

INTANGIBLE YET REAL: SPILLOVERS FROM CORPORATE INCOME TAXATION – ONLINE ANNEXES

Online Annexes 3.1–3.8 to Chapter 3 of the October 2026 World Economic Outlook provide the definitions, data sources, methodology, additional results, and robustness tests to complement the discussion in the main text.

Online Annex 3.1. Drivers of Changes in MNCs' Corporate Income Tax Payments: An Accounting Approach

1. This online annex provides the data sources and methodology used to decompose changes in the backward-looking effective tax rates (BETRs) of multinational corporations (MNCs). The analysis follows Garcia-Bernardo, Janský, and Tørsløv (2022; henceforth GBJT) and focuses on MNCs headquartered in the European Union and the United States. For the former, aggregate estimates are reported as PPP-GDP weighted averages.

Methodology

2. **Definition of the BETR:** the corporate income tax (CIT) paid by MNCs as a share of their reported income (pre-tax profits). The aggregate BETR corresponds to the profit-weighted average of the effective tax rates paid across all locations in which MNCs have affiliates, including the home country. For each economy i in year t , (cumulative) annual changes in BETRs aggregated across MNCs headquartered in that economy are given by:

$$\Delta BETR_{it} = \Delta \left(\sum_j w_{ijt} r_{ijt} \right)$$

where r_{ijt} is the ratio of (accrued) corporate income taxes to pre-tax profits booked in location j by MNCs headquartered in country i , and w_{ijt} is the share of (positive) pre-tax profits booked in location j by MNCs headquartered in country i .

3. **General decomposition.** Let W_D and $W_F = 1 - W_D$ denote the domestic and foreign profit weights of parent country i , respectively, and τ_D and τ_F the profit-weighted average effective tax rates on domestic and foreign profits, respectively. The change in the BETR between a base year (superscript 0) and an end year (superscript 1) is decomposed as:

$$\Delta BETR_i = \underbrace{W_D^0 \Delta \tau_D}_{\text{Domestic}} + \underbrace{W_F^0 \Delta \tau_F}_{\text{Foreign}} + \underbrace{\Delta W_D (\tau_D^0 - \tau_F^0)}_{\text{Globalization}} + \underbrace{\Delta W_D \Delta \tau_D + \Delta W_F \Delta \tau_F}_{\text{Residual}} + \text{Unobserved}_i.$$

The *domestic* component captures changes in the effective taxation of domestically booked profits, holding initial profit weights fixed. The *foreign* component captures changes in the effective taxation of profits reported abroad, also given initial profit weights. The *globalization* component captures the reallocation of profits between the domestic and foreign jurisdictions, given initial effective tax rate differentials. The *residual* is the second-order cross-term of weight and rate changes. The *unobserved* component closes the identity, capturing profits observed in only one of the two years, including cases arising from missing data in low-tax jurisdictions.

4. Domestic decomposition. The domestic component is further decomposed into (1) a *statutory rate effect*, $W_D^0 \Delta s_i$, where s_i is the parent country's statutory CIT rate, and (2) a *base policy effect* is defined as the remainder, $W_D^0 (\Delta \tau_D - \Delta s_i)$. Because both effects assume that the geographic distribution of profits is fixed, they are intended to abstract from MNCs' profit-shifting behavior.

5. Foreign decomposition. The foreign component is further decomposed as follows:

$$\text{Foreign}_i = \underbrace{W_F^0 \sum_j \alpha_{ij}^0 \Delta s_{ij}}_{\text{Foreign statutory rate}} + \underbrace{W_F^0 \sum_j \alpha_{ij}^0 (\Delta r_{ij} - \Delta s_{ij})}_{\text{Foreign base}} + \underbrace{W_F^0 \sum_j \Delta \alpha_{ij} r_{ij}^1}_{\text{Distribution}},$$

where $\alpha_{ij} = w_{ij}/W_F$ are profit weights normalized within the foreign block. The *distribution effect* captures changes in the allocation of profits across foreign subsidiaries and, therefore, jurisdictions. The *profit-shifting* component reported in the main text is defined as the sum of the *distribution effect* and the *globalization effect*, capturing both the reallocation of profits between the domestic and foreign jurisdictions and the reallocation between foreign jurisdictions.

6. Relative to GBJT, the methodology incorporates two modifications:

- **Annual chaining.** Rather than computing a single decomposition between the endpoints of each sub-period, the decomposition is computed for each consecutive year pair ($t \rightarrow t+1$) and the annual contributions are summed:

$$\Delta ETR_{t \rightarrow t+1} = \text{Domestic}_t + \text{Foreign}_t + \text{Globalization}_t + \text{Residual}_t + \text{Unobserved}_t,$$

Summing across annual changes preserves the accounting identity over longer periods.

- **Smoothing.** Effective tax rates and profit shares are computed using three-year centered rolling averages. Only positive-profit observations are included in each window as negative-profit years would distort the BETR denominator and, in extreme cases, generate implausible base-period BETRs. Applying the same window to rates and shares preserves internal consistency and reduces distortions from crisis-year profit shares (e.g., around the GFC).

Data and Results

7. Statutory CIT rates are taken from the Tax Policy Center's worldwide corporate tax rates dataset. PPP-GDP weights for the EU aggregation are taken from the IMF World Economic Outlook database.

8. EU-headquartered MNCs. MNC groups are identified through global ultimate owner (GUO, 50 percent control threshold) to subsidiary, covering EU MNCs over 2009–21, and 26

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EU parent countries. Parent-level financials are taken from consolidated accounts and subsidiary-level financials from unconsolidated accounts. Pre-tax profits are measured by earnings before interest and tax (EBIT), while taxes paid are reported on cash basis. Firm-level data are aggregated at the parent-country $\times$ subsidiary-country $\times$ year level before conducting the BETR decomposition. Online Annex Table 3.1.1 reports the results. The aggregate BETR for MNCs with headquarters in the EU fell from 34.9 percent to 17.3 percent over 2010–17 and was broadly flat over 2018–21. The 2010–17 decline is dominated by domestic tax policies (–12.5 percentage points), driven by changes in base measures, while changes in the statutory rate contributed only slightly. Profit shifting contributed –7.4 percentage points over 2010–17—largely through the globalization term (–6.5), reflecting the relocation of profits toward lower-tax jurisdictions abroad. This term becomes essentially zero over 2018–21, indicating that profit shifting by EU MNCs stalled or partially reversed more recently. The residual and reweighting contributions are small, so the results are not driven by the cross-terms.

9. US-headquartered MNCs. Pre-tax profits are measured by profit-type return and taxes by US and foreign income taxes sourced from the Bureau of Economic Analysis (BEA). The domestic block is constructed from parent-level tables and the foreign block from affiliate tables by host country. An industry breakdown is feasible, covering 13 sectors over 2009–23¹. Online Annex Table 3.1.2 reports the results for MNCs with headquarters in the US. The aggregate BETR declined from 29.3 percent to 21.0 percent over 2010–17, and fell a further 2.0 percentage points over 2018–23. The changes over these two periods have very different drivers. Pre-TCJA, the decline was mostly explained by foreign tax policy and profit shifting. Post-TCJA, the domestic statutory rate effect (reflecting the statutory rate cut from 35 to 21 percent) dwarfs every other component. The domestic base effect turns positive, consistent with base-broadening provisions and profit repatriation under the new territorial regime. The contribution of profit shifting is approximately zero in this later period.

Online Annex Table 3.1.1. Decomposition of Tax liabilities for MNCs with Headquarters in the EU
(percentage point unless otherwise stated)

Component	2010–17	2018–21
BETR (start, percent)	34.9	17.3
BETR (end, percent)	17.3	17.1
ΔBETR	–17.4	–0.1
Domestic Taxation	–12.5	–0.4
Domestic Statutory	–1.0	–0.7
Domestic Base	–11.5	0.3
Foreign Rates + Bases	1.4	0.3
Foreign Statutory	–0.5	–0.4
Foreign Base	1.9	0.7
Profit Shifting	–7.4	0.1
Distribution	–0.9	–0.1
Globalization	–6.5	0.2
Residual	1.0	–0.2
Memo: Country reweighting	–0.3	0.1
Coverage (EU parent countries)	25.0	26.0

Sources: Orbis (2008–2021 vintages); and IMF staff calculations.
Note: Percentage-point contributions from the chained annual decomposition, PPP-GDP weights anchored at each annual end year. ΔBETR is the sum of the annual changes and equals the sum of the listed components. To compute each annual change at the EU level, PPP-GDP weights from the ending year are used. Hence, the aggregate EU BETR at the end of one year can differ slightly from its level at the start of the next year; the memo item “Country reweighting” cumulates these differences, so that ΔBETR plus reweighting is equals to the observed cumulative change in BETRs over the full time period. Croatia is excluded under due to data limitations. BETR: backward-looking effective tax rate; ΔBETR: change in BETR (end-period value minus start-period value); EU: European Union.

Online Annex Table 3.1.2. Decomposition of Tax liabilities for MNCs with Headquarters in the US
(percentage point unless otherwise stated)

Component	2010–17	2018–23
BETR (start, percent)	29.3	21.0
BETR (end, percent)	21.0	18.9
ΔBETR	–8.3	–2.0
Domestic Taxation	–3.3	–3.9
Domestic Statutory	–0.1	–8.3
Domestic Base	–3.2	4.4
Foreign Rates + Bases	–3.9	2.5
Foreign Statutory	–0.7	–0.0
Foreign Base	–3.2	2.5
Profit Shifting	–1.7	–0.0
Distribution	–1.5	–0.2
Globalization	–0.1	0.2
Residual	0.5	–0.6

Sources: U.S. Bureau of Economic Analysis (2009–2023); and IMF staff calculations.

Note: Percentage-point contributions from the chained annual decomposition, all industries. BETR: backward-looking effective tax rate; ΔBETR: change in BETR (end-period value minus start-period value).

¹ The US industry-level results are available upon request.

10. Robustness. Country-by-country reporting (CbCR) data are used to cross-check results from the BEA and Orbis. These results are consistent with the decompositions based on BEA and Orbis for the later period².

Online Annex 3.2. Local Projection Estimates of Corporate and Personal Income Tax Shock Spillovers

11. This online annex examines the cross-border spillover effects of corporate income tax (CIT) and personal income tax (PIT) shocks in the United States, the United Kingdom, and Germany.

