A Macroeconomic Perspective on Taxing Multinational Enterprises

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Motivation

Introduction

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

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

In October 2021, 136 countries representing 90% of global GDP signed onto historic policy framework designed by OECD/G20 to address profit shifting

- Pillar 1: Sales-based allocation of profit taxation rights
- Pillar 2: Global minimum corporate income tax

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?

Overview

Introduction

What we do

1. Develop theory of profit shifting and intangible investment
2. Embed theory in multi-country, heterogeneous-firm GE model
3. Calibrate to data on profit shifting under current international tax regime
4. Evaluate impact of OECD/G20 proposal

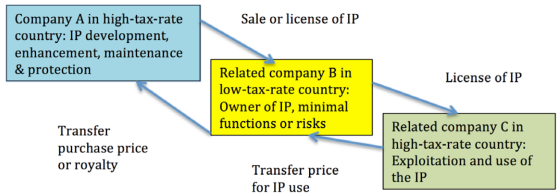
What we find

1. Profit shifting increases intangible investment, leading to higher output in all of an MNE's subsidiaries, both foreign and domestic
2. The OECD/G20 plan will largely eliminate profit shifting, but also reduce global output

Our theory of profit shifting in brief

Introduction

- MNEs shift profits by transferring nonrival intangible capital to affiliates in tax havens
- Tax-haven affiliates charge parent (and other affiliates) licensing fees
- Empirical evidence
  - Delis et al. (2021): R&D-intensive firms shift more profits
  - Accoto et al. (2021): Profit shifters import IP services from tax havens
- End result: increases after-tax return on intangible investment



"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

Contributions to the literature

Introduction

1. Profit shifting: Hines and Rice (1994), Suárez Serrato (2018), Delis et al. (2021), Accoto et al. (2021), Guvenen et al. (2022), Tørsløv et al. (2022)
   → Theory of profit shifting via transfer pricing of intangible capital
   → Embed in general-equilibrium model to study macro effects

2. MNEs: Helpman et al. (2004), Ellen R. McGrattan and Prescott (2009) and Ellen R. McGrattan and Prescott (2010), Tintelnot (2017), Arkolakis et al. (2018), Garetto et al. (2019), Ellen R. McGrattan and Waddle (2020)
   → Model where heterogeneous firms decide foreign affiliate locations, intangible investment, and profit shifting

3. Macro public finance: Harberger (1962), Auerbach (1983), Barro and Furman (2018), Kaymak and Schott (2018), Bhandari and Ellen R McGrattan (2020)
   → Aggregate implications of profit shifting for corporate tax reform

Theory of profit shifting

Environment: Basics

Theory of profit shifting

- MNE operates in N countries that differ in TFP (A_i), prices (p_i, w_i), corporate taxes (τ_i)
  - i: Parent division in home country
  - $j \neq i$: Foreign affiliates
  - j^*: Tax haven with $\tau_{j^*} = \min\{\tau_1, ..., \tau_N\}$
- Production technology in country j:

$$F_j(z, l_j) = A_j z^{\phi} l_j^{\gamma},$$

  - z: Non-rival intangible capital, purchased in home country
  - l_k: Rival factors, purchased locally in k
  - $\phi + \gamma < 1$: Decreasing returns to scale
- MNE's goal: maximize global after-tax profits $\sum_{j=1}^{N} (1 - \tau_j) \pi_j$

Environment: Transfer pricing and profit shifting

Theory of profit shifting

- Transfer pricing:
  - Foreign affiliates pay licensing fees q_j to use intangible capital
  - Arm's-length principle: $q_j = \phi p_j \left(A_j z^{\phi - 1} l_j^{\gamma} \right)$
- Profit shifting:
  - Parent division can sell fraction λ of intangible capital licensing rights to tax haven
  - Sale occurs at markdown $\varphi \leq 1$ below arm's-length price $\boldsymbol{q} = \sum_j q_j$
  - Incurs convex cost $\mathcal{C}(\lambda) = \lambda + (1 - \lambda) \log(1 - \lambda)$ per unit value of z
- Characterize solution to MNE's problem in two cases:
  - No profit shifting: $\lambda = 0$
  - With profit shifting: λ chosen optimally

Profit accounting

Theory of profit shifting

No profit shifting:

$$\begin{aligned}
\text{[Parent]} \quad & \pi_i = p_i\left(A_i z^{\phi} l_i^{\gamma}\right) - w_i l_i - p_i z + \boldsymbol{q} z \\
\text{[Affiliate]} \quad & \pi_j = p_j\left(A_j z^{\phi} l_j^{\gamma}\right) - w_j l_j - q_j z, \quad \forall j \neq i
\end{aligned}$$

