A Macroeconomic Perspective on Taxing Multinational Enterprises

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Base Erosion and Profit Shifting (BEPS)

Tax planning strategies of **Multinational Enterprises (MNE)** that exploit gaps in tax rules to:

- artificially shift profits to low or no-tax locations with little or no economic activity
- erode tax bases through deductible payments such as interest or royalties

The magnitude of BEPS:

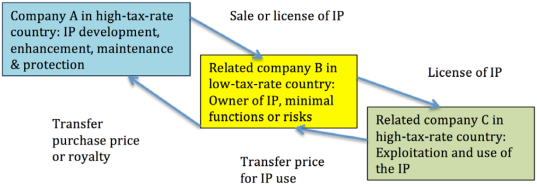
- **OECD estimate**: **$100-$240 billion** global revenues annually, equivalent of **4-10 percent** of global corporate income tax revenues
- **Tørsløv, Wier, and Zucman (2020)**: **36%** of multinational profits were shifted to tax havens globally in 2015
- **Guvenen et al. (2021)**: **37%** of income recorded by US multinationals' foreign affiliates was shifted out of the US

Multinationals shift profits by reallocating IP rights

Two ways of reallocation to the affiliates in low-tax jurisdictions:

- **IP sale**: parent loans affiliate money to buy IP outright
- **Cross licensing**: affiliate pays for portion of parent's R&D expenses

Reallocation often occurs at price **below IP's "market value"**, violating **arm's length principle**.



Source: Neubig and Wunsh-Vincent (2017)

Apple example

OECD Two-Pillar Proposal on Taxing MNEs

An agreement to address BEPS problem:

- signed in October 2021 by 137 countries and tax jurisdictions
- signatories account for **90% of global GDP**
- to be implemented in 2023

Two-Pillar Solution:

1. **Pillar One**: Profit allocation and nexus.
   - **25%** of profits above a set profit margin (residual profits) would be reallocated to the market jurisdictions where the MNE's **users and customers** are located
2. **Pillar Two**: Global minimum taxation.
   - minimum effective corporate profits tax rate of **15%**

What we do

1. **Analytically characterize** the impact of transfer pricing and profit shifting on production inputs in simplified model.

2. Develop a general-equilibrium **macroeconomic framework** that reflects the key features of the current international tax regime.

3. **Quantify** the effects of Two-Pillar Solution proposed by the OECD.

Findings:

1. **Key trade-off**: profit shifting erodes high-tax countries' tax bases, but incentivizes the MNEs to invest in the intangible capital.
2. **Shutting down profit shifting:** increases corporate tax revenue by **0.18%** of GDP and reduces GDP by **0.41%** in North America.
3. **Global Minimum Corporate Tax**: increases corporate tax revenue by **0.11%** of GDP and reduces GDP by **0.12%** in North America.

Outline of the Talk

1. Simple model of profit shifting.

2. Quantitative model.

3. Taking the model to the data.

4. Inspecting the economic mechanisms.

5. Quantifying the global minimum corporate income tax.

SIMPLE MODEL OF PROFIT SHIFTING

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:

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

  where:
  - $\boldsymbol{z}$ 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:

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

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

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 competitive price of z
- i^* is the tax haven i.e. : $\tau_{i^*} = \min\{\tau_1, ..., \tau_K\}$

Profit maximization

Consider after-tax MNE's profit maximization problem for each case:

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

where

- $j \in \{FT, TP, PS\}$
- denote allocations of intangible capital accordingly by: z^{FT}, z^{TP}, z^{PS}
- For $j = PS$, MNE chooses also λ

Profit-shifting margin

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

Under the Assumption, the share of shifted intangible capital λ *is:*

1. Decreasing in φ.

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

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

Key trade-off: base erosion –> increase in z

Lemma

The following hold:

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

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

Key trade-off: base erosion –> increase in z

Lemma

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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^*}.

with the following elasticities:

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

and

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

Pillar 1: profit allocation rule

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 allocated to jurisdiction k according to the sales share

Pillar 1: profit allocation rule

Lemma

The following hold:

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^*}*:*

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

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

where

$$\widehat{\tau} \equiv \sum_i \tau_i \cdot \frac{p_i y_i}{\sum_k p_k y_k}.$$

QUANTITATIVE MODEL

Model environment

- **Helpman, Melitz, and Yeaple (2004)** meets **McGrattan and Waddle (2020)** + **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 operate foreign affiliates
  - invest in **nonrival intangible capital** in parent division, charge foreign affiliates for rights to use it
  - **shift profits** to lowest-tax productive region and/or tax haven

Consumers Final goods producers

Firm's problem

Each firm ω in region i chooses:

- markets:
  - export destinations J_X, subject to fixed cost κ_{ij}^X. algebra
  - foreign affiliates J_F, subject to fixed cost κ_{ij}^F. algebra
- R&D and employment:
  - intangible capital investment z. algebra
  - local factors ℓ_j. algebra
- profit shifting:
  - the share of intangible capital λ to shift algebra

to maximize after-tax global profit:

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

Technology Details Firm's Problem

Shifted Profits in the Model

- Shifted profits by firm ω from region j

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

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

- **Total shifted profits** from region j is

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

These measures can be defined in GE or PE:

- **PE**: hold fixed allocations of factors and measure how profitable each division would be if it was not allowed to profit-shift.

TAKING THE MODEL TO THE DATA

Calibration

- **Five regions**: North America, Europe, Rest of the World, Low Tax and Tax Haven.
  - Low Tax: Belgium, Switzerland, Netherlands, Ireland etc.
  - Tax Haven: Antigua, Aruba, the Bahamas, Barbados etc.
- Non-country-specific params from **McGrattan and Prescott (2010)**.
- Discipline profit shifting φ_i by matching lost profit data measured by **Tørsløv, Wier, and Zucman (2020)**.
  - **Lost profit/GDP**: 0.6% for North America, 1.4% for EU and 0.7% for RoW.
- We calibrate
  - **TFP** (A_i) and **prod. dispersion** (σ_a): GDP and firm size dist.
  - **Trade costs** (κ^X, ξ): export participation and trade data.
  - **FDI costs** (κ^F, σ): Domestic MNEs' and foreign MNEs' VA shares

common region lost profit targets

QUANTITATIVE EXPERIMENTS

Inspecting the Mechanism

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

- **On impact:**
  - **MNEs:** after-tax marginal revenue product $z \downarrow$ + corporate revenues $\uparrow$ –> intangible capital $z \downarrow$ –> output, employment, exports $\downarrow$
  - **Non-MNEs**: no direct effect
  - **Extensive margin:** MNEs less profitable –> % of MNEs $\downarrow$, % of exporters $\uparrow$ –> less MNEs with subsidiaries in both LT and TH jurisdictions
- **GE:**
  - **Non-MNEs:** Wages $\downarrow$ –> employment, output and exports $\uparrow$

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

Inspecting the mechanism: macro variables

Region	GDP	Emp.	Tech. capital		
			Total	MNEs	non MNEs
(a) Free transfer (FT) –> transfer pricing (TP)					
North America	-0.57	-0.07	-0.29	-1.20	1.32
Europe	0.46	0.06	-0.04	-0.07	0.01
Low tax	-0.55	-0.12	0.95	1.51	0.08
Rest of world	0.08	0.01	0.01	0.01	0.02
(b) Transfer pricing (TP) –> profit shifting (PS)					
North America	0.41	0.13	0.10	0.18	-0.04
Europe	0.16	0.07	0.16	0.30	-0.03
Low tax	-2.42	-0.48	0.98	2.31	-1.11
Rest of world	0.24	0.10	0.15	0.24	-0.05

Notes: All columns report **percentage changes**.

