Globalization and Factor Income Taxation*

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Abstract

Exploiting a new global macro-historical database of effective tax rates, we uncover an intriguing pro-tax-capacity effect of international trade. While effective capital tax rates have fallen in developed countries, they have risen in developing countries since the mid-1990s. Event studies of trade liberalization shocks and instrumental variable regressions show that a significant share of this rise can be explained by trade integration, which increases the share of output produced in large corporations, where capital is easier to tax. In contrast to a widely held view, globalization appears in many countries to have supported the ability of government to tax capital.

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1 Introduction

How has globalization affected the relative taxation of labor and capital, and why? Has international economic integration uniformly eroded the amount of taxes paid by capital owners, shifting tax burdens to workers? Or have some countries managed to increase effective capital tax rates, and if so through which mechanisms? Answering these questions is critical to better understand the macroeconomic effects and long-run social sustainability of globalization.

This paper makes some progress on these issues by uncovering an intriguing pro-tax-capacity effect of international trade. Thanks to a new global database of effective tax rates on labor and capital, we document that in developing countries, effective capital tax rates have increased in the post-1995 era of hyper-globalization. Consistently across a variety of research designs, we find that a significant part of this rise can be explained by trade liberalization. By increasing the concentration of economic activity in formal corporate structures at the expense of smaller informal businesses, trade liberalization facilitates the imposition of taxes, particularly of corporate taxes. The effect is sizable: trade liberalization can explain about 20% of the rise in effective capital tax rates in developing countries. Of course, globalization has also had widely noted negative effects on capital taxation, because of international tax competition. On balance, we find that this negative race-to-the-bottom effect has dominated in high-income countries, but that the pro-tax-capacity effect of trade we uncover has prevailed in emerging economies. In contrast to a widely held view, globalization has not uniformly eroded the ability of governments to tax capital, and in fact appears to have supported it in many countries.

To establish these results, this paper makes two contributions. The first is to build and analyze a macro-historical database of effective tax rates on labor and capital covering 155 countries in total with over half starting in 1965. In contrast to existing series that focus on high-income countries, this global database allows us to characterize the evolution of taxation in developing economies systematically, and thus to compare the evolution of tax structure across countries with different development levels.

A simple and striking fact emerges from this database. We uncover an asymmetric evolution of capital taxation in the era of hyper-globalization. In high-income countries, effective capital tax rates collapsed, from close to 40% in the post-World

War II decades to about 30% in 2018. For instance, in the United States, the average effective capital income tax rate fell from more than 40% in the 1960s to 25% in 2018. By contrast, in developing countries effective capital tax rates have been on a rising trend since the 1990s, albeit starting from a low level. Effective capital tax rates rose from about 10% in the 1990s to 20% in 2018, with the increase happening primarily in large economies. Between 1995 and 2018, for example, the effective capital tax rate rose from 10% to 30% in China, 18% to 28% in Brazil, 7% to 11% in India, and 5% to 10% in Mexico. This increase is one factor explaining the rise in the overall tax-to-GDP ratio of developing countries, along with the increase of indirect taxes and a slow but steady rise in labor taxation.

This rise of capital taxation in low- and middle-income countries had not been noted in the literature before, due to the limited data on the evolution of tax structures in developing countries. The finding appears to be robust. It holds when we exclude China and oil-rich countries; when we restrict the analysis to a balanced sample of countries; and under different weighting schemes. It holds with alternative approaches to computing capital and labor income in non-corporate businesses, where factor shares are not directly observable. It is also robust to alternative ways of assigning the personal income tax to capital versus labor.

What can explain the asymmetric evolution of capital taxation across development levels? The second contribution of this paper is to formulate and test a hypothesis that sheds light on this puzzle. Our hypothesis is motivated by the observation that the increase in capital taxation in developing countries coincides with their trade liberalization. Between the late 1980s and the early 2000s, many countries opened their markets and reduced tariffs. This policy revolution, combined with technological improvements (e.g., the rise of container shipping), led to a boom in international trade and reshaped the economy of countries such as Mexico, India, and China. We hypothesize that trade liberalization exerts a positive effect on developing countries' ability to raise tax revenue. By leading to the expansion of larger and formal firms relative to smaller and informal firms, trade openness increases the share of economic activity in formal, corporate structures, where capital (and labor) is easier to tax.

To test this hypothesis, we implement three research designs. First, we run non-parametric estimations of the five-year relation between changes in effective tax rates and changes in trade openness. Second, we analyze major trade liberalization events which occurred in seven large developing countries. These events caused large and sudden reductions in trade barriers, including for instance the often-discussed WTO accession of China in 2001 (Goldberg and Pavcnik, 2016; Brandt et al., 2017). We use synthetic control methods to create counterfactuals for each country's event, and present event-study graphs. Last, we extend the instruments for trade openness presented in Egger, Nigai, and Strecker (2019) to estimate the effects of trade on factor taxation.