With profit shifting:

$$\begin{aligned}
\text{[Parent]} \quad & \pi_i = p_i\left(A_i z^{\phi} l_i^{\gamma}\right) - w_i l_i - p_i z + \left[\varphi\lambda\boldsymbol{q} - \lambda q_i + (1-\lambda)\sum_{j\neq i} q_j - \mathcal{C}(\lambda)\boldsymbol{q}\right] z \\
\text{[Tax haven]} \quad & \pi_{i^*} = p_{i^*}\left(A_{i^*} z^{\phi} l_{i^*}^{\gamma}\right) - w_{i^*} l_{i^*} + \left[\lambda\sum_{j\neq i^*} q_j - (1-\lambda) q_{i^*} - \varphi\lambda\boldsymbol{q}\right] z \\
\text{[Affiliate]} \quad & \pi_j = p_j\left(A_j z^{\phi} l_j^{\gamma}\right) - w_j l_j - q_j z, \quad \forall j \neq i, i^*
\end{aligned}$$

Solution to MNE's problem

Theory of profit shifting

No profit shifting:

$$z = \left(\frac{\sum_{j=1}^{N} \phi \Lambda_j}{p_i} \right)^{\frac{1-\gamma}{1-\phi-\gamma}}$$

- Λ_j is a constant that depends on A_j, p_j, and w_j
- Unaffected by corporate taxes. Transfer pricing $\Rightarrow$ costs and benefits of z are taxed in i

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With profit shifting:

$$z = \left(\frac{\sum_{j=1}^{N} \phi \Lambda_j}{p_i} \right)^{\frac{1-\gamma}{1-\phi-\gamma}} \underbrace{\left(1 - \mathcal{C}(\lambda) + \frac{\lambda(1-\varphi)(\tau_i - \tau_{i^*})}{(1-\tau_i)} \right)^{\frac{1-\gamma}{1-\phi-\gamma}}}_{\text{Per-unit net gain from profit shifting} > 1}$$

- Profit shifting increases $z \Rightarrow$ higher output in all production locations
- Effect increasing in τ_i, decreasing in φ and τ_{i^*}

Policy implications & additional results

Theory of profit shifting

Key tradeoff: profit shifting reduces high-tax countries' corporate tax bases, but also increases MNEs' incentives to invest in intangible capital

- Global minimum tax (i.e., increase in τ_{i*}) and other policies intended to curb profit shifting have adverse macroeconomic side effects

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

- Similar effects as raising τ_{i*} or φ: Reduces profit shifting but also intangible investment
- Makes profit shifting and intangible investment less sensitive to tax rates $\Rightarrow$ global minimum tax and profit reallocation are substitutes

Quantitative model & calibration

Model environment

Quantitative model & calibration

- 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
- N productive regions
  - Representative consumer, gov't, and measure of firms
  - Differ in population, TFP, trade/FDI openness, corporate taxes
- 1 unproductive region ("tax haven")
  - Gov't earns revenue by taxing profits of foreign MNEs' affiliates

Firms in quantitative model

Quantitative model & calibration

- Productivity heterogeneity and monopolistic competition as in Chaney (2008)
- Choices of firm based in region i:
  - $J_X \subseteq \{1, \ldots, N\} \setminus \{i\}$: set of export destinations, subject to fixed cost κ_{ij}^X
  - $J_F \subseteq I\{1, \ldots, N\} \setminus \{i\}$: set of foreign affiliate locations, subject to fixed cost κ_{ij}^F
  - $z \geq 0$: Intangible investment, requires R&D labor in home country
  - $\ell_j, k_j \geq 0$: rival local factors for $j \in J_F \cup \{i\}$
  - $\lambda > 0$: share of intangible capital to shift
- Allow simultaneous exporting and FDI ($J_X \cap J_F \neq \emptyset$) as in Garetto et al. (2019), Ellen R. McGrattan and Waddle (2020)
- Interdependence between z and (J_F, λ) makes MNEs (especially those that shift profits) more intangible-intensive. Requires solving mixed discrete-continuous optimization problem.

Calibration

Quantitative model & calibration

Aggregate countries into 5 regions:

- High-tax regions: North America (NA), Europe (EU), Rest of the World (RW)
- Profit-shifting destinations 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.
  - NA, EU, and RW firms can shift profits to LT and/or TH (after paying fixed FDI costs)

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): taken from Tørsløv et al. (2022)
- Profit shifting costs (φ_i): Lost profit estimates from Tørsløv et al. (2022)
  - Lost profits/GDP: 0.6% for NA, 1.4% for EU, 0.7% for RoW.

