A Macroeconomic Perspective on Taxing Multinational Enterprises

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Motivation

MNEs shift large portions of their profits to tax havens, reducing tax revenues in their home countries by hundreds of billions of dollars each year

- Tørsløv et al. (2022): **36% of MNEs profits** shifted to tax havens
- OECD: **$240 bn. (10%)** of global corporate tax revenues lost annually

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- Pillar 2: Global minimum corporate income tax at 15%

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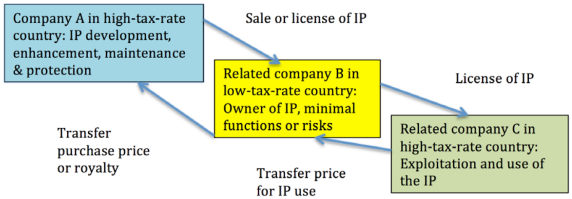
This paper:

- How does profit shifting affect MNEs' production decisions at the micro level?
- What are the aggregate consequences of these micro effects?
- How will the OECD/G20 framework affect the global economy?

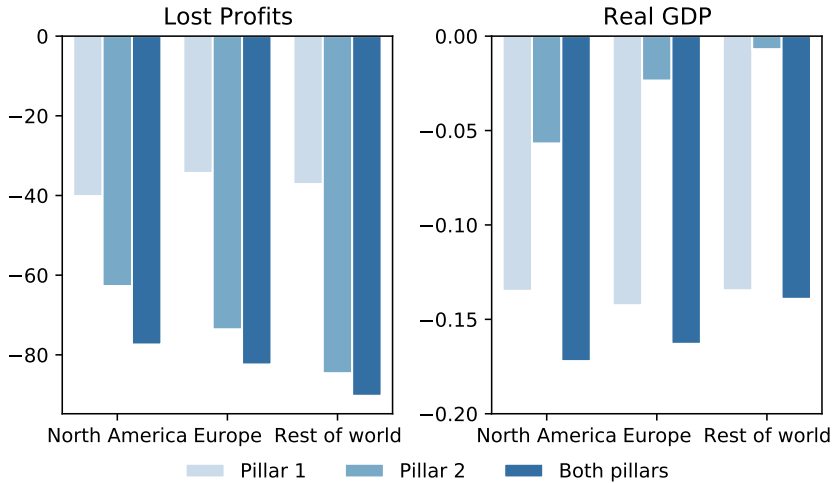
Our theory of profit shifting in brief



"95 percent of Apple's R&D… is conducted in the United States… [During] 2009 to 2012, ASI [Apple Ireland] paid… $5 billion to [Apple USA] as its share of the R&D costs. Over that same time period, ASI received profits of $74 billion. The difference between ASI's costs and the profits, almost $70 billion, is how much taxable income [should] have flowed to the United States."
— U.S. Senator Carl Levin, May 21, 2013

- MNEs shift profits by transferring **nonrival** IP to tax-haven affiliates
- Tax-haven affiliates charge parent (and other affiliates) licensing fees to use IP
- Transfer occurs at below market-value price, violating **arm's length principle**
- Empirical evidence
  - Delis et al. (2021): R&D-intensive firms shift profits
  - Accoto et al. (2021): Firms that shift profits import IP services
- **End result:** raise after-tax return on intangible investment.

Preview of the OECD/G20 plan's consequences



THEORY OF PROFIT SHIFTING AND INTANGIBLES

Environment

- MNE with its parent division in i operates in K locations.
- Location $k \in \{1, ..., K\}$:
  - Population: N_k
  - Productivity: A_k
  - Corporate profit tax rate: τ_k
  - Prices: p_k, w_k
- Technology:

$$F(z, l_k) = A_k \left(N_k \boldsymbol{z}\right)^{\phi} l_k^{\gamma}$$

  - $\boldsymbol{z}$ is **non-rival**, intangible capital
  - l_k is labor input
  - DRS: $(\gamma + \phi) < 1$

Accounting profits

Free Transfer (FT): z transferred at no cost across locations:

$$\pi_i = p_i \left(A_i \left(N_i z \right)^{\phi} l_i^{\gamma} \right) - w_i l_i - p_i z$$

$$\pi_k = p_k \left(A_k \left(N_k z \right)^{\phi} l_k^{\gamma} \right) - w_k l_k, \quad \forall k \neq i$$

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Transfer pricing (TP): parent division retains legal ownership of z and licenses the rights to use it to its foreign affiliates.