In each case we find that trade openness leads to a large rise in effective capital taxation in developing countries (and a smaller increase in effective labor taxation). On the contrary, trade integration has a null or negative effect on capital taxation in high-income countries (and a positive effect on labor taxation). Although the identification strategies are different in our three empirical specifications, our results are consistent across them and robust to a range of sensitivity checks.

To better understand these results, we study potential mechanisms using event studies and the instrumental variable research designs. Consistent with our tax-capacity hypothesis, we find that trade openness leads to a rise in the fraction of domestic product that originates from the corporate sector, at the expense of the non-corporate business sector. This change leads to a growing fraction of output being produced in a sector that is more visible and more easily enforceable. Globally, the fraction of net domestic output originating from corporations increased from 55% to 65% in developing countries between 1995 and 2015, while this fraction remained stable at 70% in high-income countries. We also find that trade increases the average effective tax rate on capital inside the corporate sector, consistent with trade causing an expansion of larger, initially formal firms that have higher effective tax rates. We provide complementary micro-evidence from Rwanda, by merging several administrative data-sets. Using an IV based on the shift-share design of Hummels et al. (2014), we find that increased exposure to international trade at the firm level causes an increase in the individual firm's corporate effective tax rate.

We also find that the positive impact of trade on capital taxation, in addition to being concentrated in developing countries, is stronger in populous countries and in countries with restrictions on capital flows. This finding is consistent with the notion that large countries and countries managing their capital accounts are less exposed to the race-to-the-bottom effect that has pushed capital taxation down in high-income countries. Last, trade liberalization is associated with a decline in statutory corporate tax rates across all countries, but more so in high-income countries. On net, the trade-induced increases in tax capacity dominates the statutory tax rate reduction in developing countries, but not in rich countries.

We conclude by discussing implications for public finance and globalization in developing countries. Despite potential revenue losses at the border, the positive impact of trade openness on the direct tax bases of capital and labor are sufficiently large that overall tax revenue increases. This is a policy relevant result, given that potential tax revenue losses arising from trade liberalization remain an important concern amongst policy-makers (United-Nations, 2001). Moreover, we find that the positive effect of trade on effective taxation is larger for capital than for labor. Given the higher concentration of capital income relative to labor income, the globalization-induced changes in taxation may have attenuated, rather than exacerbated, the distributional impacts of economic integration on pre-tax income (Goldberg and Pavcnik, 2007).

The rest of the paper proceeds as follows. In the following sub-section, we relate our work to the existing literature. Section 2 describes the methodology and data collection. Section 3 presents our findings on the evolution of effective tax rates over the long-run. Section 4 presents our results on the effects of trade openness on effective tax rates, and Section 5 investigates mechanisms. Section 6 concludes.

1.1 Related literature

Globalization and tax structure Our paper contributes to the literature on globalization and governments' tax structure and size (for a recent review, see Adam et al. (2013)). Starting with Rodrik (1998), several papers investigate the 'social insurance' hypothesis, whereby governments raise revenue, usually social security taxes on labor, to provide insurance to workers at risk of being displaced by international competition. A second hypothesis, the 'race to bottom', posits that governments reduce the tax burden on factors of production that become more mobile following trade liberalization (likely capital) (Wilson, 1999; Egger, Nigai, and Strecker, 2019). To achieve revenue-neutrality, governments may then raise tax rates on the less mobile factor (likely labor). Further studies focus on the role of terms-of-trade externalities (Epifani and Gancia, 2009), and population size (Alesina and Wacziarg, 1998). Most studies concern high-income countries. By expanding the scope to developing countries, we formulate and test a new mechanism, where the trade-induced relaxation of enforcement constraints allows governments to tax both capital and labor more effectively, and thus grow in size. We find that the tax-capacity mechanism operates primarily in developing countries, but the race to bottom and social insurance mechanisms are active at all development levels.

Tax capacity and trade in developing countries The tax capacity mechanism is related to a small literature on trade and taxation in developing countries (Fisman and Wei, 2004; Javorcik and Narciso, 2017). Recent papers have investigated whether trade-induced reductions in *border taxes* are recovered, with a focus on the role of indirect domestic taxes such as VAT, and several studies find net revenue losses (including Baunsgaard and Keen, 2009; Cage and Gadenne, 2018). We contribute by showing positive effects of openness on *domestic direct tax bases* of capital and labor. Our results are intuitive when we consider that the trade literature finds positive effects on outcomes, including market shares (McCaig and Pavcnik, 2018), firm-size (Alfaro-Urena, Manelici, and Vasquez, 2022), and local development (Mendez and Patten, 2022), which the public finance literature has separately identified as important determinants of tax capacity (Besley and Persson, 2014). Our paper tries to link these two literatures, by directly testing the impacts of trade openness on domestic tax collection. These impacts are mediated by trade's effect on the share of output produced in formal firms; our results are compatible with findings from recent trade-formalization studies, which have instead focused on share of formal workers and/or firms (see review in Engel et al., 2021).