Validation

Quantitative model & calibration

1. 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

2. Global MNE spending on profit-shifting employees
   - → Tørsløv et al. (2020): $25 billion
   - → Model: $75 billion

3. Firm-level semi-elasticity of domestic parent profits w.r.t. int'l tax gap

Source	Estimate
Heckemeyer and Overesch (2017)	0.79
Beer et al. (2020)	0.98
Johansson et al. (2017)	1.11
Model	0.87

Experiments & results

OECD/G20 plan details

Experiments & results

Pillar 1: Sales-based profit allocation

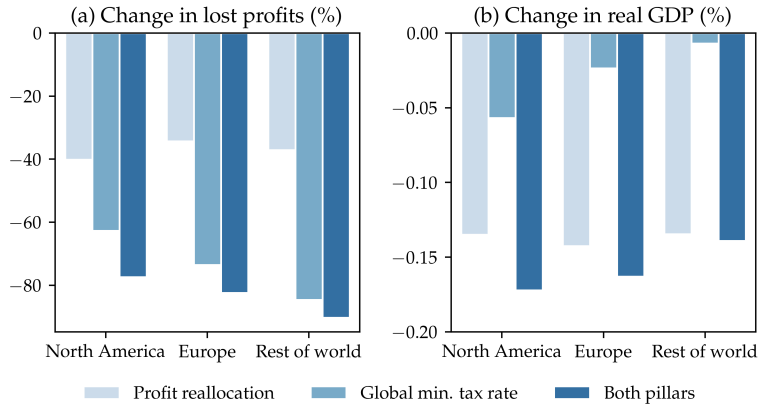
- Allocate rights to tax 25% of an MNE's global residual profits based on countries' shares of its global sales
- Residual profits defined as reported profits above pre-determined share of revenues
- Independent of a physical presence; export destinations without foreign affiliates get a cut

Pillar 2: Global minimum corporate income tax

- If firm from i reports profits in j with $\tau_j < \underline{\tau} = 15\%$, then i taxes these profits at rate $\underline{\tau} - \tau_j$
- Does not require tax havens to change their tax rates or affect their tax revenues (unless firms react by shifting fewer profits). Parent corporate in i just pays larger tax bill.

OECD/G20 plan: effects on profit shifting and output

Experiments & results



OECD/G20 plan: effects on profit shifting and output

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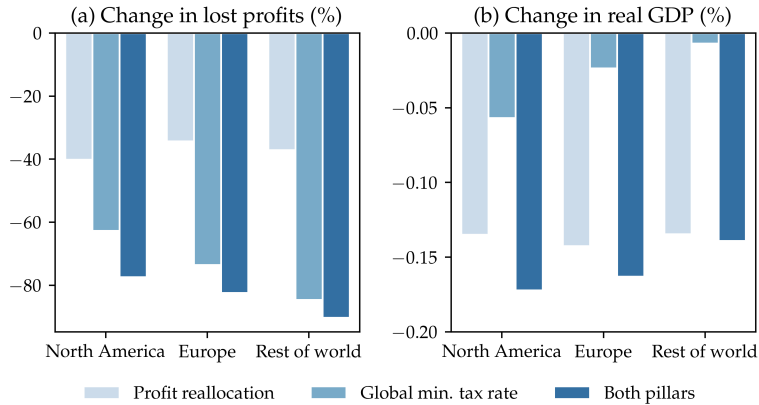
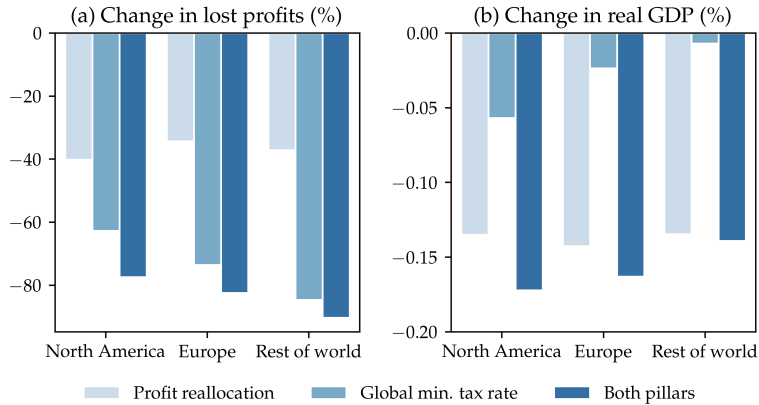