12. To identify orthogonalized PIT and CIT shocks, we follow Mertens and Ravn (2013) and estimate separate proxy SVARs for each implementing (source) economy. We rely on narrative CIT and PIT shocks constructed by Hayo and Uhl (2014), Hayo and Mierzwa (2023), and Mierzwa (2021) for Germany; Cloyne (2013) for the United Kingdom; and Mertens and Ravn (2013) and Cloyne and others (2022) for the United States. We use the resulting narrative tax shocks as instruments for each economy's average corporate and personal income tax rate ($ACITR_{s,t}$ and $APITR_{s,t}$). The corresponding structural corporate and personal tax shocks, $z_{CIT,s,t}$ or $z_{PIT,s,t}$, are then recovered and used in a local projection framework to estimate macroeconomic spillovers to other economies.

Data

13. The three shock series cover the following periods: 1992Q1–2018Q2 for Germany, 1993Q1–2007Q4 for the United Kingdom, and 1951Q1–2019Q4 for the United States. We examine spillovers to a panel of 29 AEs and EMES: Australia, Austria, Belgium, Brazil, Canada, Chile, China, Finland, France, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, and Türkiye.

Methodology

14. We use a local projection instrumental variable (LP-IV) approach following Jordà (2005) to estimate the dynamic effects of tax shocks originating in the three source countries on the rest of the world. To maximize power, we use a stacked panel setting³:

For each horizon $h = 0, 1, \dots, H$ we estimate the stacked dyadic specification:

$$y_{i,s,t+h} - y_{i,s,t-1} = \alpha_i^h + \beta^h ATR_{s,t} + \sum_{j=1..p} \phi_j^h \Delta y_{i,t-j} + \sum_{j=1..p} \theta_j^h ATR_{s,t-j} + \gamma^h W_{i,s,t} + u_{i,s,t}^h.$$

The unit of observation is the dyad recipient-source country pair (i, s) at quarter t . $y_{i,s,t+h} - y_{i,s,t-1}$ is the recipient country's log real GDP or log real investment cumulative response h quarters ahead, repeated across the three source countries (s) for a given recipient-quarter pair

² These results are available upon request.

³ In other words, we create three panel datasets where each country shock appears as the main shock variable and stack them. This is equivalent to a dyadic panel (recipient $\times$ source $\times$ time) with the shock sitting in a single column.

(i, t).⁴ $ATR_{s,t}$ is the endogenous regressor of interest: the source country's $ACITR_{s,t}$ or $APITR_{s,t}$ depending on whether the specification estimates CIT or PIT spillovers. It is instrumented by the corresponding structural tax shock, $z_{CIT,s,t}$ or $z_{PIT,s,t}$. By construction, $z_{CIT,s,t}$ and $z_{PIT,s,t}$ are orthogonal to each other; therefore, we do not include the other tax instrument simultaneously. α_i^h denotes recipient-country fixed effects. The lags $\Delta y_{i,t-j}$ and $ATR_{s,t-j}$ capture recipient country own-dynamics and tax-rate persistence. $W_{i,s,t}$ denotes the control variables, which include four lags of the source country's $APITR$ and $ACITR$; four lags of the recipient country's output growth; and contemporaneous values plus four lags of the Global Financial Cycle index of Miranda-Agrippino and Rey (2020). As a robustness check, we also include contemporaneous values and four lags of country i 's external demand and the Chicago Fed's Adjusted National Financial Conditions Index; the results are broadly unchanged. The impulse response to a tax cut is traced by $\{-\beta^h\}_{h=0}$. Standard errors are computed using the Driscoll and Kraay (1998) estimator.

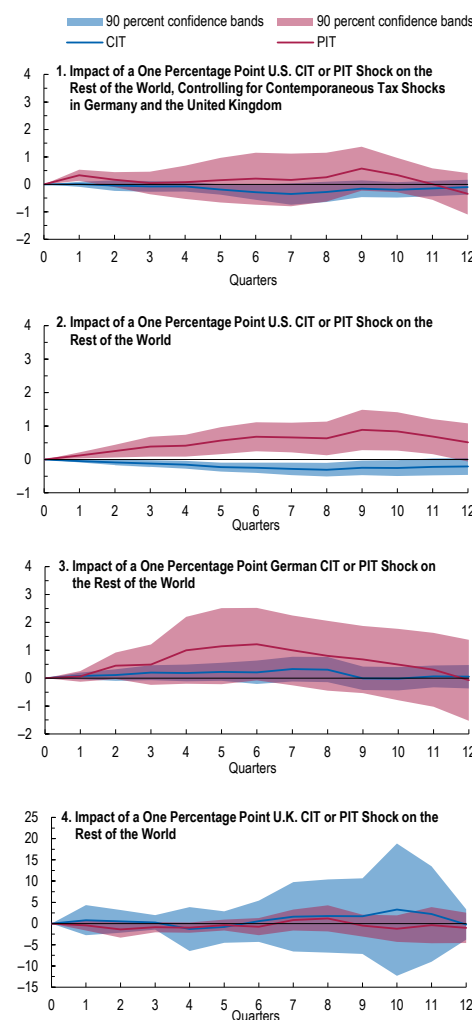
Power and Threats to Validity

15. The instruments are jointly significant in the first stage, with the F-statistic for the excluded instruments well above 20 at each horizon. Although the tax shock series are orthogonal to each source country's business cycle, they may still be correlated across countries. To assess this concern, we re-estimate the LP-IV specification using a country-time panel that controls for contemporaneous tax shocks in the other source countries. Because this substantially reduces the sample size, the specification includes two lags of each control rather than four. Given the resulting loss of statistical power, we report only the impulse responses for the United States. The results remain qualitatively similar to the baseline, although they are less precisely estimated (Online Annex Figure 3.2.1, panel 1).

Additional Results

16. Country-level estimates are more precise for U.S. spillovers, reflecting the longer time series (Online Annex Figure 3.2.1, panel 2). Spillovers from U.K. and German tax shocks are not statistically different: the former are particularly imprecise, whereas the latter are qualitatively

Online Annex Figure 3.2.1. Spillovers from Domestic Tax Cuts: Empirical Estimates
(Percentage points)



Sources: Cloyne et al. (2025); Cloyne (2013); Mertens and Ravn (2013); Hayo and Uhl (2014); and IMF staff calculations.

Note: The charts show the cumulative associated impact of a one percentage point decrease in the average personal income tax or the average corporate income tax in Germany, the U.K. or the U.S., instrumented by narrative shocks, on real GDP and real investment in the rest of the world. Shaded areas denote 90 percent confidence intervals.

⁴ The use of repeated outcome variables for each source country could induce an attenuation bias as it would mechanically increase the variance of the variable of interest while keeping the variance of the outcome variable fixed and reducing the covariance between the two.

similar, with larger spillovers from PIT shocks than from CIT shocks (Online Annex Figure 3.2.1, panels 3 and 4).

Online Annex 3.3. GIMF Spillover Simulations

17. This online annex uses the IMF's Global Integrated Monetary and Fiscal model (GIMF) to examine the spillovers from domestic corporate income tax changes. A detailed exposition of the model can be found in Kumhof and others (2010).

Model Structure

18. The model comprises 8 regions: the United States, the euro area, Japan, Other Advanced Economies, China, Other Asia, Latin America and remaining economies. Profit-maximizing firms (owned by households) operate in monopolistically competitive markets, and produce goods in non-tradable, tradable, and the Global Value Chain (GVC) sectors, calibrated to the OECD Inter-Country Input-Output Tables (OECD 2021). Trade between regions consists of consumption goods, capital goods, and tradable and GVC intermediate goods.

19. Frictions in the form of sticky prices and wages, real adjustment costs, liquidity-constrained households, along with households with finite-planning horizons (OLG), provide a role for monetary and fiscal policy in economic stabilization. Governments have a range of tax instruments with which to raise revenue, including corporate and wage income taxes, and can also spend on government consumption, investment, and transfers. Governments can also issue debt to households. Households can hold government debt and can also issue or purchase tradable U.S.-dollar-denominated obligations, allowing cross-border net asset positions to exist. In addition to wage income, OLG households also receive dividends from firms.

20. To produce intermediate output in the non-tradable, tradable, and GVC sectors, firms combine capital and labor. Final goods manufacturers assemble consumption and investment bundles from domestically-produced and imported intermediate goods. In addition, capital goods entrepreneurs supply capital to intermediate goods producers. These firms finance part of their investment with bank loans and are subject to financial accelerator-type frictions (Bernanke and others, 1998).

Firms and Corporate Income Tax Structure

21. Monopolistic intermediate-goods producers and final-goods manufacturers and import agents are taxed on their economic profits, which they gain from charging a markup over marginal costs (subject to pricing frictions). These are measured as revenues net of labor, capital and intermediate-input costs. In addition, capital-owning entrepreneurs in each sector are taxed on capital rental income, with depreciation and interest payments deducted from the taxable base. The simulations considered in this chapter reflect changing the corporate tax rate on the profits of firms in all the production, distribution and capital rental sectors of the model. Full details of the corporate tax structure in GIMF can be found in Carton and others (2019).

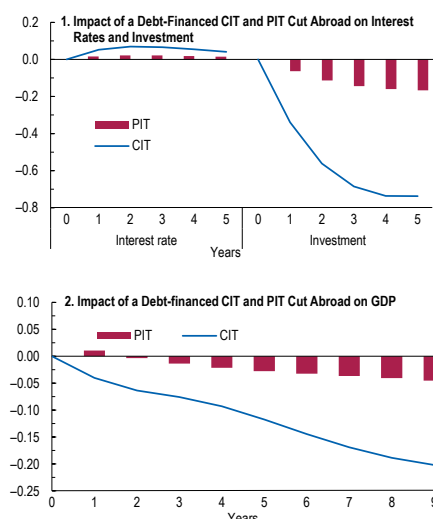
Transmission of Corporate Income Tax Policy Changes

22. The opposite spillover effects from CIT and PIT shocks originating in the United States, the United Kingdom and Germany present an interesting macroeconomic puzzle (Online Annex

3.2). Although both policies stimulate output in the implementing economy, they move activity abroad in different directions. One explanation, explored elsewhere in the chapter, is tax competition: a CIT cut increases the after-tax return and can induce MNCs to relocate tangible investment and book a larger share of profits in the implementing economy, reducing activity elsewhere. This channel is muted for labor income tax shocks, given the limited international mobility of labor in response to tax differentials.