$$\pi_i^{TP} = \pi_i + \sum_{k \neq i} q_k z$$
$$\pi_k^{TP} = \pi_k - q_k z \quad \forall k \neq i$$

where

$$q_k \equiv \underbrace{\phi p_k N_k \left(A_k \left(N_k z \right)^{\phi - 1} l_k^{\gamma} \right)}_{\text{Marginal revenue product of } z}$$

Accounting profits

Profit Shifting (PS):

$$\pi_i^{PS} = \pi_i + z\left[\varphi\lambda\sum_k q_k - \lambda q_i + (1-\lambda)\sum_{k\neq i} q_k - \mathcal{C}(\lambda)\sum_k q_k\right]$$

$$\pi_{i^*}^{PS} = \pi_{i^*} + z\left[\lambda\sum_{k\neq i^*} q_k - (1-\lambda)q_{i^*} - \varphi\lambda\sum_k q_k\right]$$

$$\pi_k^{PS} = \pi_k - q_k z \quad \forall k \neq i, i^*$$

where

- $\lambda \in [0,1]$ a fraction of intangible capital z transferred to the tax haven
- $\mathcal{C}(\lambda)$ is the cost of shifting the fraction λ
- $\varphi \leq 1$ is a markdown below the marginal revenue product of z
- i^* is the tax haven, i.e., $\tau_{i^*} = \min\{\tau_1, ..., \tau_K\}$

Profit Maximization

Optimal profit shifting

Assumption

Let $\mathcal{C}(\lambda) \equiv \lambda - (1-\lambda)\log(1-\lambda)$, *implying* $\mathcal{C}'(\lambda) = -\log(1-\lambda)$, $\mathcal{C}(0) = 0$, $\mathcal{C}(1) = 1$, *and* $\lambda \in [0,1]$.

The share of shifted intangible capital:

$$\lambda = 1 - \exp\left(-\frac{(1-\varphi)(\tau_i - \tau_{i^*})}{1-\tau_i}\right)$$

Lemma

The share of shifted intangible capital λ *is:*

1. *Decreasing in* φ.
2. *Decreasing in* τ_{i^*} *with elasticity given by*

$$\varepsilon^{\lambda}_{\tau_{i^*}} = -\frac{1-\lambda}{\lambda}\left(\frac{1-\varphi}{1-\tau_i}\right)\tau_{i^*}$$

Profit shifting and optimal intangible investment

Proposition

1. *If* $\tau_i = \max\{\tau_k\}_{k=1}^K$ *then* $z^{TP} < z^{FT}$.
2. $z^{PS} > z^{TP} \iff \varphi < 1$ *and* $z^{PS} = z^{TP} \iff \varphi = 1$.
3. z^{PS} *is decreasing in* φ.
4. z^{PS} *is decreasing in* τ_{i^*}.

We show

$$z^{TP} = \left(\frac{\sum_{k=1}^K \phi \Lambda_k}{p_i} \right)^{\frac{1-\gamma}{1-\phi-\gamma}} < \left(\frac{\sum_{k=1}^K (1-\tau_k)\phi \Lambda_k}{(1-\tau_i)p_i} \right)^{\frac{1-\gamma}{1-\phi-\gamma}} = z^{FT}$$

where Λ_k is a function of A_k, p_k, N_k, w_k. Then z^{PS} is

$$z^{PS} = z^{TP} \underbrace{\left((1 - \mathcal{C}(\lambda)) + \frac{\lambda(1-\varphi)(\tau_i - \tau_{i^*})}{(1-\tau_i)} \right)^{\frac{1-\gamma}{1-\phi-\gamma}}}_{>1}$$

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with the following elasticities:

$$\varepsilon_{\tau_{i^*}}^{z^{TP}} = 0$$

and

$$\varepsilon_{\tau_{i^*}}^{z^{PS}} = \frac{1-\gamma}{1-\phi+\gamma}\left(\frac{-\tau_{i^*}}{\tau_i - \tau_{i^*}}\right)\frac{1}{\left[1+\frac{1-\mathcal{C}(\lambda)}{\mathcal{C}'(\lambda)}\right]} < \mathbf{0}$$

Effects of OECD/G20 pillar 1 (sales-based profit allocation)

The MNE's tax base in jurisdiction k as:

$$T_k = \underbrace{\pi_k^r}_{\text{Routine profit}} + (1-\boldsymbol{\theta}) \times \underbrace{\pi_k^R}_{\text{Residual profit}} + \boldsymbol{\theta} \times \underbrace{\frac{\boldsymbol{p_k y_k}}{\sum_k \boldsymbol{p_k y_k}}}_{\text{Sales share of } k} \times \underbrace{\prod^R}_{\text{Global residual profit}}$$

where:

- $\pi_k^r = \boldsymbol{\mu} p_k y_k$
- $\pi_k^R = \pi_k^{PS} - \pi_k^r$
- $\prod^R = \sum_k \pi_k^R$

with two policy parameters:

- $\boldsymbol{\mu}$ is the routine profit margin
- $\boldsymbol{\theta}$ is the fraction of global residual profits reallocated according to sales shares

Effects of OECD/G20 pillar 1 (sales-based profit allocation)

Proposition

1. $\hat{\lambda} < \lambda$ *and* $\hat{z}^{PS} < z^{PS}$.
2. $\hat{\lambda}$ *and* $\hat{z}^{PS}$ *are decreasing in* θ.
3. *The economy is less responsive to changes in* τ_{i^*}*:*

$$\left|\varepsilon^{\hat{z}^{PS}}_{\tau_{i^*}}\right| < \left|\varepsilon^{z^{PS}}_{\tau_{i^*}}\right|$$

$$\lambda = 1 - \exp\left(-\frac{(1-\varphi)(\tau_i - \tau_{i^*})}{1-\tau_i}\right)$$

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$$\hat{\lambda} = 1 - \exp\left(-\frac{(1-\varphi)(1-\boldsymbol{\theta})(\tau_i - \tau_{i^*})}{1-((1-\boldsymbol{\theta})\tau_i + \boldsymbol{\theta}\widehat{\boldsymbol{\tau}})}\right).$$

where

$$\widehat{\tau} \equiv \sum_j \tau_j \cdot \frac{p_j y_j}{\sum_k p_k y_k}.$$

QUANTITATIVE MODEL

Model environment

- Synthesis of Helpman, Melitz, and Yeaple (2004) and McGrattan and Prescott (2010), plus **transfer pricing** and **profit shifting**
- I productive regions
  - Representative consumer, gov't, and measure of firms
  - Differ in size, TFP, trade/FDI openness, corporate taxes
- 1 unproductive region ("tax haven")
  - Gov't earns revenue by taxing profits of foreign MNEs' affiliates
- Firms in productive regions:
  - Heterogeneous in productivity, compete monopolistically a là Melitz
  - Choose whether to export and/or establish foreign affiliates
  - Parent division invests in nonrival intangible capital, foreign affiliates pay licensing fees
  - Shift profits to lowest-tax productive region and/or tax haven as in theory

Consumers | Final goods producers | Profit Shifting

TAKING THE MODEL TO THE DATA

Calibration: Region-specific target moments

Region	North America	Europe	Low-tax	RoW	Tax haven
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)					
North America	–	1.28	1.77	1.74	–
Europe	1.70	–	12.39	3.78	–
Low tax	0.35	2.98	–	0.59	–
Row	6.15	7.96	6.78	–	–

Validation

Compare semi-elasticity of profit shifting in simulated firm-level data to empirical estimates

$$\log \pi_i^{k,PS}(\omega) = \beta_0 + \beta_\ell \log \ell_i^k(\omega) + \beta_z \log z^k(\omega) - \beta_\tau \hat{\tau}_i^k + \epsilon_i^k(\omega)$$

- $\hat{\tau}_i^k$: tax differential between an MNE's home region and LT or TH.
- β_τ: Percentage change in reported profit in response to a one-percentage-point change in the tax differential between the home country and a tax haven
- k: the index of the counterfactual economy

Study	**Data source**	β_τ
Johansson et al. (2017)	ORBIS, 2000-2010	1.11
Heckemeyer and Overesch (2017)	Meta: 27 studies, 203 estimates	0.79
Beer et al. (2020)	Meta: 38 studies, 402 estimates	0.98
This paper	Simulated model data	**0.87**

More validations

QUANTITATIVE EXPERIMENTS

OECD Reform Proposal: Macro Effects

Region	Lost profits (benchmark = 1)	Corp. tax rev. (% chg.)	Value added (% chg.)	Tech. capital (% chg.)		
				Total	Non MNEs	Domestic MNEs
(a) Pillar 1: Profit reallocation						
North America	0.60	2.54	-0.13	**-0.40**	**0.15**	**-0.80**
Low tax	0.69	-11.40	-0.13	0.79	0.23	1.35
(b) Pillar 2: Global minimum tax rate						
North America	0.37	3.24	-0.06	**-0.15**	**0.08**	**-0.31**
Low tax	0.49	-9.70	0.02	0.32	0.36	0.28
(c) Pillars 1 & 2 together						
North America	0.23	4.36	-0.17	**-0.48**	**0.17**	**-0.94**
Low tax	0.33	-16.46	-0.13	1.00	0.48	1.51

Notes: For the low-tax region, lost profits are negative in both the benchmark equilibrium and in the policy counterfactuals, i.e., profits are shifted inward to the low-tax region.