Inspecting the mechanism: MNEs & lost profits

Region	% MNEs/Firms			% Lost profits/GDP		% Corp. tax. revenue/GDP
	Total	LT	TH	Total	TH	
(a) Free transfer (FT) –> transfer pricing (TP)						
North America	-0.27	-0.23	–	–	–	12.69
Europe	-0.03	-0.12	–	–	–	-7.37
Low tax	0.15	–	–	–	–	4.36
Rest of world	0.26	-0.51	–	–	–	-1.38
(b) Transfer pricing (TP) –> profit shifting (PS)						
North America	-0.06	0.04	0.88	79.34	32.88	-17.60
Europe	0.09	-0.14	7.95	62.55	42.65	-10.83
Low tax	0.16	–	0.01	-453.61	2.41	51.07
Rest of world	-0.20	-0.52	26.03	83.05	54.58	-14.33

Notes: All columns report changes in **basis points**.

OECD pillar 2: macro variables

			Tech. capital		
Region	GDP	Emp.	Total	MNEs	non MNEs
North America	-0.12	-0.07	-0.19	-0.35	0.07
Europe	-0.09	-0.06	-0.24	-0.44	0.04
Low tax	1.17	0.11	0.80	1.30	-0.01
Rest of world	-0.14	-0.08	-0.22	-0.36	0.07

Notes: All columns report **percentage changes**.

- **Sizeable macro effects** despite small number of firms shifting profits
  - On average in high-tax regions, 0.3% of firms are MNEs and 0.06% of firms have affiliates in the tax haven
- **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)**

OECD pillar 2: MNEs & lost profits

Region	% MNEs/Firms			% Lost profits/GDP		% Corp. tax. revenue/GDP
	Total	LT	TH	Total	TH	
North America	0.02	-0.24	-0.82	-45.72	-28.41	10.66
Europe	-0.04	-0.12	-7.90	-54.80	-41.46	9.74
Low tax	0.15	–	-0.01	211.44	-2.41	31.45
Rest of world	0.12	-0.70	-25.76	-71.01	-52.42	12.51

Notes: All columns report changes in **basis points**

Main Takeaways

1. We develop **a model of international profit shifting** in which MNEs can transfer ownership of intangible capital to low-tax countries.
2. The key **economic trade-off**: profit shifting erodes high-tax countries' tax bases, but incentivizes the MNEs to invest in the intangible capital.
3. Global minimum corporate income tax has **sizeable macroeconomic effects** despite very small number of firms being engaged in profit shifting.

Common parameters

Table: Common parameters

Parameter	Description	Value	Target or source
ϕ	Tech capital income share	0.07	McGrattan and Prescott (2010)
τ_ℓ	Labor wedge	0.34	McGrattan and Prescott (2010)
τ_d	Dividend tax rate	0.28	McGrattan and Prescott (2010)
ϱ	EoS between products	5	Standard

return

Region-specific parameters

(a) Multilateral parameters

Region	Pop. (N_i)	Corp. tax rate ($\tau_{\pi i}$)	TFP (A_i)	markdown (φ_i)
North America	100	22.5	100	5
Europe	92	17.3	87	11
Low tax	11	11.4	136	–
RoW	1323	17.4	21	5
Tax haven	–	3.3	–	–

(d) Variable FDI costs (σ_{ij})

Source/Destination	North America	Europe	Tax haven	RoW
North America	–	0.55	0.60	0.49
Europe	0.47	–	0.60	0.49
Low tax	0.47	0.55	–	0.49
RoW	0.47	0.55	0.60	–

(e) Fixed FDI costs (κ_{ij}^F)

Source/Destination	North America	Europe	Tax haven	RoW
North America	–	1.00	1.00	1.00
Europe	1.00	–	1.00	1.00
Low tax	0.80	0.80	–	0.80
RoW	2.00	2.00	2.00	–

return

Calibration targets

(a) Region-level statistics

Region	Real GDP (NA = 100)	Export participation (%)	Emp. share of firms w/ < 100x avg.	Lost profits (% GDP)
North America	100	22.71	58.91	0.68
Europe	80.78	35.51	58.91	1.40
Low tax	14.57	35.51	58.91	-11.53
RoW	297.10	16.43	58.91	0.70

