Corporate Income Taxation and Multinational Production

Yang Shen (션양)

Hanyang University

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"Under our framework, we will dramatically cut the business tax rate so that American companies and American workers can beat our foreign competitors and start winning again."

— Donald J. Trump

Multinational enterprises (MNEs) are instrumental to globalization:

- Trade: 2/3 of world trade
- Multinational production (MP): 1/4 of world GDP

$\Longrightarrow$ A recent literature on trade and MP

- Study determinants of MNEs' location and production decisions
  - Costs of establishing foreign affiliates
  - Market-entry costs, shipping costs, etc.
  - Productivity and market potential of foreign plants
- Quantify welfare gains from openness (trade and MP)

This paper

A "new" determinant: corporate income taxation

- New in the trade/MP literature
- Old in the tax literature

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Trade/MP literature

- MP flows are explained by the standard gravity equation (country size and trade/MP barriers)
- Can't rationalize the rise of tax haven countries

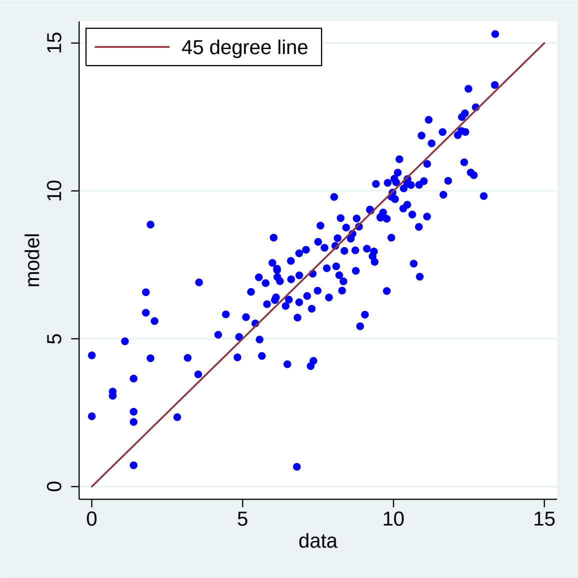

Figure: MP Flows: Gravity Model versus Data

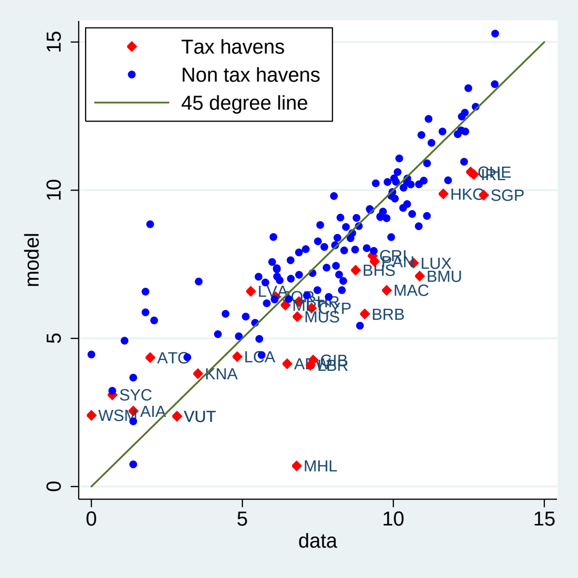

Figure: MP Flows: Gravity Model versus Data

Table: Top 10 Affiliate Locations of U.S. MNEs in 2013

	No. Affiliates	Net Income	Value Added
1	United Kingdom	**Netherlands**	United Kingdom
2	Canada	**Luxembourg**	Canada
3	**Netherlands**	**Ireland**	Germany
4	Germany	**Bermuda**	**Ireland**
5	China	Canada	France
6	France	**Switzerland**	China
7	Australia	United Kingdom	Australia
8	Mexico	**UK Is., Caribbean**	**Switzerland**
9	**Luxembourg**	**Singapore**	Japan
10	**Ireland**	Mexico	Brazil

Two issues:

- How tax affects MNEs' profit-shifting strategy
  - ✘ Not this paper
- How tax affects the actual location of production
  - ✔ This paper

