{\Omega_{ji}} p_{ji}(\omega)^{1-\varrho} \, d\omega \right]^{\frac{1}{1-\varrho}}$$

Quantitative model details: accounting measures

Nominal GDP:

$$GDP_i = \sum_{j=1}^{I} \int_{\omega \in \Omega_j, i \in J_F(\omega)} p_{ji}(\omega) y_{ji}(\omega) \ d\omega.$$

Goods Trade:

$$EX_i^G = \sum_{j \neq i} \int_{\Omega_i} p_{ij}(\omega) \left(1 + \xi_{ij}\right) q_{ij}(\omega) \ d\omega,$$

$$IM_i^G = \sum_{j \neq i} \int_{\Omega_j} p_{ji}(\omega) \left(1 + \xi_{ji}\right) q_{ji}(\omega) \ d\omega.$$

Net factor receipts and payments:

$$NFR_i = \sum_{j \neq i} \int_{\Omega_i} \pi_{ij}(\omega) d\omega$$

$$NFP_i = \sum_{j \neq i} \int_{\Omega_j} \pi_{ji}(\omega) d\omega$$

Quantitative model details: accounting measures

Services Trade:

– high-tax regions

$$EX_i^S = \sum_{j \neq i} \int_{\Omega_i} [1 - \lambda_{LT}(\omega) - \lambda_{TH}(\omega)] \, \vartheta_{ij}(\omega) z(\omega) \; d\omega$$

$$IM_i^S = \sum_{j \neq i} \int_{\Omega_i} [\lambda_{LT}(\omega) + \lambda_{TH}(\omega)] \, \vartheta_{ij}(\omega) z(\omega) \; d\omega + \sum_{j \neq i} \int_{\Omega_j} \vartheta_{ji}(\omega) z(\omega) \; d\omega$$

– low-tax regions:

$$EX_{LT}^S = \sum_{j \neq i} \int_{\Omega_i} [1 - \lambda_{TH}(\omega)] \, \vartheta_{ij}(\omega) z(\omega) \; d\omega + \sum_{j \neq i} \int_{\Omega_j} \lambda_{LT} \vartheta_{ji}(\omega) z(\omega) \; d\omega$$

$$IM_{LT}^S = \sum_{j \neq i} \int_{\Omega_i} \lambda_{TH}(\omega) \vartheta_{ij}(\omega) z(\omega) \; d\omega + \sum_{j \neq i} \int_{\Omega_j} [1 - \lambda_{LT}(\omega)] \vartheta_{ji}(\omega) z(\omega) \; d\omega$$

– tax haven:

$$EX_{TH}^S = \sum_{j=1}^{I} \int_{\Omega_j} \lambda_{TH} \vartheta_{ji}(\omega) z(\omega) d\omega$$

Quantitative model details: market clearing

Labor market:

$$L_i = \overbrace{\sum_{j=1}^{I} \int_{\Omega_j} \ell_{ji}(\omega)\ d\omega}^{\text{goods production}} + \overbrace{\int_{\Omega_i} z(\omega)/A_i\ d\omega}^{z \text{ production}} + \overbrace{\int_{\Omega_i} \left(\sum_{j \in J_X(\omega)} \kappa_i^X + \sum_{j \in J_F(\omega)} \kappa_i^F + \lambda_{TH}(\omega) > 0 \kappa_i^{TH} \right)\ d\omega}^{\text{fixed costs}}$$

$$+ \underbrace{\int_{\Omega_i} \left(\mathcal{C}_{i,TH}(\lambda_{TH}) + \mathcal{C}_{i,LT}(\lambda_{LT}) \right) \nu(\omega) z(\omega)\ d\omega}_{\text{costs of shifting } z}$$

Capital market:

$$K_i = \sum_{j=1}^{I} \int_{\Omega_j} k_{ji}(\omega)\ d\omega$$

Government budget constraint:

$$G_i = \tau_i \sum_{j=1}^{I} \int_{\Omega_j} \tilde{\pi}_{ji}(\omega)\ d\omega, \quad \text{where } \tilde{\pi}_{ij}(\omega) \text{ denotes taxable profits}$$