23. This section shows that the same qualitative pattern can emerge through macroeconomic channels alone, even in the absence of MNCs. Although GIMF does not feature MNCs, capital is mobile across regions. Production in each region relies on a sector-specific capital stock owned by domestic entrepreneurs, while households can trade bonds internationally, with arbitrage linking real returns across borders. When a CIT cut raises the after-tax marginal product of capital in one region, higher global real interest rates increase the user cost of capital faced by entrepreneurs elsewhere, weakening investment abroad. In effect, savings are redirected toward the higher-return economy, while foreign entrepreneurs scale back capital accumulation. GIMF thus captures the macroeconomic analogue of the FDI-relocation channel highlighted in the chapter's empirical and spatial-model analyses.

Online Annex Figure 3.3.1. Transmission of Corporate Tax Spillovers and Contrast with Personal Income Taxes
(Percent, deviation from baseline)



Source: IMF staff estimates.
Note: Permanent unilateral 5 percentage point cut in the corporate income tax (CIT) and personal income tax (PIT) rate in a major advanced economy. Tax cuts are deficit-financed for 40 years. Responses are GDP-weighted impacts in regions other than the tax-cutting economy.

Corporate and Personal Income Tax Changes

24. Interest rates abroad rise by more and investment abroad is greater in response to a 5-percentage point CIT cut (Online Annex Figure 3.3.1, panel 1). Higher global interest rates and a reallocation of investment to the implementing country more than offset the positive external demand generated by the CIT cut, resulting in a negative GDP spillover (Online Annex Figure 3.3.1, panel 2). By contrast, a 5-percentage point PIT cut, the rise in global interest rates and fall in investment is smaller, with the overall effect broadly neutral.

25. Deficit financing amplifies these dynamics. When the CIT cut is not offset by lower spending or higher taxes elsewhere, public borrowing rises. In aggregate, higher government dissaving must be matched by some combination of higher private saving and lower investment, at home and abroad. This result depends on the non-Ricardian structure of the framework: households are made up of consumers from overlapping-generations and a fraction are liquidity-constrained, so that households do not fully offset lower government saving in anticipation of future tax liabilities. As a CIT cut also raises desired investment, domestic absorption increases by more than private saving, pushing up the world real interest rate.

26. PIT cuts behave differently. In addition to stimulating demand, they quickly strengthen labor supply. Labor supply increases, and disposable income lifts consumption on impact. As a result, the gap between demand and capacity is much smaller than under a CIT cut, and the upward pressure on real interest rates is correspondingly weaker. The positive domestic demand

impulse from higher consumption is transmitted abroad through higher import demand and the expenditure-switching effect of a real appreciation, without being offset by tighter global financial conditions to the same degree as CIT cuts.

Online Annex 3.4. Tax Competition and Base Spillovers

27. This online annex describes the estimation of spillovers from changes in CIT policies due to the strategic interactions between governments. It covers: (1) the estimation of strategic tax competition among governments; (2) the response of bilateral FDI to tax differentials at the country level; and (3) sector-level results at the extensive and intensive margins.

Estimating Governments' Strategic Response

28. A peer effects model identifies country i 's tax policy response to tax competition,

$$\tau_{i,t} = \alpha + \beta_1 \tau_{i,t}^{peers} + \beta_2 X_{i,t} + \beta_3 \sum_{j \neq i} w_{ij,t} X_{j,t} + \phi_W + \phi_{W,t} + \theta_i + \gamma_t + u_{i,t}, \quad (1)$$

where $\tau_{i,t}$ is the CIT rate — statutory, effective marginal, or effective average— in country i at time t sourced from International Tax Institutions (ITI) database. The variable of interest is the peers' weighted average CIT rate, defined as:

$$\tau_{i,t}^{peers} = \sum_{j \neq i} w_{ij,t} \tau_{j,t}.$$

29. In the baseline specification, peers are defined using geographical distance.⁵ To identify which country peers can be more influential, alternative specifications use weights based on similarity in receiving FDI inflows, obtained from a gravity model of international capital flows (see Naitram 2022). Controls include country i 's own characteristics, $X_{i,t}$, the peers' characteristics, $\sum_{j \neq i} w_{ij,t} X_{j,t}$, and the lagged tax rate to capture persistent tax policy effects. β_1 is the endogenous strategic competition effect, capturing how peers' tax policies affect a country's own tax policy. If β_1 is positive (negative), government responses are strategic complements (substitutes). β_3 is the exogenous contextual effect—the degree to which peers' exogenous characteristics affect country i 's tax policy. ϕ_W and $\phi_{W,t}$ are unobserved effects common to peers, and θ_i and γ_t are country and time fixed effects respectively.

30. The identification strategy exploits changes in the political system of peers, such as time since election and share of opposition in parliament, while controlling for domestic political shocks. The identifying assumption is that political shocks in peer countries only determine tax policy choices in those countries, (Manski 1993; Bramoullé and others 2012). Including interaction terms in equation (1) allows for heterogeneous tax competition elasticities over time

⁵ The choice of peers—captured by $w_{ij,t}$ —is important for modeling cross-sectional interdependence.

and across country groups.

Online Annex Table 3.4.1. Strategic Tax Competition: CIT saturated, EATR and EMTR

Dependent Variable: Own Tax Rate. Endogenous regressor: Peers Tax Rate.

	Statutory CIT		EATR		EMTR	
	Pooled (1)	Interacted (2)	Pooled (3)	Interacted (4)	Pooled (5)	Interacted (6)
Peers Tax Rate (Standard Error)	0.404*** (0.039)	0.431*** (0.058)	0.285*** (0.137)	0.297*** (0.115)	0.312** (0.155)	0.345*** (0.132)
Peers Tax Rate $\times$ (year $\geq$ 2017) (Standard Error)		-0.169** (0.08)		-0.026 (0.059)		-0.040 (0.07)
Post-2016 Response (Peers Tax Rate $\times$ Peers Tax Rate $\times$ (year $\geq$ 2017)) (Standard Error)		0.262*** (0.06)		0.270** (0.122)		0.305** (0.142)
Memo: Pre-2017 Subsample (Standard Error)	0.431*** (0.058)	0.431*** (0.058)	0.358*** (0.133)	0.358*** (0.133)	0.337** (0.151)	0.337*** (0.151)
Memo: Pre-2017 Minus Pooled (SE of the Difference)	0.027 (0.042)	0.027 (0.042)	0.073 (0.098)	0.073 (0.098)	0.025 (0.113)	0.025 (0.113)
p-value, H0: Pre-2017 = Pooled	0.515	0.515	0.458	0.458	0.823	0.823
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,875	3,870	2,618	2,618	2,618	2,618
Countries	152	152	151	151	151	151
Cragg-Donald Wald F	80.4	34.4	39.4	29.6	31.9	23.5
First-stage F, Peers Tax Rate (Sanderson-Windmeijer)	80.4	34.8	39.4	29.9	31.9	23.8
First-stage F, Peers Tax Rate Cluster Robust (Sanderson-Windmeijer)		57.9		263.9		260.4
Same, Cluster-robust: Peers Tax Rate		18.5		100.4		114.7
Same, Cluster-robust: Peers Tax Rate $\times$ (year $\geq$ 2017)		84.7		361.0		296.6

Note: Fixed-effects two-stage least squares. The dependent variable is country i 's own tax rate and the independent variable is the inverse-distance-weighted average of peer countries' rates, instrumented with peer political-cycle variables and their second- to fourth-order spatial lags, together with spatial lags of peer log GDP, log population and trade openness. TCJA indicates years after 2016. Controls are the lagged dependent variable, the own-country political variables and their interactions, log GDP, log population, trade openness, and spatial lags of the last three. Standard errors in parenthesis.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Estimating the Spillovers From Base Shifting

31. To assess the response of cross-border investment to tax differentials at the country level, a gravity framework for bilateral FDI flows is estimated as follows:

$$Y_{ij,t+h} = \eta(\tau_{i,t} - \tau_{j,t}) + \zeta_1 X_{i,t} + \zeta_2 X_{j,t} + \zeta_3 X_{ij,t} + \epsilon_{ij,t}, \quad (2)$$

where $Y_{ij,t+h}$ denotes bilateral cumulative FDI flows between countries as percent of the destination country GDP at time $t - 1$. Bilateral flows are sourced from the World Bank Harmonized Bilateral FDI Database (Steenbergen and others 2022). $X_{i,t}$, $X_{j,t}$, and $X_{ij,t}$ are country-specific and pairwise controls, including population, GDP, bilateral trade, contextual effects, and lagged bilateral inflows. η is the semi-elasticity of FDI to tax differentials. To address endogeneity concerns, the tax differential is instrumented with peers' political cycle.

32. The sector-level estimation gauges the relation between tax differentials and cross-border investment at the intensive and extensive margins, for both greenfield and M&A projects:

$$Y_{ij,s,x(s),t+h} = \eta_{x(s)}(\tau_{i,s,t} - \tau_{j,s,t}) + \theta X_{ij,t} + \delta_s + \epsilon_{ijs,t}, \quad (3)$$

where $Y_{ij,s,x(s),t+h}$ is the bilateral FDI outcome in sector s . The specification in (3) allows for heterogeneous responses across the intensity of intangibles at the sectoral level, $x(s) = \{\text{tangible}, \text{intangible}\}$. Intangible sectors include Information, Legal Services, and Management of Companies and Enterprises.

33. Outcomes include: a) the count of brownfield and greenfield projects (extensive margin), and b) the level of investment as percent of GDP. ⁶ Sectoral outcomes are sourced from

⁶ To account for endogeneity, the intensive margin estimation uses a control function approach while the extensive margin estimation uses 2SLS.

MREID, a comprehensive panel dataset constructed from firm-level records, covering MNCs' activities across 185 countries and 25 industries.

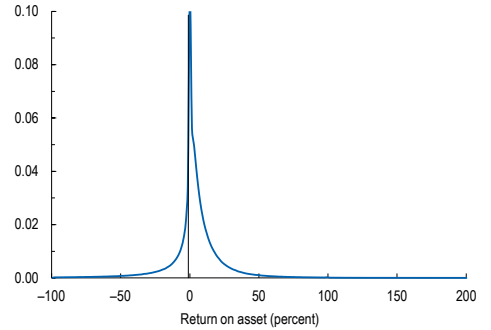
Online Annex 3.5. Profit-shifting Estimation

34. This online annex summarizes the methodology, main results, and robustness tests underlying the sensitivity analysis of MNCs' reported income in a given jurisdiction to the global CIT landscape.