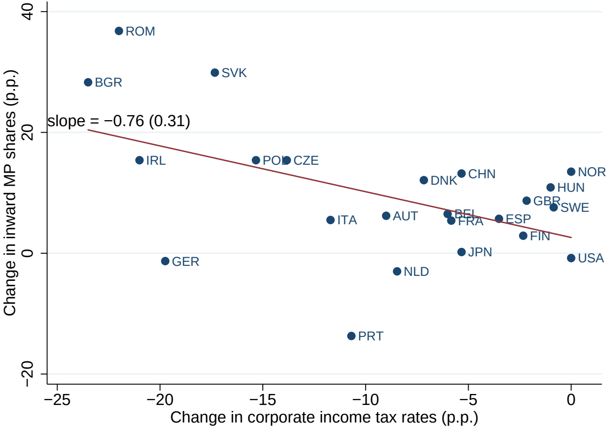

Figure: Tax Cuts and MP Changes

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Tax literature

- Well-established empirical evidence
  - Extensive margin: Location decisions
    Devereux and Griffith (1998), Buettner and Ruf (2007)
    tax rate $\uparrow \;\Rightarrow\;$ probability of choosing the location $\downarrow$
  - Intensive margin: Production/investment decisions
    Hartman (1984), Grubert and Mutti (2000)
    tax rate $\uparrow \;\Rightarrow\;$ FDI $\downarrow$
- No general equilibrium model
- Can't perform counterfactual analysis to evaluate tax policies

This paper

- A general equilibrium model of trade and MP
- Corporate income taxation is a novel friction
- Theoretical foundation for the extensive and intensive margin effects of corporation taxation on investment
- Counterfactual exercises: welfare implications of tax changes
  - Non-cooperative Nash equilibrium (tax competition)
  - Elimination of corporate income taxation

Related Literature

Multinational Production

- Arkolakis et al. (2013), Tintelnot (2017), Fan (2017), Garetto (2013), Irarrazabal et al. (2013), Ramondo and Rodriguez-Clare (2013), Sun (2017), Wang (2016)

Tax Competition

- Zodrow and Mieszkowski (1986), Wilson (1986), Kanbur and Keen (1993), Hauflera and Wootonb (1999)

Outline

- Model
- Calibration
- Quantitative Analysis
- Sensitivity Analysis
- Conclusion

Model

Demand

- N countries
- Utility of a representative consumer in country i over a continuum of goods indexed by ω:

$$U_i = \left[\int_{\omega \in \Omega_i} q_i(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

$\sigma > 1$: elasticity of substitution between any two goods

Demand

- Utility maximization $\implies q_i(\omega) = \dfrac{p_i(\omega)^{-\sigma}}{P_i^{1-\sigma}} X_i$
  - X_i: total income in country i
  - $p_i(\omega)$: price of good ω
  - P_i: price index in country i:

$$P_i \equiv \left[\int_{\omega \in \Omega_i} p_i(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} .$$

The firm's problem: an overview

- Labor is the only factor of production
- Country i is endowed with L_i units of inelastically supplied labor and a measure M_i of firms
- Each firm produces a single good under monopolistic competition
- Firms can reach markets via exporting, MP, or both

The firm's problem: an overview

- i: origin, n: production location, d: destination
- To serve d, a firm from i can
  - produce in i and export to d, or
  - build a plant in d and sell domestically, or
  - build a plant in $n \neq i, d$ and export from n to d
- Frictions:
  - Market-entry: fixed marketing cost $w_d F_d$
  - Export: iceberg shipping cost τ_{dn}
  - MP: fixed cost $w_n \varepsilon_{ni}(\omega)$, iceberg cost γ_{ni}
  - Corporate income tax: t_n, taxed on operating profits if production takes place in n

The firm's problem: an overview

- A two-stage optimization problem:
  1. Given knowledge about fixed MP costs for all locations, the firm chooses a set of potential production locations
  2. After observing a productivity level in each potential location, the firm chooses, for each destination market, a plant for production. The firm will serve the market iff the profits are higher than the fixed marketing costs