(b) Bilateral imports/GDP

Destination/Source	North America	Europe	Low tax	RoW
North America	–	1.70	0.35	6.15
Europe	1.28	–	2.98	7.96
Low tax	1.77	12.39	–	6.78
RoW	1.74	3.78	0.59	–

(c) Value added shares by firm type(%)

Region	Non-MNE	Domestic MNE	Foreign MNE
North America	68.71	20.17	11.12
Europe	68.41	11.77	19.82
Low tax	60.71	10.56	28.73
RoW	72.52	17.93	9.55

Sources: Real GDP: World Bank WDI. Export participation: World Bank Exporter Dynamics Database and EFIGE. Employment distribution: U.S. Census. Lost profits: Tørsløv, Wier, and Zucman (2020). Bilateral imports: WIOD. Value added shares: OECD AMNE.

return

The Missing Profits of Nations

Tørsløv et al. (2020) computes missing profits by country:

- The thought experiment is that 1) absent profit shifting and 2) keeping total global profits fixed, how much more profit should be booked in non tax-haven countries.

The computation is done in two steps:

1. Computes excess profits in each tax haven:
    - Compare profit-to-wage ratio of foreign-owned affiliates and local firms in tax havens.
    - Purge out capital intensity differences; obtain total shifted profits of a tax haven from the profit-to-wage ratio gap.
2. Reallocated excess profits to non tax haven countries to:
    - Source countries, based on bilateral excess-risk services exports.
    - Parent countries, based on ownership.

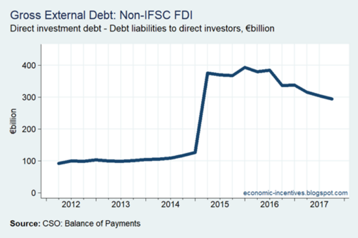
return

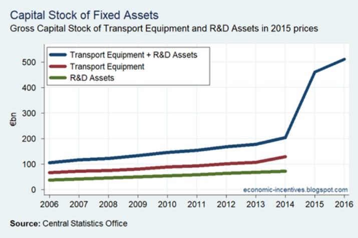
Example: Apple return

Before 2015: Profits shifted to Ireland via cross-licensing scheme

> *...95 percent of Apple's R&D, the engine behind the success of Apple products, is conducted in the United States...* ***[Apple Ireland] paid approximately $5 billion to [Apple USA] as its share of the R&D costs. Over that same time period, [Apple Ireland] received profits of $74 billion.*** *The difference between [Apple Ireland's] costs and the profits, almost $70 billion, is how much taxable income, in the absence of [Apple USA's] cost-sharing agreement with its own subsidiaries and its use of other tax loopholes, would otherwise have flowed to the United States. - Sen. Carl Levin, 2013*

After 2015: Law changes forced Apple to sell IP to Irish affiliate, increasing Ireland's aggregate capital stock by 40% in one year





Ireland's Service Trade return

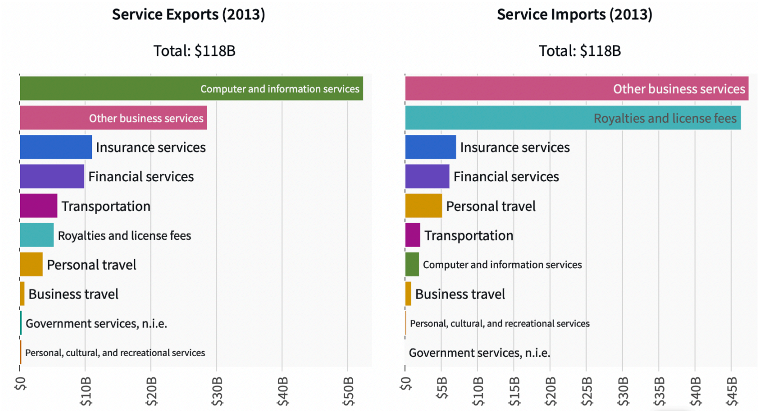


Figure: Ireland's serivce trade in 2013

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.

$$P_i C_i = (1 - \tau_{i\ell})\, W_i L_i + (1 - \tau_i)\, D_i$$

return

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 :