Data

35. The analysis uses a panel of unconsolidated balance sheet data from Orbis covering the period 2009–23. All balance sheet variables are transformed into real (2019) USD terms. The unit of observation corresponds to a subsidiary f , in country j , active in economic sector k —based on the NACE Rev. 2 classification—and year t . Moreover, using Orbis' ownership database, each subsidiary is linked to a global ultimate owner (G) in country i ⁷. The sample covers about 500,000 MNE groups and over 3 million subsidiary-year observations, over the 2009–23 period, covering over 100 host countries, with headquarters in over 40 jurisdictions.

Online Annex Figure 3.5.1. Kernel Density of Return on Asset (Density)



Sources: Orbis; and IMF staff calculations.

Methodology

36. The analysis captures both the extensive and intensive margins of MNCs' profit shifting. The intensive margin of profit shifting refers to the distribution of an MNC's *positive* profits across its subsidiaries (e.g. literature Beer and Loeprick 2015). The extensive margin refers to MNC's strategic decision to report zero (or negative) profits to entirely eliminate the tax liability in a given jurisdiction (Fuest, 2022; Francois and Vicard 2025). To capture both, we focus on return on assets (ROA) as the dependent variable. An affiliate's returns are measured as earnings before interest and tax (EBIT), which is the accounting measure most closely aligned with taxable income. Online Annex Figure 3.5.1 shows the distribution of the reported ROA at the affiliate level, based on our sample. Consistent with Francois and Vicard (2025), the baseline specification treats MNCs' reported taxable income as censored at zero.

37. The main empirical specification is given by:

$$ROA_{G,i,f,j,k,t} = \beta_0 + \beta_1 \bar{\tau}_{j,t} + \gamma' X_{f,j,t} + \delta' X_{G,i,t} + \rho' X_{j,k,t} + \phi_G + \phi_k + \phi_{j,t} + u_{G,i,f,j,k,t} \quad (1)$$

where $\bar{\tau}_{j,t} = \tau_{j,t} - \sum_{l \neq j}^G w_{l,t} \tau_{l,t}$ corresponds to the difference between the statutory CIT rate in affiliate jurisdiction j and the asset-weighted average of CIT statutory rates across jurisdictions $l \neq j$ in which the MNC has affiliates⁸.

⁷ The global ultimate owner is identified as the entity holding at least a 50 percent ownership stake, at the consolidated level.

⁸ We use statutory CIT rates, as profit-shifting decisions are sensitive to this measure, as opposed to effective tax rates, which are relevant for investment decisions (see Devereux and Griffith, 1998, 2003)

38. The controls include: a vector of time-variant covariates at the affiliate level, $\mathbf{X}_{f,j,t}$, which include the log of turnover (capturing firm-specific changes in firm performance) and the log of employment (capturing firm size); the vector of controls at the industry-level of the jurisdiction where the affiliate is located, $\mathbf{X}_{j,k,t}$, which include a turnover based Herfindahl index of concentration to control for market structure forces that may affect the degree to which CIT changes pass through to real variables; and a vector of conglomerate controls, $\mathbf{X}_{G,k,t}$, which include profitability at the MNC level to ensure estimates of profit-shifting are conditional on the MNC's overall productivity. The specification also includes year, conglomerate and subsidiary-jurisdiction-year fixed effects to capture, respectively, global shocks, industry-specific characteristics, and cyclical developments in the country of the subsidiary.

39. The coefficient of interest, β_1 , is expected to be negative: all else equal, an increase in the CIT rate in one jurisdiction vis-à-vis the average CIT rate across all other countries where the MNC operates, is expected to lower the reported income in that jurisdiction. Evaluated for an MNC with the average ROA, the estimated coefficient implies an elasticity of reported income to tax differentials of -1.2 (Online Annex Table 3.5.1, column 1).

40. Subsequently, we explore whether sensitivity to tax differentials for MNCs varies with intangibles intensiveness and whether the responsiveness of profit-shifting elasticity has changed since 2017, when actual and anticipated international tax reforms may have reduced profit-shifting opportunities. Specifically, we estimate the following regression:

$$ROA_{G,i,f,j,k,t} = \beta_0 + \beta_1 \bar{\tau}_{j,t} + \gamma' \mathbf{X}_{f,j,t} + \delta' \mathbf{X}_{G,i,t} + \rho' \mathbf{X}_{j,k,t} + \beta_2 (\bar{\tau}_{j,t} \cdot D_{2017}) + \alpha_2 D_{2017} + \beta_3 (\bar{\tau}_{j,t} \cdot I_G) + \alpha_3 (D_{2017} \cdot I_G) + \beta_4 (\bar{\tau}_{j,t} \cdot D_{2017} \cdot I_G) + \phi_G + \phi_k + \phi_{j,t} + u_{G,i,f,j,k,t} \quad (2)$$

where D_{2017} is a dummy which takes the value of 1 if the year of observation is 2017 or after. Intangible intensiveness at the MNC level is measured as the ratio of the GUO's intangible fixed assets to total fixed assets. A subsidiary is classified as high-intangibles intensive ($I_G = 1$) if it belongs to a conglomerate, for which this ratio averages at least 50 percent. This threshold corresponds to the 75th percentile of the sample. Note that the intangibles intensiveness indicator is time-invariant.

Online Annex Table 3.5.1. Baseline Regressions

Dependent Variable: Censored Return on Asset (ROA)

	Average (1)	Time effect (2)	ATA (3)
$\tau - \sum \omega \tau$	-0.327*** (0.0894)	-0.190* (0.101)	-0.239* (0.126)
$(\tau - \sum \omega \tau) \times \text{high-intangibles}$		-0.280*** (0.0780)	-0.546*** (0.126)
$(\tau - \sum \omega \tau) \times \text{post 2017}$		0.251** (0.117)	
$(\tau - \sum \omega \tau) \times \text{post 2017} \times \text{high-intangibles}$		-0.368** (0.143)	
$(\tau - \sum \omega \tau) \times \text{TP doc. HQ}$			0.242** (0.104)
$(\tau - \sum \omega \tau) \times \text{TP doc. HQ} \times \text{high-intangibles}$			0.243* -0.126
TP doc. HQ			-1.662** -0.705
<i>Overall profits semielasticity for average affiliate</i>			
Low II	-1.168*** (0.319)	-0.679* (0.361)	-2.148 0.353
Low II post-2017 / TP doc		0.219 (0.483)	-0.488 0.332
High II		-1.678*** (0.348)	
High II post-2017 / TP doc		-2.095*** (0.426)	
Observations	3,198,284	3,198,284	3,198,284
R ²	0.65	0.65	0.65

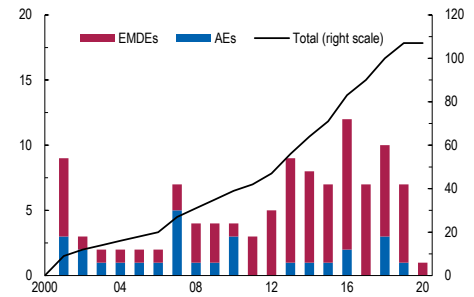
Source: IMF staff calculations.

Note: Robust standard errors in parentheses, clustered at the MNC level. TP doc. = transfer pricing documentation requirements. HQ = headquarter. II = intangibles intensity.

*** p<0.01, ** p<0.05, * p<0.1.

41. The coefficients on the interaction terms capture differential effects (Online Annex Table 3.5.1, column 2). The implied elasticities of reported income for an MNC with average ROA are reported at the bottom of the table. If the MNC with average ROA has low-intangibles intensity, its reported income semielasticity before 2017 is proportional to (β_1) and equivalent to -0.68 , and after 2017 the semielasticity is proportional to $(\beta_1 + \beta_2)$ and equivalent to 0.2 . Moreover, the latter is not statistically different from zero. By contrast, if the average MNC is intangibles-intensive, its semielasticity of reported income before 2017 is proportional to $(\beta_1 + \beta_3)$ and equivalent to -1.7 ; after 2017, it is proportional to $(\beta_1 + \beta_2 + \beta_3 + \beta_4)$ and equivalent to -2.1 . Overall, the semielasticity of reported income for high intangibles-intensive MNCs is, on average, larger than for low intangibles-intensive firms. While profit-shifting responsiveness among low intangibles-intensive firms declines markedly after 2017 and is no longer statistically significant, there is no statistically significant change for high intangible-intensive MNEs. One interpretation is that the growing importance of intangible assets continued to facilitate profit shifting despite stronger anti-avoidance efforts. In addition, several countries expanded profit-based tax incentives to attract income derived from intangible assets after 2017 (see Box 3.2).

Online Annex Figure 3.5.2. Legislation of Transfer Pricing Documentation Requirements
(Number of countries per year; cumulative, right scale)



Sources: International Tax Institutions Database (<https://www.rsit-uni-tuebingen.de/data>); and IMF staff calculations. EMDEs = emerging market and developing economies; AEs = advanced economies.

42. Finally, we examine whether the semielasticity of reported income to tax differentials changes for MNCs headquartered in countries that introduced transfer pricing documentation requirements. Following Beer and Loeprick (2015), we focus on this type of regulation, which is commonly assumed to have a strong signaling and compliance effect on MNCs, and can be interpreted as a proxy for actual administrative enforcement of the “Arm’s Length Principle”. Moreover, the implementation of this type of regulation has broadened since the mid-2010s, following the BEPS 15 Action Plan (Online Annex Figure 3.5.2).