The firm's problem: stage 2

- $\boldsymbol{\delta}^* \in \boldsymbol{\Delta}$: the set of locations that firm ω from i has chosen. Assume that $\boldsymbol{\delta}^*$ contains $K \leq N$ countries
- z_k: the firm's productivity at location $k = \{1, \dots, K\}$
- CRS $\implies c_{dki}(\omega) = \dfrac{\gamma_{ki}\tau_{dk}w_k}{z_k}$
- $p_{dki}(\omega) = \overline{m}c_{dki}(\omega)$, where $\overline{m} = \dfrac{\sigma}{\sigma - 1}$

The firm's problem: stage 2

- For every market d, the firm chooses a production location in order to maximize its after-tax operating profits:

$$\max_{k \in \boldsymbol{\delta}^*} (1 - t_k) \frac{1}{\sigma} \left(\frac{\overline{m}\, c_{dki}(\omega)}{P_d} \right)^{1-\sigma} X_d \iff \min_{k \in \boldsymbol{\delta}^*} \frac{c_{dki}(\omega)}{(1 - t_k)^{\frac{1}{\sigma - 1}}}$$

- The firm will serve market d iff $\min_{k \in \boldsymbol{\delta}^*} \frac{c_{dki}(\omega)}{(1 - t_k)^{\frac{1}{\sigma - 1}}} \leq \overline{c}_d$, where

$$\overline{c}_d \equiv \left(\frac{X_d}{\sigma w_d F_d} \right)^{\frac{1}{\sigma - 1}} \frac{P_d}{\overline{m}}$$

The firm's problem: stage 2

- Assume $\mathbf{z}^{\boldsymbol{\delta}} = \{z_1, \ldots, z_K\}$ is drawn from a multivariate Pareto distribution:

$$G_i(z_1, \ldots, z_K \mid \boldsymbol{\delta}) = 1 - \left[\sum_{k=1}^{K} \left(T_{ki} z_k^{-\theta} \right)^{\frac{1}{1-\rho}} \right]^{1-\rho},$$

where $\rho \in [0, 1)$, and $\theta > \max(1,\ \sigma - 1)$

The firm's problem: stage 2

- The probability that firm ω from country i will serve market d from country n with tax-adjusted unit cost $c \leq \overline{c}_d$ is:

$$\Pr\left(\arg\min_k \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} = n \cap \min_k \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} = c \;\middle|\; \boldsymbol{\delta}\right) = \begin{cases} \psi^{\boldsymbol{\delta}}_{dni}\Psi^{\boldsymbol{\delta}}_{di}\theta c^{\theta-1}, & \text{if } n \in \boldsymbol{\delta} \\ 0 \qquad , & \text{otherwise} \end{cases},$$

where

$$\Psi^{\boldsymbol{\delta}}_{di} \equiv \left[\sum_{k=1}^{K}\left(T_{ki}\left(\frac{\gamma_{ki}\tau_{dk}w_k}{(1-t_k)^{\frac{1}{\sigma-1}}}\right)^{-\theta}\right)^{\frac{1}{1-\rho}}\right]^{1-\rho} \quad \text{and} \quad \psi^{\boldsymbol{\delta}}_{dni} \equiv \left(\frac{T_{ni}\left(\frac{\gamma_{ni}\tau_{dn}w_n}{(1-t_n)^{\frac{1}{\sigma-1}}}\right)^{-\theta}}{\Psi^{\boldsymbol{\delta}}_{di}}\right)^{\frac{1}{1-\rho}}$$

- The probability that firm ω from country i will serve market d from country n is:

$$\Pr\left(\arg\min_k \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} = n \cap \min_k \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} \leq \overline{c}_d \;\middle|\; \boldsymbol{\delta}\right) = \begin{cases} \psi^{\boldsymbol{\delta}}_{dni}\Psi^{\boldsymbol{\delta}}_{di}(\overline{c}_d)^{\theta}, & \text{if } n \in \boldsymbol{\delta} \\ 0 \qquad , & \text{otherwise} \end{cases}.$$

Lemma 1

(Intensive margin effect) For a given location set δ such that $i \in \delta$, the probability that a firm from country i will produce in country $n \in \delta$ and serve market d is a decreasing function of the corporate tax rate imposed by country n, t_n.