Wages

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OECD Reform Proposal: VA decomposition

Region	Value added (% chg.)			
	Total	Non MNEs	Domestic MNEs	Foreign MNEs
(a) Pillar 1: Profit reallocation				
North America	**-0.13**	**-0.01**	**-0.30**	**-0.05**
Low tax	-0.13	-0.10	0.36	-0.56
(b) Pillar 2: Global minimum tax rate				
North America	**-0.06**	**0.01**	**-0.10**	**-0.13**
Low tax	0.02	0.23	0.19	-0.46
(c) Pillars 1 & 2 together				
North America	**-0.17**	**-0.02**	**-0.36**	**-0.11**
Low tax	-0.13	0.07	0.50	-0.98

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North America	-0.06	0.01	-0.10	-0.13
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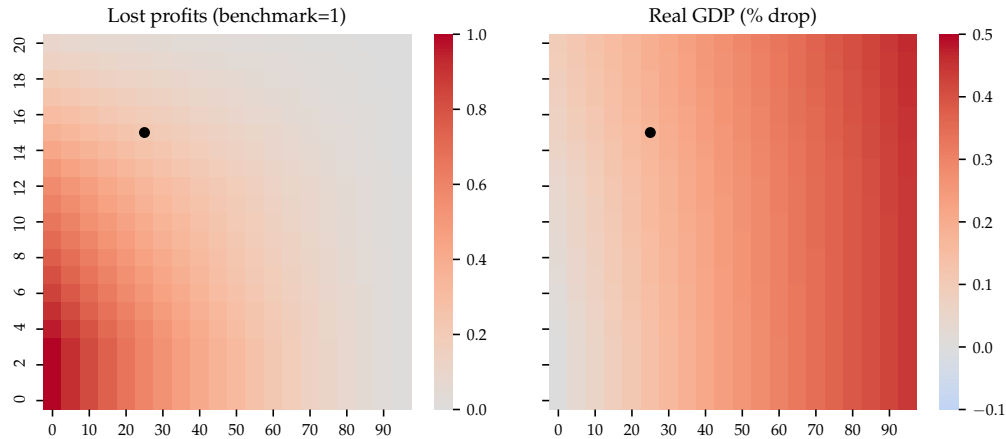
OECD/G20 plan: varying the sizes of the pillars (NA only)



Note: X-axis in each plot represents the reallocation share for pillar 1. Y-axis in each plot represents the global minimum corporate income tax rate for pillar 2.

Summary

1. **Methodology**: We develop a theory in which MNEs can shift profits by transferring IP to tax havens and integrate it into a quantitative GE model

2. **Theoretical insight**: profit shifting erodes high-tax countries' tax bases, but also incentivizes their MNEs to invest more heavily in intangible capital

3. **Quantification**: OECD/G20 reform designed to address profit shifting will materially reduce global GDP despite small number of firms targeted
   - Similar magnitude to welfare effects of major trade liberalizations
     - U.S. gained 0.06% from NAFTA (Caliendo and Parro, 2014)
     - OECD gained 0.15% from China trade (di Giovanni et al., 2014)

Calibration Overview

Parameter	Description	Value(s)	Target/source
(a) Assigned parameters			
ϱ	EoS between products	5	Standard
N_j	Population	Varies	World Development Indicators
τ_j	Corporate income tax rate	Varies	Tørsløv, Wier, and Zucman (2022)
(b) Calibrated parameters			
ϕ	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: Region-specific target moments

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Calibration: Internally-calibrated parameter values

Region	North America	Europe	Low-tax	RoW	Tax haven
TFP (A_i)	1.00	0.89	1.58	0.20	–
Prod. dispersion (η_i)	4.28	4.31	4.83	4.12	–
Utility weight on leisure (ψ_i)	1.06	1.08	1.09	1.06	–
Fixed export cost (κ_i^X)	1.7e-3	3.5e-3	1.0e-3	1.4e-2	–
Variable FDI cost (σ_i)	0.47	0.56	0.52	0.53	–
Fixed FDI cost (κ_i^F)	1.80	1.59	0.46	8.75	–
Cost of shifting profits to LT (ψ_{iLT})	3.40	0.38	–	2.35	–
Cost of shifting profits to TH (ψ_{iTH})	2.25	1.25	–	1.76	–
Fixed FDI cost to TH (κ_i^{TH})	0.09	0.06	–	0.59	–
Variable trade cost from…					
North America	–	3.21	3.41	2.07	–
Europe	1.89	–	1.69	1.33	–
Low tax	2.04	1.59	–	1.56	–
RoW	2.26	2.59	3.01	–	–