Both pillars reduce profit shifting, but also GDP

OECD/G20 plan: effects on profit shifting and output

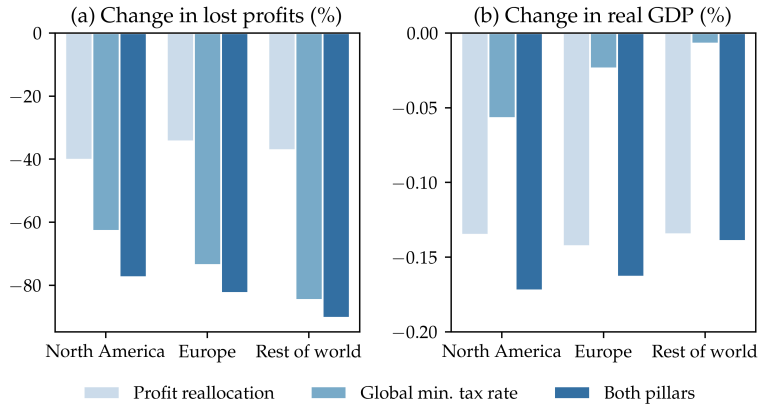
Experiments & results



Global min tax has larger effect on profit shifting, but smaller effect on output

OECD/G20 plan: effects on profit shifting and output

Experiments & results



Combined effect of both pillars on profit shifting similar to effect of global min tax. Combined effect on GDP similar to effect of profit reallocation.

OECD/G20 plan: decomposition of output effects (NA vs. LT)

Experiments & results

Region	Value added (% chg.)				Intang. capital (% chg.)		
	Total	Non MNEs	Domestic MNEs	Foreign MNEs	Total	Non MNEs	Domestic MNEs
(a) Pillar 1: Profit reallocation							
North America	-0.13	-0.01	-0.30	-0.05	-0.40	0.15	-0.80
Low tax	-0.13	-0.10	0.36	-0.56	0.79	0.23	1.35
(b) Pillar 2: Global minimum tax rate							
North America	-0.06	0.01	-0.10	-0.13	-0.15	0.08	-0.31
Low tax	0.02	0.23	0.19	-0.46	0.32	0.36	0.28
(c) Pillars 1 & 2 together							
North America	-0.17	-0.02	-0.36	-0.11	-0.48	0.17	-0.94
Low tax	-0.13	0.07	0.50	-0.98	1.00	0.48	1.51

OECD/G20 plan: decomposition of output effects (NA vs. LT)

Experiments & results

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Output falls in both high- and low tax regions, but for different reasons.

OECD/G20 plan: decomposition of output effects (NA vs. LT)

Experiments & results

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In high-tax regions, losses come primarily from domestic MNEs' lower intangible investment. But foreign MNEs matter too.

OECD/G20 plan: decomposition of output effects (NA vs. LT)

Experiments & results

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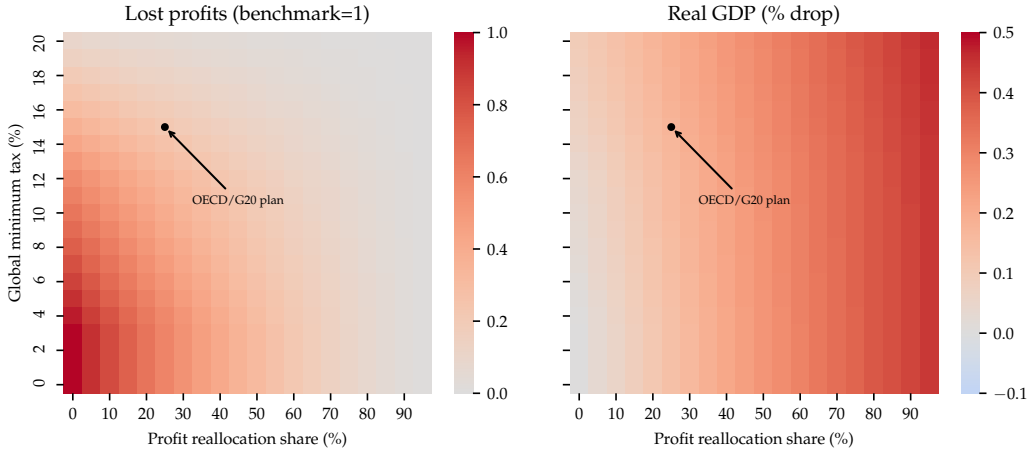
Low tax	-0.13	0.07	0.50	-0.98	1.00	0.48	1.51

In low-tax region, losses come solely from foreign MNEs' lower intangible investment. Note domestic firms actually invest and produce more.