The firm's problem: stage 1

- Given $\boldsymbol{\varepsilon_i}(\omega) = \{\varepsilon_{1i}(\omega), \ldots, \varepsilon_{Ni}(\omega)\}$, the firm chooses a production location set that maximizes its expected net profits:

$$\boldsymbol{\delta}^*(\boldsymbol{\varepsilon_i}(\omega)) = \arg\max_{\boldsymbol{\delta} \in \boldsymbol{\Delta}} \mathbb{E}_\varepsilon \left[\Pi_i(\omega) \mid \boldsymbol{\delta} \right],$$

where

$$\mathbb{E}_\varepsilon \left[\Pi_i(\omega) \mid \boldsymbol{\delta} \right] = \sum_d \left\{ \max\left(\mathbb{E}\left[\widetilde{\Pi}_{di} \,\middle|\, \boldsymbol{\delta} \right] - w_d F_d,\ 0 \right) \right\} - \sum_{k \in \boldsymbol{\delta}} w_k \varepsilon_{ki}(\omega),$$

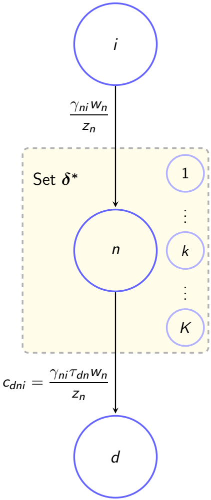
and

$$\mathbb{E}\left[\widetilde{\Pi}_{di}(\omega) \,\middle|\, \boldsymbol{\delta} \right] = \sum_{n=1}^{K} \mathbb{E}\left[\widetilde{\Pi}_{dni}(\omega) \,\middle|\, \boldsymbol{\delta} \right] \cdot \Pr\left(\arg\min_{k \in \boldsymbol{\delta}} \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} = n \cap \min_{k \in \boldsymbol{\delta}} \frac{c_{dki}(\omega)}{(1-t_k)^{\frac{1}{\sigma-1}}} \leq \overline{c}_d \,\middle|\, \boldsymbol{\delta} \right)$$
$$= \frac{\kappa}{\sigma} \Psi_{di}^{\boldsymbol{\delta}} \left(\frac{1}{\sigma w_d F_d} \right)^{\frac{\theta-\sigma+1}{\sigma-1}} P_d^\theta X_d^{\frac{\theta}{\sigma-1}}, \qquad \kappa \equiv \frac{\theta \overline{m}^{-\theta}}{\theta - \sigma + 1}$$

Lemma 2

(Extensive margin effect) The probability that a firm chooses a location set containing country n over a location set that does not contain country n is a decreasing function of the corporate tax rate of country n, t_n.

The firm's problem: a summary



Choose location set $\boldsymbol{\delta}^*$ conditional on fixed MP costs and country-specific factors

⇓

Observe $\boldsymbol{z}^{\boldsymbol{\delta}^*}$, then choose the country with min $\frac{c_{dki}}{(1-t_k)^{\frac{1}{\sigma-1}}}$ to serve d

⇓

Serve d iff $\frac{c_{dni}}{(1-t_n)^{\frac{1}{\sigma-1}}} \leq \overline{c}_d$

Aggregation

- Assume that the elements of the fixed MP costs, $\varepsilon_{\boldsymbol{i}}(\omega)$, are drawn independently across countries from a continuous distribution denoted by $H_i(\cdot)$
- The measure of firms from i that chooses set $\boldsymbol{\delta}$ is:

$$M_i^{\boldsymbol{\delta}} = M_i \int_{\varepsilon} \mathbb{1}\left[\boldsymbol{\delta}^*(\varepsilon) = \boldsymbol{\delta}\right] dH_i(\varepsilon)$$

- The measure of firms from i serving d from country n is:

$$M_{dni} = \sum_{\boldsymbol{\delta}} M_i^{\boldsymbol{\delta}} \psi_{dni}^{\boldsymbol{\delta}} \Psi_{di}^{\boldsymbol{\delta}} (\overline{c}_d)^{\theta} = \left(\frac{X_d}{\sigma w_d F_d}\right)^{\frac{\theta}{\sigma-1}} \frac{P_d^{\theta}}{\overline{m}^{\theta}} \sum_{\boldsymbol{\delta}} M_i^{\boldsymbol{\delta}} \psi_{dni}^{\boldsymbol{\delta}} \Psi_{di}^{\boldsymbol{\delta}}$$