Consumer's Problem

Consumers choose labor supply L and consumption C:

$$U(C_i, L_i) = \max_{C_i, L_i} \left[\log\left(\frac{C_i}{N_i}\right) + \psi \log\left(1 - \frac{L_i}{N_i}\right) \right]$$

s.t.

$$P_i C_i = W_i L_i + (1 - \tau_i) D_i$$

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 :

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

Technology

Technology of firm ω in region

$$y_j(\omega) = \sigma_{ij} A_j a(\omega) \left(N_j z(\omega)\right)^{\gamma} \ell_j(\omega)^{\phi}. \tag{2}$$

where

- σ_{ij} is openness of j to FDI from i
- A_j is TFP in region j
- a is the firm-specific productivity
- N_j is population in region j
- z is firm's intangible capital
- ℓ_j is labor hired in j
- γ and ϕ are returns to scale parameters

Trade and Foreign Direct Investment

- Firms from region i can serve the domestic market freely.
- Two options for serving foreign markets:
  - Export domestically produced goods. Fixed cost: κ_{ijX}
  - Open a foreign affiliate and produce locally. Fixed cost: κ_{ijF}
- The firm's resource constraints

$$y_i = q_{ii} + \sum_{j \in J_X} \xi_{ij} q_{ij}^X \tag{3}$$

$$y_j = q_{ij}, \ \ j \in J_F \tag{4}$$

where

  - $J_X \subseteq J \setminus i$: set of foreign destinations to which the firm exports
  - $J_F \subseteq J \setminus i$: set of foreign destinations in which the firm operates a subsidiary

Scale Choice

We use non-exporting foreign affiliate as an example.

Given z, an affiliate of firm $\omega \in \Omega_i$ in region j chooses labor input l to maximize profit:

$$\begin{aligned}\pi_{ij}^{F}(a,z) &= \max_{q,\ell} p_{ij}(q)q - W_i\ell \\ &= \max_{\ell} P_j Q_j^{\frac{1}{\varrho}} \left(\sigma_{ij}A_j a\right)^{\frac{\varrho-1}{\varrho}} \left(N_j z\right)^{\gamma\frac{\varrho-1}{\varrho}} \ell^{\phi\frac{\varrho-1}{\varrho}} - W_j\ell\end{aligned}$$

From the FOC, ℓ can be solved as:

$$\ell = \left\{ \left[\frac{\phi(\varrho-1)}{\varrho}\right]^{\varrho} \left(P_j/W_j\right)^{\varrho} Q_j \left(\sigma_{ij}A_j a\right)^{\varrho-1} \left(N_j z\right)^{\gamma(\varrho-1)} \right\}^{\frac{1}{\phi+\varrho-\phi\varrho}}$$

IP Choice

R&D technology: number of workers required to produce 1 unit of intangible capital in country j is B_j

Under free transferability, the optimal choice of z is

$$z = \left\{ \left(\frac{\phi + \varrho - \phi\varrho}{\gamma(\varrho - 1)} \right) \left[\frac{(1-\tau_i) W_i / A_i}{(1-\tau_i)\left(\bar{R}_{ii} - \bar{C}_{ii}\right) + \sum_{j \in J_F} (1-\tau_j)\left(\bar{R}_{ij} - \bar{C}_{ij}\right)} \right] \right\}^{\frac{\phi+\varrho-\phi\varrho}{\gamma\varrho+\phi\varrho-\gamma-\phi-\varrho}}$$

Within the square bracket (the exponent outside is negative):

- The numerator is the marginal cost of producing z.
- The denominator is the marginal benefit.
- Adding transfer pricing and profit shifting will change optimal z through the denominator.

Profit Shifting Choice

From the FOC, optimal λ can be solved as (independent of z):

$$\lambda = (\mathcal{C}')^{-1} \left[(1 - \varphi) \frac{(\tau_i - \tau_{i^*})}{1 - \tau_i} \right]$$

We can see that λ:

- decreases with the discount factor φ.
- decreases with lowest tax rate τ_{i^*}.