Our mechanism focuses on the role of corporations in alleviating enforcement constraints. In current high-income countries, the rise of the corporate sector is considered an important historical determinant of the long-run growth in effective tax rates (Kleven, Kreiner, and Saez, 2016). Similarly, in developing countries today, tax collection is strongly concentrated in corporations, because they have complex production structure, are large in size, and employ many workers, resulting in information trails that make it it harder to misreport taxes (Kleven, Knudsen, et al., 2011; Pomeranz, 2015; Naritomi, 2019). We focus on a specific enforcement mechanism, but many links between international trade, firm structure, and taxation in developing countries remain to be explored (Atkin and Khandelwal, 2020).

2 Construction of factor shares and effective tax rates

This section presents the new database of effective tax rates (ETRs) on labor and capital, which covers 155 countries, starting in 1965 when possible, until 2018. We first outline the conceptual framework to build ETRs, we then present the data sources, and finally the resulting sample coverage. Further details in Appendix B.

2.1 Conceptual framework and methodology

Effective tax rates We compute macroeconomic effective tax rates following the methodology of Mendoza, Razin, and Tesar (1994), which divides realized tax revenue by its associated tax base. Thus, the effective tax rate on a factor of production (capital or labor) corresponds to the ratio of total tax revenue collected on that factor over its share of national income:

$$ETR_L = \frac{T_L}{Y_L} \qquad \text{and} \qquad ETR_K = \frac{T_K}{Y_K} \tag{1}$$

The numerator is the total tax revenue assigned to labor, or to capital:

$$T_L = \sum \lambda_j \cdot \tau_j \quad \text{and} \quad T_K = \sum (1-\lambda_j) \cdot \tau_j \tag{2}$$

where λ_j is the allocation to labor of each type j of tax τ_j. Types of taxes follow the OECD classification (see Table B2). We allocate types of taxes as follows: (1) corporate income taxes, wealth taxes, and property taxes are allocated to capital; (2) payroll taxes and social security payments are allocated to labor; (3) personal income taxes are allocated partly to labor and partly to capital, in a country-time specific manner (see below). Indirect taxes are neither assigned to labor nor to capital, but we analyse their evolution in Section 4.3. Table A1 summarizes our allocation. As is standard in the literature the allocation does not account for tax shifting (the initial impact is considered its final incidence), but nonetheless produces a well defined object: total taxes collected on capital or on labor.

For the denominator, we decompose net domestic product into labor and capital:

$$Y = Y_L + Y_K = \underbrace{CE + \phi \cdot OS_{PUE}}_{Y_L} + \underbrace{(1-\phi) \cdot OS_{PUE} + OS_{CORP} + OS_{HH}}_{Y_K} \tag{3}$$

where labor income equals the compensation of employees (CE) plus a share ϕ of mixed income (operating surplus of private unincorporated enterprises OS_{PUE}), and capital income equals the remaining share $(1-\phi)$ of mixed income, plus firms' profits net of depreciation (operating surplus of corporations OS_{CORP}), plus actual and imputed rental income (operating surplus of households OS_{HH}).[1]

These macroeconomic effective tax rates capture the overall tax burden on labor and capital and thus the economically relevant tax wedges on each factor of production (i.e., the wedges that matter for production decisions), such as the difference between the costs to employ a worker and what the worker receives. Since national account statistics are compiled following harmonized methods, ETRs are comparable over time and across countries, and by relying on taxes effectively collected, they incorporate the net effects of all tax rules—base reductions, exemptions, and tax credits—and of tax avoidance and evasion.

Yet, as recognized by the literature (see Carey and Rabesona, 2004), macroeconomic ETRs rely on several assumptions. In particular, the tax revenue streams need to be comparable to their macroeconomic tax base measured in national accounts. This generates two key challenges for our ETRs: (i) for the numerator, how to allocate the personal income tax revenues to capital versus labor; and (ii) for the denominator, what share of mixed income to allocate to capital versus labor. We discuss below our benchmark assumptions, further detailed in Appendix B.2.