43. To gauge the effectiveness of this type of regulation, we estimate the equation below:

$$ROA_{G,i,f,j,k,t} = \beta_0 + \beta_1 \bar{\tau}_{j,t} + \gamma' X_{f,j,t} + \delta' X_{G,i,t} + \rho' X_{j,k,t} + \beta_2 (\bar{\tau}_{j,t} \cdot R_{i,t-1}) + \alpha_2 R_{i,t-1} + \beta_3 (\bar{\tau}_{j,t} \cdot I_G) + \alpha_3 (R_{i,t-1} \cdot I_G) + \beta_4 (\bar{\tau}_{j,t} \cdot R_{i,t-1} \cdot I_G) + \phi_G + \phi_k + \phi_{j,t} + u_{G,i,f,j,k,t} \quad (3)$$

where $R_{i,t-1}$ is a dummy that takes the value of 1 if the economy where the conglomerate has its headquarters (country i) has introduced transfer-pricing documentation requirements (TPDRs) into its legislation. Again, the results indicate that profit location choices are more sensitive to tax differentials for high intangibles-intensive MNCs (Online Annex Table 3.5.1, column 3). The results show that the sensitivity of reported income to CIT rates is lower for MNCs headquartered in countries that have introduced TPDRs. If the MNC is low-intangibles intensive and the jurisdiction where it is headquartered does not have such requirements, the semielasticity is -0.85 ; if the headquarters is subject to such requirements, the semielasticity becomes statistically indistinguishable from zero. By contrast, if the MNC is high intangibles-intensive and its headquarter is located in a jurisdiction without TPDRs, the semielasticity is equivalent to -2.8 , which falls with the introduction of TPDRs, with a statistically significant difference of 1.7 . It is also important to note the negative coefficient on the non-interacted anti-avoidance

measure variable (α_2) suggests that MNCs headquartered in jurisdictions that introduce TPDRs would report a larger share of profits domestically than abroad.

Robustness

44. The chapter’s main findings prove robust across a wide range of specifications. Results are consistent when controlling for alternative anti-avoidance measures, including controlled foreign corporation and earnings-stripping rules, and continue to show that profits of intangible-intensive firms are more responsive to tax differentials while TPDRs dampen that sensitivity. Similar conclusions emerge under alternative specifications that impose common post-2017 or policy effects across firms, account for strategic tax interactions across countries, use alternative measures of firm size, and employ broader or more restricted samples, including G20-headquartered MNCs and their foreign affiliates.⁹

Online Annex 3.6. Location Choice Tax Sensitivity

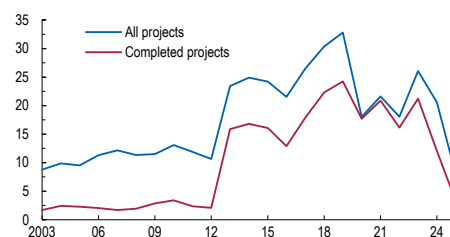
45. This online annex provides the details behind the estimation of the elasticities in the analysis of the location choice of FDI.

Data

46. The analysis focuses on project level data from the project level database provided by Orbis Cross-Border Investment. The status of these projects can be classified as *Announced*, *Cancelled*, *Completed* or *Completed Assumed*. Each project includes identifiers for the investing firm (the investing firm) and the “target” firm (the firm created as a result of the investment). Additional information includes the date of the investment, the country of the two firms and the size of the investment. Leveraging the ownership data in Orbis we are able to connect most firms to their global ultimate owner (GUO). Additionally, the investment data is matched with firms’ financials and characteristics data available in other Orbis databases, including the tangible and intangible fixed assets of the investing firm and – if available – of its GUO, as well as the sector of the two firms and GUO. Relevant country-level information, such as GDP, population and trade openness are from the IMF *World Economic Outlook* database, and effective average tax rates (EATRs) are from the International Tax Institute (ITI) database.

47. The database coverage increases over time (Online Annex Figure 3.6.1). Hence, we focus on the years following 2012. Given the availability of EATRs ends in 2020, observations after that year are discarded. Additionally, all projects that are classified as *Announced* or *Cancelled* are dropped from the analysis. In the 2013–2020 original sample there are 25,000 yearly projects on average, and a total of around 202,000 observations. After dropping the *Announced* or *Cancelled* projects, the sample is reduced to an average of around 18,000 projects per year and a total of around 144,000 observations.

Online Annex Figure 3.6.1. Evolution of Coverage in the Orbis Project Database
(Number of observations, thousands)



Sources: Orbis Cross Border Investment; and IMF staff calculations.

⁹ These results are available upon request.

48. In the sample, investing firms are located in 154 countries and invest in 164 jurisdictions. In our baseline analysis we focus on 25 possible location choices: 19 countries in the G20, 5 low tax jurisdictions¹⁰ and the aggregate of all other possible locations.

Methodology

49. The exercise assesses how tax differentials between countries affect the decision of investing in a specific location. The approach follows closely Arulampalam et al. 2019, and it assumes that an investing firm f compares potential profits originating from the investment across J possible locations, and picks the location where such profits are maximized.

50. In particular, profits are modeled as a function of the MNC's intangibles-intensity, the investing country's economic conditions – GDP, population and trade openness, X_f –, EATRs, demand conditions in each location –captured by the country-specific intercept, GDP, population, and the ease of attracting FDI proxied by trade openness, $(Z_{c(j)})$ – and unobserved factors. The impact of taxation is assumed to be homogeneous across countries, but it can vary over time and firms' intangibles-intensity. The origin country's variables are assumed to have a homogenous impact on profits, while the destination countries' conditions are allowed to impact profits differentially. In sum, potential profits from an investment by firm f in location j is assumed to take the following form:

$$\pi_{fjt} = k(\beta, D_g)(\tau_j - \tau_{c(f)}) + \gamma X_f + \delta_j Z_{c(j)} + \phi_t + \alpha_j + \varepsilon_{fj}, \varepsilon_{fj} \sim \text{Gumbel}, \forall j \in C_f, |C_f| = J$$

Where $\tau_j - \tau_{c(f)}$ is the tax differential between the country of the investing firm and the destination country, X is a set of firm level characteristics (including the characteristics of its country), $Z_{c(j)}$ is a set of characteristics of the destination country, including a post 2017 dummy, and the unobserved component ε_{fj} , which is assumed to follow a Gumbel distribution. Note that the time fixed effects drop in estimation. This setting delivers the standard conditional logit model, where the probability that firm f invests in country j is

$$P(\pi_{fjt} > \pi_{fkt}, \forall j \neq d \text{ and } j \in C_f) = \frac{\exp[k(\beta, D_g)(\tau_j - \tau_{c(f)}) + \gamma X_j + \delta_j Z_{c(j)} + \phi_t + \alpha_j]}{\sum_{k \in C_f} \exp[k(\beta, D_g)(\tau_k - \tau_{c(f)}) + \gamma X_k + \delta_j Z_{c(j)} + \phi_t + \alpha_j]}$$

51. The interactions in $k(\beta, D_g)$ capture the time varying impact of the tax differential, which is interacted with a dummy that takes value one for the years 2017-2020. The dummy is allowed to have a different impact across locations, to capture location specific changes that might have happened after 2017. To capture the differential impact across firms with different degree of intangible-assets intensity, the differential is also interacted with a dummy that takes value 1 if the investing firm's GUO has fixed-intangible assets to total fixed assets ratio above 0.5 (around one third of the firm in the sample). The tax differential is also interacted with the product of the two dummies.¹¹

¹⁰ The low tax jurisdictions include Singapore, Ireland, Switzerland, Luxembourg and Bahrain, which are the five countries in our sample with most inward FDI, according to Keen et al. (2014),.

¹¹ Namely $k(\beta, D_{g(f,t)}) = \beta_\tau + \beta_{int} D_{int,ft} + \beta_{post} D_{post2017,ft} + \beta_{int,post} D_{int,ft} \times D_{post2017,ft}$ where $D_{int,ft}$ is a dummy that takes value 1 if firm f in year t is classified as high-intangible intensive, and where $D_{post2017,ft}$ is the investment is done after 2017.

Results and Robustness

52. The exercise allows us to estimate the elasticities of the location choice to EATRs, and how they vary over time and across MNCs with high and low intangibles intensity. The elasticity in the different groups is recovered from the estimated coefficients as

$$\frac{d \log p_{ij}}{d \log \tau_j} = (1 - p_{ij}) \tau_j k(\beta, D_g)$$

Where $k(\beta, D_g)$ is the linear function of the coefficients recovered from the multinomial logit and the relevant dummy variables. The average elasticity referenced in the main text is computed at the choice observed in the data, within each group of firms.¹² Standard errors are clustered at the investing firm level.

53. As illustrated in the main text, the results from this empirical exercise suggest that location choice of FDI – the extensive margin of MNCs’ investment decision - became more sensitive to tax differentials after 2017. The results also demonstrate that investment sensitivity to the tax-differentials became more similar between firms with different intangibles-intensity. These baseline estimates are based on a sample including investing firms from all sectors and between 2013 and 2020. The results are robust to excluding firms investing in sectors typically enjoying special tax regimes (e.g. mining sector), dropping data for 2020 to account for the disruption caused by the COVID pandemic, and to both.¹³

Online Annex 3.7. The Impact of Taxation on the Intensive Margin of Investment

54. This online annex provides the methodology, main results, heterogeneity analysis, and robustness tests for estimating how effective marginal tax rates (EMTRs) affect the investment rate of existing MNC subsidiaries.

Data

55. The analysis uses a firm-level panel of multinational corporations drawn from the Orbis database covering the period 2010–2020. The unit of observation is the subsidiary-year. MNC structures are identified using Orbis ownership data, defining the Global Ultimate Owner (GUO) as the entity holding at least a 50 percent ownership stake. The sample covers approximately 500,000 distinct MNE groups and over 6.3 million subsidiary-year observations in the baseline specification. Key financial variables drawn from Orbis include subsidiary total assets—used to construct the investment rate—and both subsidiary and GUO NACE Rev. 2 sector codes, which are mapped to one-letter ISIC categories for merging with the EMTR data from the International Tax Institute (ITI) database, which vary at the country–ISIC sector–year

¹² For example, the elasticity for firms with high intangible asset intensity after 2017 is computed as $\frac{1}{N_{int,post}} \sum_{C_i=j, j \in IntPost} ((1 - p_{int,post}^j(x_{i,j})) \tau_j * (\hat{\beta}_\tau + \hat{\beta}_{int} + \hat{\beta}_{post} + \hat{\beta}_{int,post}))$, where $N_{int,post}$ is the number of high-intangible intensity firms in the post period, $p_{int,post}^j(x_{i,j}) = P(\hat{\theta}, X|X = x_i, Int_i = 1, Post_{2017,i} = 1, C_i = j)$ is the estimated probability that a firm i picked the observed choice (j) conditional on its observables x , (including the “high intangible intensity dummy” Int , the post 2017 dummy $Post_{2017}$).