Balance of payments:

$$EX_i^G + EX_i^S - IM_i^G - IM_i^S + NFR_i - NFP_i = 0$$

Calibration: summary

Parameter	Description	Value(s)	Target/source
(a) Assigned parameters			
ϱ	EoS between products	5	Standard
$1-\gamma-\alpha$	Labor share	0.65	Standard
N_j	Population	Varies	World Development Indicators
τ_j	Corporate income tax rate	Varies	Tørsløv et al. (2021)
(b) Calibrated parameters			
γ	Technology capital share	0.11	MNEs' intangible income share
A_i	Total factor productivity	Varies	Real GDP
η_i	Productivity dispersion	Varies	Large firms' employment share
ψ_i	Utility weight on leisure	Varies	$L_i = N_i/3$
ξ_{ij}	Variable export cost	Varies	Bilateral imports/GDP
κ_i^X	Fixed export cost	Varies	Pct. of firms that export
σ_i	Variable FDI cost	Varies	Foreign MNEs' share of value added
κ_i^F	Fixed FDI cost	Varies	Avg. emp. of firms w/ foreign affiliates
ψ_{iLT}	Cost of shifting profits to LT	Varies	Total lost profits
ψ_{iTH}	Cost of shifting profits to TH	Varies	Share of profits shifted to TH
κ_i^{TH}	Fixed cost of TH affiliate	Varies	Avg. emp. of firms w/ TH affiliates

Calibration details: region-specific target moments

Region	NA	EU	LT	RW	TH
Population (NA = 100)	100	92	11	1,323	–
Real GDP (NA = 100)	100	80.78	14.57	297.10	–
Corporate tax rate (%)	22.5	17.3	11.4	17.4	3.3
Foreign MNEs' VA share (%)	11.12	19.82	28.73	9.55	–
Total lost profits ($B)	143	216	–	257	–
Lost profits to TH (%)	66.4	44.5	–	71.1	–
Imports from... (% GDP)					
NA	–	1.28	1.77	1.74	–
EU	1.70	–	12.39	3.78	–
LT	0.35	2.98	–	0.59	–
RW	6.15	7.96	6.78	–	–

Calibration details: internally-calibrated parameter values

Region	NA	EU	LT	RW	TH
TFP (A_i)	1.00	0.90	1.43	0.28	–
Prod. dispersion (η_i)	4.30	4.32	4.87	4.15	–
Utility weight on leisure (ψ_i)	1.46	1.49	1.51	1.47	–
Fixed export cost (κ_i^X)	2.5e-3	5.2e-3	1.5e-3	2.1e-2	–
Variable FDI cost (σ_i)	0.46	0.55	0.52	0.55	–
Fixed FDI cost (κ_i^F)	2.56	2.27	0.65	12.70	–
Cost of shifting profits to LT (ψ_{iLT})	3.73	0.42	–	2.73	–
Cost of shifting profits to TH (ψ_{iTH})	2.46	1.37	–	2.05	–
Fixed FDI cost to TH (κ_i^{TH})	0.13	0.08	–	0.75	–
Variable trade cost from…					
NA	–	3.25	3.45	2.12	–
EU	1.87	–	1.69	1.35	–
LT	2.00	1.59	–	1.58	–
RW	2.19	2.56	2.96	–	–

Calibration details: validation

- Share of corporate income taxes paid by foreign MNEs

Source	NA	EU	LT	RW
Data	16.65	41.58	72.40	16.32
Model	24.40	40.56	73.30	18.54

- Intangible shares of domestic-owned vs. foreign-owned firms
  - Cadestin et al. (2021): 22% vs. 28%
  - Model matches both exactly, although we only target foreign-owned firms' 28% share
- Global MNE spending on profit-shifting workers
  - Tørsløv et al. (2022): $25 billion
  - Model: $75 billion
- Firm-level semi-elasticity of domestic parent profits w.r.t. int'l tax gap
  - Empirical estimates: avg. = 0.96, range = [0.79,1.11]
  - Model: 0.87