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

return

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

return

Trade and Foreign Direct Investment

return

- 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:

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

return

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

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

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.

return

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^*}.

return

Firm's problem: free transfer of z

return

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

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

$$\pi_{ij}^F(a, z) = \max_{q_{ij},\ell_j} \; p_{ij}(q_{ij})q_{ij} - W_j\ell_j.$$

Firm's problem: free transfer of z

return

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

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

Firm's Problem: transfer pricing

return

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

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

Firm's Problem: profit shifting

return

$$d_i^{PS}(\omega) = \max_{z, J_X, J_F, \lambda_{LT}, \lambda_{TH}} \Bigg\{ (1-\tau_i) \Bigg[\pi_i^D(a, z; J_X) - W_i \Bigg(B_i z + \sum_{J \in J_X} \kappa_{ijX} + \sum_{j \in J_F} \kappa_{ijF} \Bigg)$$

$$+ \overbrace{\sum_{j \in J_F} (1 - \lambda_{LT} - \lambda_{TH}) \vartheta_{ij}(z) z}^{\text{Licensing fee receipts}} + \overbrace{(\varphi_i \lambda_{LT} + \varphi_i \lambda_{TH})\, v_i(z) z}^{\text{Proceeds from selling } z}$$

$$- \overbrace{(\lambda_{LT} + \lambda_{TH}) \vartheta_{ii}(z) z}^{\text{Licensing fee payments}} - \overbrace{W_i \kappa_{iTH} 1(\lambda_{TH} > 0)}^{\text{Tax haven affiliate cost}} - \overbrace{C(\lambda_{TH} + C(\lambda_{LT})) \nu_i(z) z}^{\text{Cost of shifting } z} \Bigg]$$

$$+ (1 - \tau_{LT}) 1_{(LT \in J_F)} \Bigg[\pi_{i,LT}^F(a, z) + \overbrace{\sum_{j \in J_F \cup \{i\} \setminus \{LT\}} \lambda_{LT} \vartheta_{ij}(z) z}^{\text{Licensing fee receipts}} - \underbrace{\varphi_i \lambda_{LT} v_i(z) z}_{\text{Cost of buying } z} - \underbrace{\vartheta_{iLT}(z) z}_{\text{Licensing fee pay}} \Bigg]$$

$$+ (1 - \tau_{TH}) 1_{(\lambda_{TH} > 0)} \Bigg[\underbrace{\sum_{j \in J_F \cup \{i\}} \lambda_{TH} \vartheta_{ij}(z) z}_{\text{Licensing fee receipts}} - \underbrace{\varphi_i \lambda_{TH} v_i(z) z}_{\text{Cost of buying } z} \Bigg]$$

$$+ \sum_{j \in J_F \setminus \{LT\}} (1 - \tau_j) \Bigg[\pi_{ij}^F(a, z) - \underbrace{\vartheta_{ij}(z) z}_{\text{Licensing fee}} \Bigg] \Bigg\}$$

Pillar One: Residual profits

return

Under pillar 1, the tax base of a subsidiary in jurisdiction k is

$$T_k = \Pi_k^r + (1-s)\cdot\Pi_k^R + s\cdot\frac{p_k y_k}{\sum_k p_k y_k}\cdot\Pi^R$$

where routine profit is

$$\Pi_k^r = \mu p_k y_k$$

Residual profit in jurisdiction k is

$$\Pi_k^R = \pi_k^{PS} - \mu p_k y_k$$

and total global residual profit

$$\Pi^R = \sum_i \Pi_i^R$$

Hence the problem of the MNE with profit reallocation is

$$\max_{z,J_x,J_F,\lambda_{LT},\lambda_{TH}}\left\{\sum_j\left(\pi_j^{PS}-\tau_j T_j\right) - W_i\left(\sum_{j\in J_X}\kappa_{ijX} - \sum_{j\in J_F}\kappa_{ijF} + \kappa_{iTH}1(\lambda_{TH}>0)\right)\right\}$$