Firm's problem: free transfer of z

$$d_i^{FT}(\omega) = \max_{z,\ell,J_X,J_F,q} \Bigg\{ (1-\tau_i) \overbrace{\left[p_{ii}(q_{ii})q_{ii} + \sum_{j\in J_X} \left(p_{ij}^X(q_{ij}^X)q_{ij}^X - W_i\kappa_{ijX}\right) - W_i(\ell_i + z/A_i) - W_i \sum_{J\in J_F} \kappa_{ijF} \right]}^{\text{Domestic parent profits}} + \sum_{j\in J_F} (1-\tau_j) \underbrace{\left[p_{ij}(q_{ij})q_{ij} - W_j\ell_j\right]}_{\text{Foreign subsidiary profits}} \Bigg\} \tag{5}$$

subject to (1), (2), (3), and (4).

Simplify the notation:

$$\pi_i^D(a, z; J_X) = \max_{q_{ii}, \{q_{ij}^X\}_{j\in J_X}, \ell_i} \left\{ p_{ii}(q_{ii})q_{ii} + \sum_{j\in J_X} p_{ij}(q_{ij}^X)q_{ij}^X - W_i\ell_i \right\}$$

$$\text{s.t} \quad q_{ii} + \sum_{j\in J_X} \xi_{ij} q_{ij} = y_i = A_i a (N_i z)^\gamma \ell_i^\phi$$

and

Firm's problem: free transfer of z

Thus, the conglomerate's problem can be written more succinctly as

$$d_i^{FT}(\omega) = \Bigg\{(1-\tau_i)\Bigg[\pi_i^D(a,z;J_X) - W_i\Bigg(z/A_i + \sum_{J\in J_X}\kappa_{ijX} + \sum_{j\in J_F}\kappa_{ijF}\Bigg)\Bigg] + \sum_{j\in J_F}(1-\tau_j)\pi_{ij}^F(a,z)\Bigg\}$$

Firm's Problem: transfer pricing

Building upon $d^{FT}(a)$, the TP version of the problem can be written as

$$d_i^{TP}(\omega) = \max_{z, J_X, J_F} \Bigg\{ (1-\tau_i) \Bigg[\pi_i^D(a, z; J_X) - W_i \Bigg(z/A_i + \sum_{J \in J_X} \kappa_{ijX} + \sum_{j \in J_F} \kappa_{ijF} \Bigg) + \overbrace{\sum_{j \in J_F} \vartheta_{ij}(z) z}^{\text{Licensing fees}} \Bigg] + \sum_{j \in J_F} (1-\tau_j) \Bigg[\pi_{ij}^F(a, z) - \underbrace{\vartheta_{ij}(z) z}_{\text{Licensing fee}} \Bigg] \Bigg\}$$

Firm's Problem: profit shifting

$$
\begin{aligned}
d_i^{PS}(\omega) = \max_{z, J_X, J_F, \lambda_{LT}, \lambda_{TH}} \Bigg\{ & (1-\tau_i)\Bigg[\pi_i^D(a,z;J_X) - W_i\Bigg(z/A_i + \sum_{J\in J_X}\kappa_{ijX} + \sum_{j\in J_F}\kappa_{ijF}\Bigg) \\
& + \overbrace{\sum_{j\in J_F}(1-\lambda_{LT}-\lambda_{TH})\vartheta_{ij}(z)z}^{\text{Licensing fee receipts}} + \overbrace{(\varphi_i\lambda_{LT}+\varphi_i\lambda_{TH})\,v_i(z)z}^{\text{Proceeds from selling } z} \\
& - \overbrace{(\lambda_{LT}+\lambda_{TH})\vartheta_{ii}(z)z}^{\text{Licensing fee payments}} - \overbrace{W_i\kappa_{iTH}1(\lambda_{TH}>0)}^{\text{Tax haven affiliate cost}} - \overbrace{C(\lambda_{TH}+C(\lambda_{LT}))\nu_i(z)z}^{\text{Cost of shifting } z}\Bigg] \\
& + (1-\tau_{LT})1_{(LT\in J_F)}\Bigg[\pi_{i,LT}^F(a,z) + \overbrace{\sum_{j\in J_F\cup\{i\}\setminus\{LT\}}\lambda_{LT}\vartheta_{ij}(z)z}^{\text{Licensing fee receipts}} - \underbrace{\varphi_i\lambda_{LT}v_i(z)z}_{\text{Cost of buying } z} - \underbrace{\vartheta_{iLT}(z)z}_{\text{Licensing fee pay}}\Bigg] \\
& + (1-\tau_{TH})1_{(\lambda_{TH}>0)}\Bigg[\underbrace{\sum_{j\in J_F\cup\{i\}}\lambda_{TH}\vartheta_{ij}(z)z}_{\text{Licensing fee receipts}} - \underbrace{\varphi_i\lambda_{TH}v_i(z)z}_{\text{Cost of buying } z}\Bigg] \\
& + \sum_{j\in J_F\setminus\{LT\}}(1-\tau_j)\Bigg[\pi_{ij}^F(a,z) - \underbrace{\vartheta_{ij}(z)z}\Bigg]\Bigg\}
\end{aligned}
$$