¹³ These results are available upon request.

level. Intangible intensity at the group level is measured as the ratio of the GUO's intangible fixed assets to total fixed assets; subsidiaries are classified as high-intangibles-intensive if this ratio exceeds 50 percent.

56. The EMTR data is merged with the firm-level panel at both the destination (subsidiary) country and the source (GUO) country. Under the affiliate-sector approach, the EMTR assigned to each subsidiary reflects its own NACE sector; under the GUO-sector approach, all subsidiaries of the same parent receive the EMTR corresponding to the parent's main NACE sector. Country-level anti-avoidance regulation indicators—covering controlled foreign corporation (CFC) rules, transfer pricing documentation requirements, earnings stripping rules, and intellectual property (IP) box regimes—are measured at the GUO country level and lagged one year to mitigate simultaneity. Macroeconomic controls, including log GDP per capita (PPP), log population, and trade openness, are drawn from the IMF *World Economic Outlook* database for both source and destination countries.

Methodology

57. The empirical specification estimates the effect of the EMTR differentials on the investment rate of subsidiary f located in destination country d , operating in sector s , owned by GUO g headquartered in origin country o , in year t :

$$I_{f(g),d,o,s,t} = \beta \Delta EMTR_{g,d,o,s,t} + X_{f(g),d,o,s,t} \Gamma + \alpha_g + \delta_t + \gamma_{st} + \epsilon_{f(g),d,o,st},$$

where $I_{f(g),d,o,s,t}$ is the investment rate, defined as the change in total assets relative to lagged total assets winsorized at the 1st and 99th percentiles. The coefficient of interest, β , captures the relation between the differential EMTR—denoted by $\Delta EMTR_{g,d,o,s,t}$ —and its investment rate. The sector-specific effective marginal tax rate differential is defined as follows:

$$\Delta EMTR_{g,d,o,s,t} = EMTR_{d,s,t} - \underbrace{\sum_{o'} \omega_{g,o',s,t} EMTR_{o',s,t}}_{MNC's \text{ asset weighted EMTR}},$$

that is, the differential between the EMTR at destination where subsidiary f is located— $EMTR_{d,s,t}$ —and the asset-weighted average EMTR across all existing affiliates in the MNC group. A higher EMTR increases the required pre-tax return on a marginal investment, reducing the optimal capital stock (Devereux and Griffith (1998, 2003)). Hence, we expect $\beta < 0$.

58. We control for observed firm-level characteristics, including lagged sales, employment, and return on assets, as well as a vector of macroeconomic variables of the source and destination countries (log GDP per capita, log population, trade openness). In addition, the terms α_g , δ_t , and γ_{st} denote GUO, year, and sector-year fixed effects, respectively. The specification is progressively saturated, with the baseline specification exploiting within-MNC and within-sector-year. Standard errors are clustered at the GUO level throughout.

59. The baseline is extended to capture changes in the international tax landscape since 2017 which may have altered MNCs' behavioral responses to taxation. To test whether tax sensitivity changed after these reforms, the EMTR is interacted with a post-2017 dummy:

$$I_{f(g),t} = \beta_1 \Delta EMTR_{g,d,o,s,t} + \beta_2 \Delta EMTR_{g,d,o,s,t} \cdot \text{Post2017}_t + X_{f(g),d,o,s,t} \Gamma + \alpha_g + \delta_t + \gamma_{st} + \varepsilon_{f(g),t}$$

$\beta_2 < 0$ would indicate that tax sensitivity intensified after these reforms. The intuition is that, as profit-shifting channels are curtailed, MNCs that would have previously responded to tax differentials through tax planning are forced to adjust through real investment instead.

60. But MNCs' behavioral responses to the CIT regime can be heterogeneous and depend on both the regulatory environment and firm characteristics. To explore this heterogeneity, the EMTR is interacted with a set of firm- and country-level variables:

$$I_{f(g),t} = \beta_1 \Delta EMTR_{g,d,o,s,t} + \beta_3 \Delta EMTR_{g,d,o,s,t} \times Z_{o,t-1} + X_{f(g),d,o,s,t} \Gamma + \alpha_g + \delta_t + \gamma_{st} + \varepsilon_{f(g),t}$$

The regulatory interactions test whether anti-avoidance rules at the GUO (origin) country alter the sensitivity of real investment to tax differentials. $Z_{o,t-1}$ includes lagged dummy indicators for the presence of CFC rules, earnings stripping, transfer pricing documentation requirements, and IP regimes. The hypothesis, following de Mooij and Liu (2020) and Keen, Liu, and Pallan (2023), is that anti-tax-avoidance regulations increase the sensitivity of tangible investment to tax differentials, implying $\beta_3 < 0$. IP box regimes, by contrast, reduce the effective tax burden at the origin and may dampen the incentive to reallocate investment abroad, implying $\beta_3 > 0$.

61. The intangibles-intensity interaction tests whether MNCs with a large stock of intangible assets respond differently to tax differentials. Since intangible assets are nonrival within the MNC and facilitate profit-shifting through transfer pricing and the strategic location of IP, intangibles-intensive MNCs may have historically been less sensitive to EMTRs. However, as anti-avoidance regulations curtail these channels, the sign of the interaction becomes an empirical question. All regulatory indicators are lagged one year and entered separately.

Results

62. Online Annex Table 3.7.1 reports the main results. The differential and weighted differential specifications show consistently negative coefficients across all specifications. The baseline specification (column 1) shows that a 1 percent increase in the tax differential reduces the investment rate by 0.148. The differential effect post 2017 is negative but estimated with more uncertainty. These results are robust to alternative specifications, including when controlling for destination-time fixed effects and adding GUO-time fixed effects.

63. Online Annex Table 3.7.2 presents interactions with origin-country anti-avoidance regulations (columns 1 to 4). MNCs headquartered in countries with stricter earnings stripping rules (−0.511) and transfer pricing documentation requirements (−0.607) are more sensitive to

Online Annex Table 3.7.1. Effect of EMTR Differential on Investment Rate

	(1)	(2)	(3)	(4)
Effective Marginal Tax Rate Differentials	−0.148** (0.060)	−0.117* (0.062)	−0.223** (0.097)	−0.163** (0.069)
Effective Marginal Tax Rate Differentials x Post 2017		−0.134** (0.068)	−0.385*** (0.088)	−0.056 (0.090)
GUO FE	Yes	Yes	Yes	Yes
Year FE				
Sector x Year FE	Yes	Yes	Yes	Yes
Destination x Year FE	No	No	Yes	Yes
GUO x Year FE	No	No	No	Yes
Observations	6,235,788	6,235,788	6,235,782	4,422,576
R ²	0.13	0.13	0.13	0.13

Source: IMF staff calculations.

Note: Standard errors clustered at GUO level in parentheses. Sample corresponds to affiliates of MNCs over the 2010–20 period, with headquarters in over 40 countries and subsidiaries in over 100 countries. The dependent variable is the investment rate. The main explanatory variable is tax differential in sector-specific effective marginal tax rate (EMTR) in the destination country relative to the asset-weighted group average EMTR across all subsidiaries of the MNC group.

*** p<0.01, ** p<0.05, * p<0.1.

destination taxes. This is consistent with the results in de Mooij and Liu (2020). CFC rules show no significant differential effect (−0.005), possibly because they primarily affect passive income rather than real investment decisions. Firms from countries with IP box regimes are less tax-sensitive (+0.242), suggesting these regimes reduce the effective tax burden and diminish the incentive to relocate investment. Firms that are more intensive in intangible investment don't exhibit significant differences in their investment margin (column 5).

Online Annex Table 3.7.2. Interaction of Tax Differentials with Policy and Intangible Intensity

	CFC (1)	Earnings Stripping (2)	Transfer Pricing (3)	IP Box (4)	Intangible Intensity (5)
Differential Effect	−0.005 (0.079)	−0.511*** (0.073)	−0.607*** (0.072)	0.242*** (0.066)	−0.141 (0.090)
GUO FE	Yes	Yes	Yes	Yes	Yes
Sector x Year FE	Yes	Yes	Yes	Yes	Yes
Destination x Year FE	No	No	No	No	No
GUO x Year FE	No	No	No	No	No
Observations	6,340,678	6,340,678	6,340,678	6,340,678	6,222,510

Source: IMF staff calculations.

Note:

Standard errors clustered at GUO level in parentheses. Sample corresponds to affiliates of MNCs over the 2010–20 period, with headquarters in over 40 countries and subsidiaries in over 100 countries. The dependent variable is the investment rate. The main explanatory variable is tax differential in sector-specific effective marginal tax rate (EMTR) in the destination country relative to the asset-weighted group average EMTR across all subsidiaries of the MNC group and the interaction with the variable of interest. GUO = global ultimate owner.

*** p<0.01, ** p<0.05, * p<0.1.

Online Annex 3.8. Structural Model of Multinational Production, Profit Shifting, and Tax Competition

64. This online annex describes the multi-region spatial general equilibrium model, used for two policy experiments: (1) reciprocated reductions in statutory corporate income tax (CIT) rates across regions, and (2) the use of stronger anti-avoidance enforcement in EMEs in place of matching CIT rate cuts by AEs.

Model Structure

65. The model extends the quantitative framework developed by Dyrda, Hong, and Steinberg (2024a, 2024b) to a seven-region world economy and incorporates productive public capital.

66. There are six productive regions: (1) a major advanced economy (AE); (2) other AEs; (3) a major EME; (4) G20 EMEs; (5) productive low-tax jurisdictions (PLTJs) and (6) the rest of the world (ROW) comprised of all other productive EMDEs. Additionally, there is a region of unproductive low-tax jurisdictions (ULTJs) where no production occurs but where MNCs from elsewhere can establish shell affiliates to shift profits.

67. Regions differ in population, TFP, trade costs, FDI costs, CIT rates, and the efficiency of tax enforcement. Each of the productive regions is populated by a representative household, government, and a continuum of heterogeneous firms.