Aggregation

- Total sales from country n to market d by firms from i are:

$$X_{dni} = \int_0^{\overline{c}_d} \sum_{\delta} M_i^{\delta} \psi_{dni}^{\delta} \Psi_{di}^{\delta} \theta c^{\theta-1} (\overline{m} c (1-t_n)^{\frac{1}{\sigma-1}})^{1-\sigma} P_d^{\sigma-1} X_d \, dc$$

$$= \frac{\kappa}{1-t_n} \left(\frac{1}{\sigma w_d F_d} \right)^{\frac{\theta-\sigma+1}{\sigma-1}} P_d^{\theta} X_d^{\frac{\theta}{\sigma-1}} \sum_{\delta} M_i^{\delta} \psi_{dni}^{\delta} \Psi_{di}^{\delta}$$

$$\implies M_{dni} = (1-t_n) \frac{\theta-\sigma+1}{\sigma\theta} \frac{X_{dni}}{w_d F_d}$$

Aggregation

- The aggregate price index in country d is:

$$P_d = \left[\kappa \left(\frac{X_d}{\sigma w_d F_d} \right)^{\frac{\theta-\sigma+1}{\sigma-1}} \left(\sum_j \sum_l \sum_\delta \frac{M_j^\delta \psi_{dlj}^\delta \Psi_{dj}^\delta}{1-t_l} \right) \right]^{-\frac{1}{\theta}}$$

- Can rewrite X_{dni} as

$$X_{dni} = X_d \frac{\sum_\delta M_i^\delta \psi_{dni}^\delta \Psi_{di}^\delta/(1-t_n)}{\sum_j \sum_l \sum_\delta M_j^\delta \psi_{dlj}^\delta \Psi_{dj}^\delta/(1-t_l)}$$

Aggregation

- Net profits earned by firms from country i are:

$$\Pi_i = \sum_d \sum_n \left[(1 - t_n) \frac{1}{\sigma} X_{dni} - w_d F_d M_{dni} \right] - \sum_{\delta \in \boldsymbol{\Delta}} M_i^\delta \int_\varepsilon \mathbb{1} \left[\delta^*(\varepsilon) = \delta \right] \sum_{k \in \delta} w_k \varepsilon_{ki} \, dH_i(\varepsilon)$$

- Total corporate tax revenues collected in country i are:

$$R_i = \frac{t_i}{\sigma} \sum_d \sum_j X_{dij}$$

Aggregation: market clearing conditions

- Total labor income in country i is:

$$w_i L_i = \underbrace{(1-\frac{1}{\sigma})\sum_d \sum_j X_{dij}}_{\text{production costs}} + \underbrace{w_i F_i \sum_n \sum_j M_{inj}}_{\text{fixed marketing costs}} + \underbrace{\sum_j \sum_{\delta | i \in \delta} M_j^{\delta} \int_{\varepsilon} \mathbb{1}\left[\delta^*(\varepsilon) = \delta\right] w_i \varepsilon_{ij} \, dH_j(\varepsilon)}_{\text{fixed MP costs}}$$

- Aggregate income in country i is:

$$X_i = w_i L_i + \Pi_i + R_i$$

Equilibrium

Given the set of parameters $\{\sigma, \theta, \rho, \tau_{dn}, \gamma_{ni}, T_{ni}, t_i, F_i, H_i(\varepsilon), M_i, L_i\}$*, an equilibrium of the model is a set of wages* w_i*, price indices* P_i*, incomes* X_i*, quantity demanded* $q_i(\omega)$*, and location choices* $\boldsymbol{\delta}^*$ *such that*