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:

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

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

Accounting Measures

Services Trade:

- high-tax regions

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

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

- low-tax regions:

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

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

- tax haven:

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

Accounting Measures

Net factor receipts and payments:

$$NFR_i = \sum_{j \neq i} \int_{\Omega_i} \left(1 - \tau_j\right) \pi_{ij}^{PS}(\omega) \, d\omega$$

$$NFP_i = \sum_{j \neq i} \int_{\Omega_j} \left(1 - \tau_i\right) \pi_{ji}^{PS}(\omega) \, d\omega$$

Market Clearing

Labor market:

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

Government Budget Constraint:

$$T_i = \tau_i \sum_{j=1}^{I} \int_{\Omega_j} \pi_{ji}^{PS}(\omega)\ d\omega.$$

Balance of Payments:

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

Wages and Employment

return

Region	Wages	Employment
(a) Effects of transfer pricing		
North America	-0.02	-0.08
Europe	-0.06	0.05
Low tax	0.06	-0.04
Rest of world	-0.03	0.01
(b) Effects of profit shifting		
North America	0.02	0.10
Europe	-0.03	0.11
Low tax	0.18	-0.33
Rest of world	-0.03	0.06

Wages and Employment

return

Region	Wages	Employment
(c) Pillar 1: Profit reallocation		
North America	-0.03	-0.08
Europe	-0.01	-0.05
Low tax	-0.16	0.22
Rest of world	-0.00	-0.03
(d) Pillar 2: Global minimum tax rate		
North America	-0.02	-0.08
Europe	0.03	-0.10
Low tax	-0.07	0.16
Rest of world	0.03	-0.05
(e) Pillars 1 & 2 together		
North America	-0.04	-0.12
Europe	0.01	-0.11
Low tax	-0.20	0.30
Rest of world	0.01	-0.06

Measuring profit shifting in the model

- Profits shifted out of region i by firm ω from region j:

$$\tilde{\pi}_{ij}(\omega) = \pi_{ij}^{TP}(\omega) - \pi_{ij}^{PS}(\omega)$$

  - $\pi_{ij}^{PS}(\omega)$: profit booked in region j by firm ω based in region i
  - $\pi_{ij}^{TP}(\omega)$: the same object for TP scenario

- **Total profits shifted** out of region j:

$$\tilde{\Pi}_j = \sum_{i=1}^{I} \int_{\Omega_i} \tilde{\pi}_{ij}(\omega)\, d\omega.$$

- These measures can be defined in GE or PE:
  - PE: Hold fixed all Q's and P's and measure profits if shifting was not allowed
  - GE: Allow firms to re-optimize and re-clear all markets

return

Calibration

Aggregate countries into 5 regions:

- High-tax regions: North America (NA), Europe (EU), Rest of the World (RW)
- Tax havens identified by Tørsløv et al. (2022) split into
  - Low tax (LT): Belgium, Switzerland, Netherlands, Ireland etc.
  - Tax haven (TH): Antigua, Aruba, the Bahamas, Barbados etc.

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Identification of key parameters:

- TFP (A_i) and prod. dispersion (σ_a): GDP and firm size dist.
- Intangible share (ϕ): Foreign MNEs' intangible share
- Trade costs (κ^X, ξ): Num. exporters, trade flows
- FDI costs (κ^F, σ): Num. MNEs, foreign MNEs' VA shares
- Corporate tax rates (τ): data on effective tax rates
- Profit shifting costs (φ_i): Lost profit estimates from Tørsløv et al. (2022)
  - Measured in PE, consistent with empirical methodology
  - **Lost profits/GDP:** 0.6% for NA, 1.4% for EU, 0.7% for RoW.