- **Firm Heterogeneity:** Firms in each region draw their idiosyncratic productivity from a Pareto distribution and jointly decide where to export, where to establish foreign affiliates, how much intangible capital to produce, and the share of profits they shift to LTJs. Exporting and FDI decisions are subject to fixed and variable costs (Helpman, Melitz, and Yeaple 2004). The largest MNCs also shift profits through transfer (mis)pricing of intangible assets, but account for only a small share of the overall firm population.¹⁴

¹⁴ For detailed derivations of the firm's problem and theoretical properties, including the interdependence between intangible investment and subsidiary location choice, see Dyrda, Hong, and Steinberg (2024a).

- **Production function:** The output of a firm based in region i producing in region j is given by a technology that depends on (1) aggregate TFP in the production location, (2) the firm's idiosyncratic productivity, (3) its stock of intangible capital, and (4) the labor it hires locally. Intermediate goods have different varieties—aggregated through a CES demand structure per region, with a common elasticity of substitution for domestic and imported varieties.
- **Intangible Capital.** Firms produce non-rival intangible capital by employing R&D labor domestically. Because these intangible assets can be used simultaneously across all domestic and foreign affiliates, MNCs benefit from increasing returns to R&D. Consequently, MNCs undertake the vast majority of intangible investment in equilibrium, consistent with the data.
- **Profit Shifting:** MNCs can reduce their tax liabilities by locating ownership of intangible assets in affiliates established in PLTJs and ULTJs. After paying the fixed costs of establishing these affiliates, firms transfer the rights to collect licensing income, including from other entities within the MNC group. The share of licensing income earned by LTJ affiliates is a key profit-shifting decision variable. Profit shifting is also subject to a convex cost, capturing the real resources—in domestic labor terms—devoted to tax-planning activities, which are increasingly difficult to justify to tax authorities.
- **Productive Public Capital:** In each region, effective TFP is influenced by the stock of public capital, which enters the production function with an output elasticity calibrated in line with the empirical literature.¹⁵ Public capital accumulation is financed by a share of CIT revenue, reflecting the observed heterogeneous shares of public capital in total government expenditures across regions. The remainder of public capital is funded by other tax instruments (VAT, personal income tax, and other sources), which are fixed in the counterfactual experiments.

68. The model is calibrated to match observed data on production, trade, FDI, and profit shifting across all regions.

Defining Low-Tax Jurisdictions

69. Four thresholds are used to identify PLTJs and ULTJs: (1) the CIT abuse index, constructed by the Tax Justice Network, which examines countries' tax codes to establish whether the regime is prone to avoidance, with a higher score indicating that the country's regulations are more permissive of corporate tax abuse; (2) the statutory CIT rate, considering special regimes that apply to MNCs; (3) FDI stocks—the average of assets and liabilities—as a share of GDP; and (4) population size.

70. Economies are classified as ULTJs if the following four criteria are met: CIT abuse indicator is above 60, FDI stocks are larger than the size of the economy, the statutory CIT rate is lower than 10 percent, and the population size is less than 2 million. Economies that satisfy three of these criteria—including a low CIT rate *and* low population size—are also classified as

¹⁵ Bom and Ligthart (2014) provide a meta-analysis of the output elasticity of public capital. Short-run estimates range from 0.08 to 0.15, while long-run estimates are between 0.12 and 0.25. Higher values for EMDEs are justified by larger infrastructure gaps and higher marginal returns to public investment.

ULTJs. PLTJs are economies that satisfy two criteria, or three criteria including the small population size or low CIT rate criterion.¹⁶

Transmission Channels

71. The effects of CIT rate changes operate through two broad sets of mechanisms: the direct effects on the tax-cutting economy itself, and the spillovers transmitted to other regions through trade, FDI, knowledge transfers, and profit-shifting. The net macroeconomic outcome in each region depends on the balance of these forces.

Direct effects on the tax-cutting economy

72. A reduction in the statutory CIT rate affects the tax-cutting economy through several channels, with ambiguous net effects. Lower CIT rates:

- *Stimulate intangible investment and innovation* through a reduction in the user cost of capital, thereby supporting economic activity.
- *Narrow tax differentials*, reducing the incentive for domestic MNCs to shift profits. Beyond the direct fiscal benefit of retaining a larger share of the tax base domestically, reduced profit shifting also frees resources, which can be redeployed toward production and R&D.
- *Reduce CIT revenue and public capital investment*. CIT revenue is reduced mechanically given the lower rate applied to the existing base. The decline in revenue reduces resources available for productive public investment, which impacts output through lower TFP.

The net direct effect on the tax-cutting economy depends on the degree of *fiscal productivity*, governed by the output elasticity of public capital and the share of public investment financed by CIT revenue. Because both parameters are calibrated to be higher in EMDEs—reflecting higher marginal returns to public investment and more reliance on CIT revenues—the fiscal cost of engaging in tax competition is disproportionately borne by EMEs.

Spillover effects to other regions

73. Tax competition in one region generates cross-border spillovers that affect the tax base, intangible investment, and fiscal capacity in other economies. The net effect on regions not cutting tax rates depends on the relative size of these two offsetting effects:

- The *base-shifting channel* operates negatively for non-tax-cutting regions. When one economy lowers its CIT rate, it becomes a relatively more attractive location for MNC investment and profit booking, eroding the corporate tax base of non-tax-cutting economies.
- The *intangible capital channel* captures positive spillovers through internal knowledge transfers. A lower tax rate reduces the user cost of capital in the tax-cutting country, incentivizing additional R&D investment, leading to a larger accumulation of intangible capital across all economies where the MNC has affiliates, raise the productivity of foreign affiliates.

¹⁶ These results are available upon request.

Calibration

74. Model parameters are common across the baseline and the counterfactual simulations and drawn from the economic literature. The calibration is also region-specific, drawing on production, trade, FDI, and profit shifting (Online Annex Table 3.8.1).

Online Annex Table 3.8.1. Calibration Summary

Parameter	Value	Target Moment	Data Source
<i>Assigned Parameters</i>			
Elasticity of Substitution Between Varieties (ρ)	4	Literature	Dyrda, Hong, and Steinberg (2024a)
Labor Share in Production (γ)	0.85	Literature	Dyrda, Hong, and Steinberg (2024a)
Intangible Capital Share in Production (ψ)	0.1	Intangible income share of foreign MNEs' local	OECD AMNE
TFP Elasticity to Public Capital (δ)	0.05	Conservative value from meta-analysis	Bom and Ligthart (2014)
Corporate Tax Rates (τ)	Region-specific	Statutory CIT rates	Tax Policy Center; ITI database
Population (N)	Region-specific	Taken directly	World Bank WDI, 2022
Share of Public Capital Investment in Government Revenue	0.09–0.47	Public investment shares across regions	World Economic Outlook; WoRLD
<i>Calibrated to Match Region-Level Moments</i>			
Aggregate TFP (A)	Region-specific	Real GDP per capita relative to the United	World Bank WDI, 2022
Pareto Shape Parameter (η)	2.9–3.1	Firm size distribution (Lorenz curve)	Orbis
Variable Export Costs (ϵ_{ij})	Bilateral	Bilateral import shares	CEPII BACI
Fixed Export Costs (k_{ij})	Region-specific	Export participation rate	Dyrda and others (2024)
Variable FDI Costs (σ)	Region-specific	Foreign MNEs' value-added share of GDP	OECD AMNE
Fixed FDI Costs (k_{ij})	Region-specific	Share of firms that are MNEs	Orbis
<i>Calibrated to Match Profit-Shifting Moments</i>			
Profit-Shifting Cost Parameters (Ψ)	Region-specific	Lost profits as a share of GDP	Fotis and others (2026), based on Orbis; CbCR for validation
Fixed Cost of Tax-Haven Affiliates (k_{TH})	Region-specific	Share of lost profits routed through tax haven	Fotis and others (2026), based on
Intangible Capital Shares Across Regions	Region-specific	Intangible income shares by firm type (domestic vs. foreign MNE)	Orbis

Source: IMF staff compilation.

Relationship With Empirical Estimates

75. The model generates semi-elasticities of FDI and profit shifting with respect to CIT rates as endogenous outcomes of the calibrated model. To assess their plausibility, the model-implied behavioral responses are compared with both the microeconomic evidence presented in the chapter and estimates from the broader empirical literature. Online Annex Table 3.8.2 summarizes. The model implies a combined FDI semi-elasticity of approximately -2.0 to -2.4 , consistent with the chapter's macro evidence and previous estimates in the literature based on aggregate FDI data (de Mooij and Ederveen 2003; Feld and Heckemeyer 2011). This response can be decomposed into (i) the extensive-margin—with a semi-elasticity of approximately -1.6 and (ii) the intensive-margin semi-elasticity, which ranges from -0.3 to -0.8 . Both estimates are well within the range reported in the literature and are consistent with the chapter's microeconomic results. The model also implies a profit-shifting semi-elasticity of reported pre-tax profits with respect to the tax differential of approximately -0.9 . This estimate is obtained from simulations that incrementally vary the CIT rate of LTJs and re-solves the firm's optimization problem, following Dyrda and others (2024). This value falls within the range reported in the literature—from -0.8 (Heckemeyer and Overesch 2017) to -1.1 (Johansson and others 2017) and is close to the central estimate of approximately -1.0 in Beer and others (2020). It is also consistent with the chapter's microeconomic estimate of -1.2 .

Online Annex Table 3.8.2. Semi-Elasticities of FDI and Profit Shifting with Respect to the CIT Rate

Margin	Microeconomic Estimate	Model-Implied
<i>Extensive Margin</i> (Location Choice)	-1.4	-1.6
<i>Intensive Margin</i> (Affiliate Scale)	-0.2	-0.3 to -0.8
Aggregate FDI	-2.0	-2.0 to -2.4
<i>Profit Shifting</i> (Reported Profits)	-1.2 to -2.0	-0.9

Source: IMF staff calculations.

Note: Semi-elasticities are expressed as the percent change in the outcome from a 1 percentage point increase in the CIT rate (FDI margins) or the tax differential (profit shifting). For the extensive margin, the chapter estimate is the semi-elasticity of the probability of FDI location choice. The microeconomic estimates correspond to the empirical evidence presented in the main text. FDI = foreign direct investment; CIT = corporate income tax.