(i) $q_i(\omega)$ *satisfies equation (2),*

(ii) $\overline{c}_i$ *satisfies equation (6),*

(iii) $\boldsymbol{\delta}^*$ *is the solution to equation (12),*

(iv) P_i *satisfies equation (17),*

(v) *The labor market clearing condition, equation (21), holds, and*

(vi) X_i *satisfies equation (22).*

Calibration

- Three countries: Germany, Ireland, and the United States
- Parameters $\{M_i, L_i, t_i, T_{ni}, \theta, \rho, \sigma, F_i, \tau_{dn}, \gamma_{ni}, H_i(\varepsilon)\}$

Table: Summary of Parameters Calibrated Externally

Parameters	Description	Targets/Source
M_i, L_i	Measure of firms, size of labor force	Penn World Tables, avg. 1996-2001
t_i	Statutory tax rates	Flaaen (2017), avg. 1996-2001
T_{ni}	Average productivity	Hall and Jones (1999)
θ	Dispersion in productivity	Arkolakis et al. (2013)
ρ	Correlation of productivity	Arkolakis et al. (2013)
σ	Elasticity of substitution	Mark-up = 33%

Parameters determined in the equilibrium:

- Fixed marketing costs F_i
- Iceberg trade and MP costs τ_{dn} and γ_{ni}

$$\ln \tau_{dn} = \beta^{\tau} + \beta^{\tau}_{dist}(\ln dist_{dn}) + \beta^{\tau}_{lang}(lang_{dn}) \qquad \text{for } d \neq n$$
$$\ln \gamma_{ni} = \beta^{\gamma} + \beta^{\gamma}_{dist}(\ln dist_{ni}) + \beta^{\gamma}_{lang}(lang_{ni}) \qquad \text{for } n \neq i$$

- Distribution of fixed MP costs $H_i(\varepsilon)$: $log\mathcal{N}(\mu^{\varepsilon}_{ni}, \beta^{\varepsilon 2})$, where

$$\ln \mu^{\varepsilon}_{ni} = \beta^{\mu} + \beta^{\mu}_{dist}(\ln dist_{ni}) + \beta^{\mu}_{lang}(lang_{ni}) \qquad \text{for } n \neq i$$

Targeted moments:

- Shares of non-exporters: 0.24 (Germany), 0,47 (Ireland), and 0.82 (U.S.)
- Trade and MP shares (WIOD and Ramondo et al. (2015))

$$s_{dn}^{TR} = \sum_i \frac{X_{dni}}{X_d} \quad \text{and} \quad s_{ni}^{MP} = \sum_d \frac{X_{dni}}{Y_n}$$

- Ratio of foreign affiliates (Ramondo et al. (2015))

Algorithm

- **Inner loop**:
  Given a set of parameters $\{F_i, \{\boldsymbol{\beta}^{\boldsymbol{\tau}}\}, \{\boldsymbol{\beta}^{\gamma}\}, \{\boldsymbol{\beta}^{\boldsymbol{\mu}}\}, \beta^{\varepsilon}\}$ and guesses for wages, prices and income $\{w_i, P_i, X_i\}$, the inner loop solves for the equilibrium price indices P_i
- **Middle loop**:
  In the middle loop, I solve for the equilibrium wages w_i relative to the United States (U.S. labor is the numeraire) and income X_i
- **Outer loop**:
  The outer loop iterates over guesses of $\{F_i, \{\boldsymbol{\beta}^{\boldsymbol{\tau}}\}, \{\boldsymbol{\beta}^{\gamma}\}, \{\boldsymbol{\beta}^{\boldsymbol{\mu}}\}, \beta^{\varepsilon}\}$ such that (1) the shares of domestic firm match the data, (2) trade and MP shares are the same as their data counterparts, and (3) the ratios of foreign affiliates exactly match the data