OECD/G20 plan details

Pillar 1: sales-based profit allocation

- Allocate rights to tax **25%** of an MNE's global residual profits based on countries' shares of its global sales.
- Residual profits defined as reported profits above pre-determined share of revenues
- Independent of a physical presence; export destinations without foreign affiliates get a cut

Pillar 2: global minimum corporate income tax at **15%**

- If firm based in i reports profits in j with $\tau_j < \underline{\tau}$, then these profits are taxed in i at rate $\underline{\tau} - \tau_j$.
- Additional revenue for i is

$$\tilde{R}_i = \sum_{j=1}^{I} \int_{\Omega_i} \max\left[\left(\underline{\tau} - \tau_j\right), 0\right] \pi_{ij}^{PS}(\omega) \; d\omega$$

Profit maximization

MNE's problem: choose z, $\{l_k\}_{k=1}^K$, and λ to maximize after-tax global profits:

$$\Pi^j \equiv \max_{z,\{l_k\}_{k=1}^K,\lambda} \sum_{k=1}^{K} (1-\tau_k)\pi_k^j$$

- $j \in \{FT, TP, PS\}$ denotes the scenario
- z^{FT}, z^{TP}, z^{PS} denote optimal choices of z in each scenario
- MNE only chooses λ in for scenario $j = PS$

return

Firm's problem

Each firm ω in region i chooses:

- Markets:
  - export destinations J_X, subject to fixed cost κ_i^X.
  - foreign affiliates J_F, subject to fixed cost κ_i^F.
- R&D and employment:
  - intangible capital investment z
  - local factors ℓ_j
- Profit shifting:
  - the share of intangible capital λ to shift

to maximize after-tax global profit:

$$\max_{J_X, J_F, z, \lambda, \ell} \left\{ (1-\tau_i) \left[\pi_i^{PS}(\omega) - \sum_{j \in J_X} W_i \kappa_{ij}^X - \sum_{j \in J_F} W_i \kappa_{ij}^F \right] + \sum_{j \in J_F} (1-\tau_j) \pi_{ij}^{PS}(\omega) \right\}$$

Profit Shifting

return

Additional validation

return

Table: Validation

(a) Share of corporate taxes paid by foreign MNEs (%)

Source	North America	Europe	Low tax	RoW
OECD (2022)	16.65	41.58	72.40	16.32
Model	24.40	40.56	73.30	18.54

(b) Global profit-shifting costs ($bn)

Source	Estimate
Tørsløv et al. (2022)	25
Model	76

Notes: Panel (a): Data source is OECD Corporate Tax Statistics Database (OECD, 2022). Shares are first calculated at the country level, and then aggregated to the region level by averaging, weighting by total corporate tax revenues. Panel (b): Model value calculated by summing $C(\lambda)$ across all firms, dividing by world GDP in the model, and multiplying by 2020 world GDP in the data from the World Bank ($84.91 tn). Panel (c): See Appendix **??** for empirical estimates and Appendix **??** for model estimate.

Inspecting the Mechanism: North America

Free Transfering (FT) –> Transfer Pricing (TP)

- **On impact:**
  - **Domestic MNEs:** after-tax marginal revenue product $z \downarrow$ –> intangible capital $z \downarrow$ –> Value added (VA) $\downarrow$
  - **Non-MNEs**: no direct effect
  - **Fiscal effect:** corporate tax base $\uparrow/\downarrow$

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- **GE:**
  - **Reallocation effect:** wages $\downarrow$ –> non-MNEs: z and VA $\uparrow$
  - **FDI effect:** foreign-MNEs z and VA $\uparrow$
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  - **Macro and Fiscal Effects:** composition of forces

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Transfer Pricing (TP) –> Profit Shifting (PS): **opposite direction**

Inspecting the Mechanism: Macro Effects

Region	Lost profits (% GDP)	Corp. tax rev. (% chg.)	Value added (% chg.)	Tech. capital (% chg.)		
				Total	Non MNEs	Domestic MNEs
(a) Effects of transfer pricing (no transfer pricing vs. no shifting)						
North America	0.00	4.32	-0.16	**-0.54**	**0.58**	**-1.34**
Low tax	0.00	-2.17	-0.25	**0.74**	**-0.75**	**2.28**
(b) Effects of profit shifting (no shifting vs. baseline)						
North America	0.68	-3.82	0.08	0.21	-0.11	0.45
Low tax	-4.37	23.52	-0.04	-0.55	-0.60	-0.49

Wages

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Wages

Inspecting the Mechanism: VA decomposition

Region	Value added (% chg.)			
	Total	Non MNEs	Domestic MNEs	Foreign MNEs
(a) Effects of transfer pricing (no transfer pricing vs. no shifting)				
North America	**-0.16**	**0.36**	**-0.85**	**0.35**
Low tax	**-0.25**	**-0.72**	**1.10**	**-0.56**
(b) Effects of profit shifting (no shifting vs. baseline)				
North America	0.08	-0.00	0.15	0.15
Low tax	-0.04	-0.33	-0.29	0.64

Inspecting the Mechanism: Macro Effects

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Wages

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