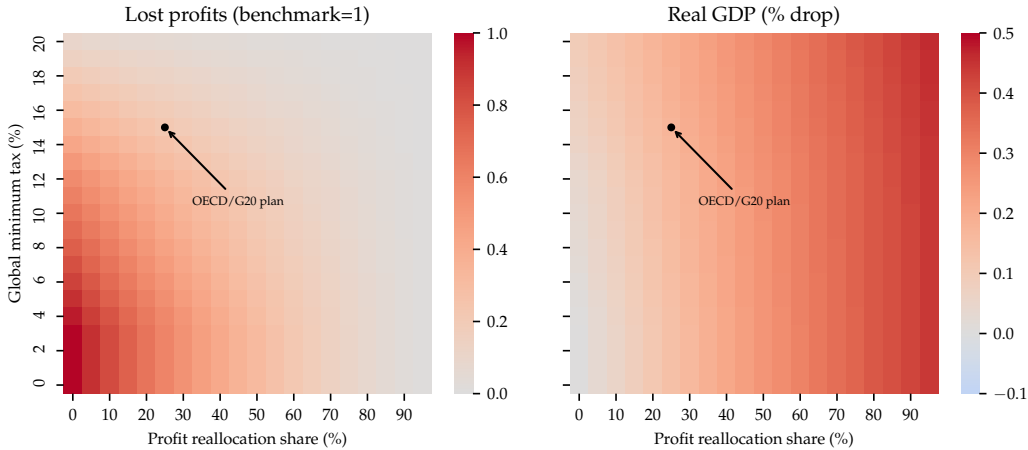
OECD/G20 plan: varying the pillar parameters (NA only)

Experiments & results



OECD/G20 plan: varying the pillar parameters (NA only)

Experiments & results



Effect of OECD/G20 plan plan on profit shifting can be achieved with smaller output loss by raising global min tax slightly and eliminting profit reallocation rule

Conclusion

Conclusion

Methodology: Develop theory in which MNEs shift profits by transferring IP to tax havens. Integrate into quantitative GE model.

Theoretical insight: Profit shifting increases' MNEs' incentives to invest in intangible investment. Boosts output both at home and abroad.

Quantification: OECD/G20 reform 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 (Giovanni et al., 2014)

Broader agenda:

- Optimal taxation of MNEs (JME 2024)
- Effects of global corporate tax reform for US economy

Appendix

Calibration overview

Appendix

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 et al. (2021)
(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

Appendix

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	–	–

Calibration: Internally-calibrated parameter values

Appendix

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	–	–

Inspecting the mechanism: macro effects

Appendix

Region	Lost profits (% GDP)	Corp. tax rev. (% chg.)	Value added (% chg.)	Tech. capital (% chg.)		
				Total	Non MNEs	Domestic MNEs
(a) Effects of transfer pricing (FT → TP)						
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 (TP → PS)						
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

Inspecting the mechanism: value added decomposition

Appendix

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: intuition (NA only)

Appendix

Effect of transfer pricing (FT $\rightarrow$ TP)

Partial equilibrium:

Domestic MNEs: after-tax marginal revenue product of $z \downarrow \rightarrow z \downarrow \rightarrow$ output $\downarrow$

Non MNEs: no direct effect

Corporate tax base $\uparrow/\downarrow$

General equilibrium

Reallocation effect: Wages $\downarrow \rightarrow$ non MNEs $z, Y \uparrow$

FDI effect: Wages $\downarrow \rightarrow$ foreign MNEs $z, Y \uparrow$

Corporate tax base $\uparrow$ Effect of profit shifting (TP $\rightarrow$ PS)

Opposite direction for all effects

Allowing MNEs to shift profits undoes adverse effects of transfer pricing regulations

Model details: consumer's problem

Appendix

Consumers choose labor supply L and consumption C:

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

subject to

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

Model details: final goods producer

Appendix

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 :

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

Model details: technology

Appendix

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

Model details: trade and FDI

Appendix

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

Model details: scale choice

Appendix

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:

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

Model details: intangible capital choice

Appendix

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.

Model details: profit shifting choice

Appendix

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^*}.

Model details: firm's problem (no transfer pricing)

Appendix

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

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

Simplify the notation:

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

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

Model details: firm's problem (no transfer pricing)

Appendix

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

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

Model details: firm's problem (transfer pricing)

Appendix

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

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

Model details: firm's problem (profit shifting)

Appendix

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

Model details: accounting measures

Appendix

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:

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

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

Model details: accounting measures

Appendix

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 region:

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

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

- Tax haven:

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

Model details: accounting measures

Appendix

Net factor receipts and payments:

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

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

Model details: market clearing

Appendix

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:

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