Counterfactuals

76. The model is used to evaluate two classes of policy experiments:

- The first scenario assumes that the major advanced economy cuts its statutory CIT rate by 3 percentage points, followed by other advanced economies cutting by 1.2 percentage points in response, consistent with the chapter's empirical estimates of strategic tax competition. All EMEs are assumed to cut by 1.2 percentage points, reflecting intensified tax competition among these economies.
- In the second scenario, advanced economies implement the same CIT rate cuts as in the first scenario, and all EMEs are assumed to strengthen anti-avoidance regulation instead of matching these tax rate cuts. Enforcement improvements are calibrated to be comparable to those achieved by AEs over the past decade, targeting reductions in profit shifting between 10 and 20 percent.

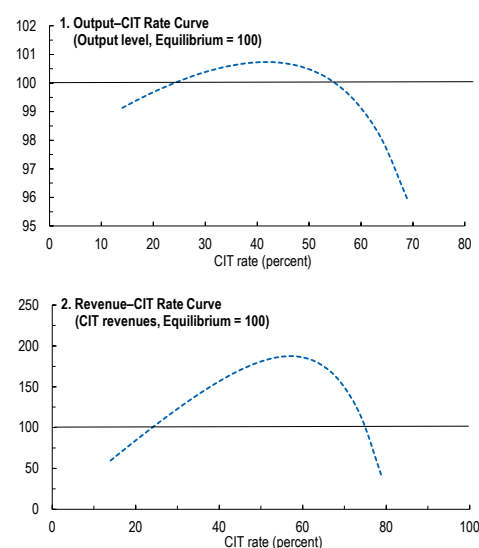
Robustness and Sensitivity Analysis

77. This section conducts a range of sensitivity analyses, examining how CIT revenues and output respond to changes in the CIT rate of a large economy, while holding tax rates in all other regions constant.

78. The analysis generates a standard Laffer curve. That is, reducing CIT rates can boost revenues when the initial rate is very high, such that the rate cut boosts economic activity and expands the CIT base. However, cutting rates beyond a certain point only lowers overall tax collections, as the base effect becomes negligible (Online Annex Figure 3.8.1, panel 1).

79. Similarly, the relation between the CIT rate and domestic output entails an inverted U-shape. Tax cuts can be linked to higher output when the initial CIT rate is very high, but beyond a certain level, reducing the CIT rate undermines economic activity. Intuitively, the output effect of a CIT rate cut depends on whether the positive effects from higher investment and

Online Annex Figure 3.8.1. Sensitivity of Revenue and Output to Initial CIT Rate: Baseline Calibration



Source: IMF staff calculations.
Note: Output and revenue outcomes in the baseline calibration normalized to 100.
CIT = corporate income tax.

base-shifting¹⁷ are offset by the adverse effects from lower revenues on public capital and productivity (Online Annex Figure 3.8.1, panel 2).¹⁸

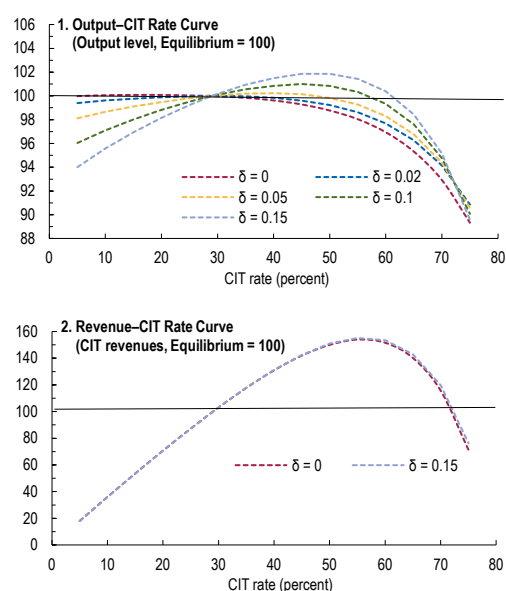
80. The counterfactual analysis of tax competition in the main text indicates that countries which cut CIT rates experience a decline in revenues and output, suggesting that the fiscal-productivity channel is relatively strong. Although the calibration relies on a prudent estimate of the TFP elasticity of public capital, several model parameterizations are explored to identify the conditions under which CIT rate cuts may lead to an underprovision of public goods and, thus, lower output.

Public Investment Needs and the Elasticity of TFP to Public Capital and Corporate Income Tax Revenues

81. CIT rate cuts are more likely to be linked to reductions in output if: (i) public investment needs are large, such that the elasticity of TFP to public capital (δ) is large; or (ii) when the government has a high propensity of spending additional CIT revenues on public investment rather than current spending (captured as household transfers in the model).

82. The results indicate that the Laffer curve is broadly invariant to different elasticities of TFP to public capital (Online Annex Figure 3.8.2, panel 2). However, this elasticity does impact the relationship between output and CIT rates (Online Annex Figure 3.8.2, panel 1). The baseline calibration uses an elasticity of $\delta = 0.05$ (yellow) based on Bom and Ligthart (2014). A higher elasticity ($\delta > 0.05$) means that the upward-sloping part of the output-CIT rate curve becomes steeper (green and light blue). Lower elasticities ($\delta < 0.05$) weaken the link between revenue and productivity, so that output gains from CIT rate cuts become more common. The extreme case of $\delta = 0$ is equivalent to a model without public capital, in which CIT rate cuts unambiguously increase output (red).

Online Annex Figure 3.8.2. Sensitivity of Revenue and Output to Initial CIT Rate: TFP Elasticity of Public Capital (δ)



Source: IMF staff calculations.
Note: Output and revenue outcomes in the baseline calibration normalized to 100.
CIT = corporate income tax; TFP = total factor productivity.

¹⁷ Lower CIT rates encourage intangible investment and make the economy a more attractive destination for multinational production, a pattern which is reinforced by profit shifting.

¹⁸ In a closed economy, without trade, FDI, or profit shifting, firms cannot relocate production or redirect profits in response to tax rate differentials. Since intangible investment is fully deductible, a positive CIT rate does not distort R&D decisions, as both costs and returns are taxed symmetrically, leaving the user cost of intangible capital invariant to the tax rate. While rents are taxed, their size is pinned down by firms' markups. CIT revenue rises almost proportionally with the rate, and real GDP is largely unaffected.

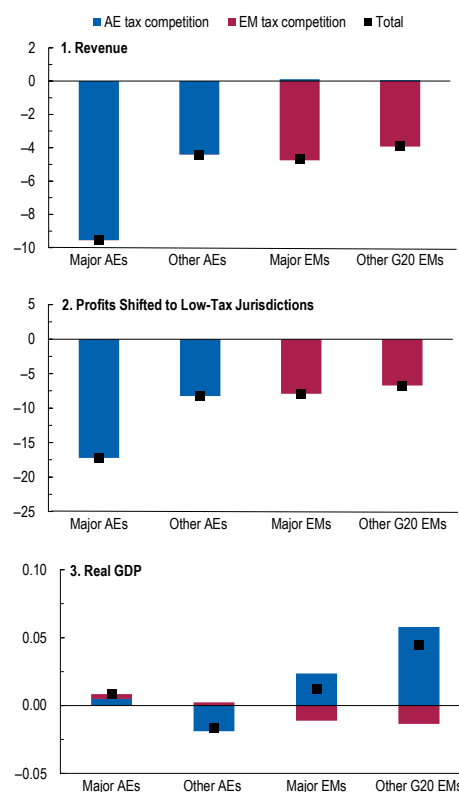
83. A counterfactual tax competition scenario that abstracts from public capital is also presented for illustrative purposes (Online Annex Figure 3.8.3) even though, in practice, governments must devote some resources to maintaining the existing public capital stock. While the effects of tax competition on revenues and shifted profits are the same as the baseline calibration, in the absence of a link between CIT revenues, public capital and productivity, the effects of CIT cuts are positive but small for the major AE (0.01 percent). The magnitudes are relatively small and positive for EMEs, while negative and small for other AEs due to the base shifting effect.

The Elasticity of FDI With Respect to the Corporate Income Tax Rate

84. The net output effects of CIT rate cuts are also shaped by the sensitivity of FDI and profit shifting to tax differentials, which reflects the degree of international capital mobility. Higher elasticities strengthen the domestic output gains from tax cuts, as MNCs are more likely to reallocate or expand investment to lower-tax jurisdictions (Online Annex Figure 3.8.4, panel 1). Accordingly, the output–CIT rate relationship becomes more pronounced when the FDI elasticity is higher (red and green), with a steeper decline in output as tax rates rise and a flatter increase at lower tax rates.

85. Greater capital mobility also affects revenues. Comparing the low- (blue) and high-elasticity (red and green) cases, revenues are lower at higher CIT rates when FDI is more responsive to taxation, as the adverse effects of a tax increase on the CIT base are larger (Online Annex Figure 3.8.4, panel 2).

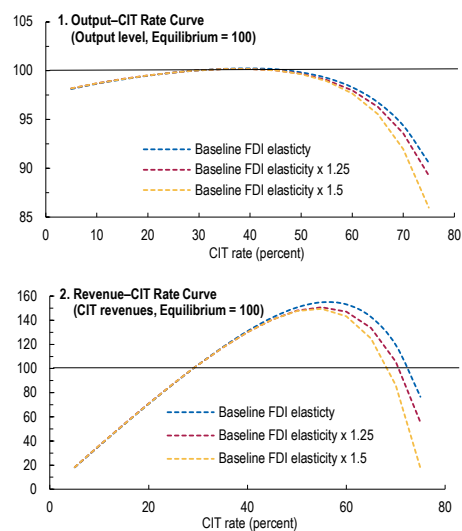
Online Annex Figure 3.8.3. Tax Competition in the Absence of Public Investment
(Percent change, relative to baseline level)



Source: IMF staff calculations.

Note: "AE tax competition" assumes a reduction in a major AE's corporate income tax rate of 3 percentage points and a reduction in the corporate income tax rate of "Other AEs" of 1.2 percentage points. "EM tax competition" assumes a reduction in the corporate income tax rates of emerging market economies by 1.2 percentage points. AEs = advanced economies; EMEs = emerging market economies; G20 = Group of Twenty.

Online Annex Figure 3.8.4. Sensitivity of Revenue and Output to Initial CIT Rate: FDI Elasticity



Source: IMF staff calculations.

Note: Output and revenue outcomes of the baseline calibration normalized to 100. Baseline FDI elasticity is 1.08. CIT = corporate income tax; FDI = foreign direct investment.

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CHAPTER 3 INTANGIBLE YET REAL: SPILLOVERS FROM CORPORATE INCOME TAXATION

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