Quantitative Analysis

Unilateral Optimal Tax Rates

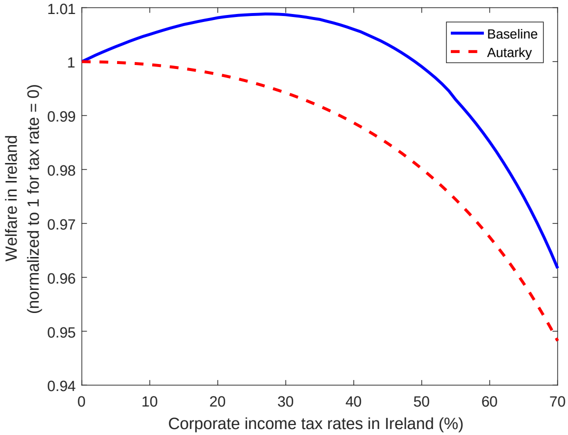


Figure: Optimal Corporate Tax Rate in Ireland

TUnilateral Optimal Tax Rates

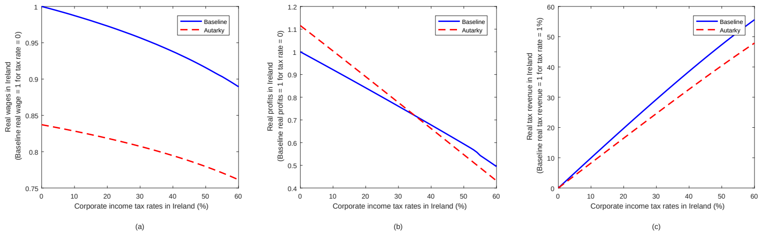


Figure: Real Wages, Profits, and Tax Revenue in Ireland

Tax Competition - Nash Corporate Income Tax Rates

Algorithm

- **Step 1**: Fix tax rate in the US at the initial level, and compute the Nash tax rates for Germany and Ireland.
- **Step 2**: Compute optimal tax rate for the US given the other two countries' optimal tax rates. If the US optimal tax rate is the same as the one from the previous step, then stop. If not, update the optimal tax rate for the US and repeat Step 1.

Tax Competition - Nash Corporate Income Tax Rates

Table: Nash Corporate Tax Rates under Baseline Model

	Baseline tax rates	Nash tax rates	ΔWelfare (%)	ΔInward MP Share (p.p.)	ΔImport Share (p.p.)
Germany	50	14	0.78	-1.53	-1.11
Ireland	34	26	-0.39	-2.42	-4.00
United States	39	4	0.90	-0.88	-0.26

Tax Competition - Driving Forces

Table: Nash Corporate Tax Rates under Different Scenarios

		Nash tax rates (%)		
	Description	Country A	Country B	Country C
Case 1	Symmetry	11	11	11
Case 2	A, B low τ	7	7	10
Case 3	A, B low γ	16	16	12
Case 4	A, B low L	18	18	5

Elimination of Corporate Taxes

Table: Consequences of Elimination of Corporate Taxes

	ΔWelfare (%)	ΔInward MP Share (p.p)	ΔImport Share (p.p.)
Germany	1.65	1.91	-0.38
Ireland	0.06	2.71	-1.53
United States	1.30	-0.02	0.10

Welfare gains from MP, Trade, and Openness

Table: Gains from MP, Trade, and Openness

	MP	Trade	Openness
Germany	1.0184	1.0115	1.0350
Ireland	1.0656	1.0973	1.1815
United States	1.0053	1.0031	1.0099

Sensitivity Analysis

The Correlation and Dispersion Parameters

Table: Sensitivity with respect to ρ and θ

	Nash tax rates (%)		
	Germany	Ireland	U.S.
Panel A			
$\rho = 0.55$ (Baseline)	14	26	4
$\rho = 0.99$	13	24	4
$\rho = 0$	18	27	6
Panel B			
$\theta = 4.5$ (Baseline)	14	26	4
$\theta = 5$	9	21	2
$\theta = 4$	22	33	7

Effective Marginal Tax Rates

- Use effective marginal tax rates instead of statutory rates and re-calibrate parameters determined in the equilibrium
- 28% (Germany), 7% (Ireland), 24% (U.S.)
- Nash tax rates: 18%, 24%, 7%
- c.f. Baseline Nash tax rates: 14%, 26%, 4%

Conclusion

- Develops general equilibrium model of trade and MP with corporate income taxation
- Rationalizes the extensive and intensive margin effects of taxes
- Calibrates to Germany, Ireland, and the US
- Conducts counterfactual exercises to investigate welfare implications of tax changes