Allocation of personal income taxes (PIT) The main empirical difficulty in assigning taxes to labor or capital concerns the allocation of the PIT. A naive procedure allocates 70% of the PIT to labor and 30% to capital, matching roughly their income shares. In practice, however, not all labor and capital income is subject to PIT, since not all individuals are required to file PIT, and exemptions apply to some income types. Exemptions for capital (e.g., imputed housing rents, undistributed profits) are typically larger than for labor (e.g., pension contributions). Further, labor and capital income might not face the same tax rate: dual income tax systems tax labor income with progressive rates but capital income with flat rates. In the United

[1] We estimate factor shares of net domestic product (NDP) which subtracts the consumption of fixed capital (CFC) from gross domestic product (GDP). NDP is thus lower than GDP by around 10%. We exclude capital depreciation from our measurement since it does not accrue to any factors of production and it is usually tax-exempt. We also omit net indirect taxes NIT from factor shares, implicitly assigning its incidence to labor and capital proportionally to the economy.

States, 75% of labor income was subject to PIT in 2015, versus a third of capital income (Piketty, Saez, and Zucman, 2018). This suggests allocating 15% of the personal income tax to capital and 85% to labor.[2]

Starting from a baseline where 15% of PIT revenues derive from capital (consistent with US data) we perform two country-year adjustments. We raise capital revenues for countries with a high PIT exemption threshold in the income distribution (data from Jensen, 2022) and lower it in countries where dividends face lower taxes than wages (OECD, 2020). The resulting imputed capital share of PIT revenue varies between 7% and 35%, depending on countries and years. Over time, this share falls from a global average of 19% in 1965 to 14% in 2018, due to a reduction in PIT exemption thresholds and increased prevalence of dual tax systems.

The labor share of mixed income The labor share of mixed income (unincorporated enterprises) is notoriously hard to measure (Gollin, 2002). In the absence of a consensus, we assume $\phi = 75\%$ in our benchmark, such that 25% of mixed income is considered capital income. This is lower than the 30% used in Distributional National Accounts (DINA) guidelines (Blanchet et al., 2021), but given that the global average of the capital share in the corporate sector is 27%, assuming that the capital share of unincorporated enterprises is slightly lower seems reasonable (see Guerriero, 2019). We also construct two bounding scenarios, which we systematically show for robustness: (i) mixed-income is assumed to be 100% labor; and (ii) the labor share of the corporate sector is assigned to as labor's share of mixed income.

2.2 Data sources

2.2.1 National income components

To estimate factor shares for 155 countries since 1965, we create a harmonized panel of national accounts using data from the United Nations (SNA). From the World Inequality Database, we retrieve SNA data that covers over 2,000 - TOO MUCH ROUND NUMBER, USE TABLE B1 TO QUOTE THE EXACT NUMBERS country-years. In addition, the UN Statistics Division provided access to archival

[2]If 75% of labor income is taxable and labor income is 70% of national income (respectively 33% and 30% for capital income), then $75\% \times 70\%/(75\% \times 70\% + 33\% \times 30\%) = 84\%$ of the PIT base is from labor income.

data for another 2,000 country-year observations from the 1960s and 1970s.[3] When data are incomplete (e.g., a component of national income is missing), we recover missing values with accounting identities or via imputation, and thus construct a balanced panel of factor income shares. Our work expands Karabarbounis and Neiman (2014) by integrating the UN SNA (1968) data which extends coverage in time and space, and by computing factor shares for total domestic output (vs. only the corporate sector).

2.2.2 Tax revenue data

More importantly, we construct a new tax revenue dataset that dis-aggregates revenues by source following the OECD (2020) classification of taxes, and digitizes archival data from developing countries. Our database includes all taxes—on personal and corporate income, social security and payroll, property, wealth and inheritance, and consumption—at all levels of government. We ensure a systematic separation of income taxes into personal and corporate income. We gather existing data from OECD (2020) and ICTD/UNU-WIDER (2020), complemented with archival data and online data from finance ministries.

When available, OECD data is our preferred source, as it covers all types of tax revenues and goes back to 1965 for OECD countries. It accounts for 2,862 = CHECK ALL NUMBERS IN THIS PARAGRAPH country-year observations (42% of the sample). Its drawback is its limited coverage of non-OECD countries: in total it covers 93 countries, but developing countries only appear recently. We augment the OECD data with revenue data from ICTD/UNU-WIDER (2020). This combined dataset now covers most countries but faces limitations: it only starts in the 1980s; it sometimes mixes personal and corporate income taxes; and, it often lacks payroll taxes. As a result, we only add 1,227 country-years (18% of the sample). To complement this data, we digitized official archival data (e.g. public finance yearbooks) and collected online data from finance ministries to add 2,726 observations (40% of sample).[4]

[3] The archival data follows the UN SNA (1968) system which we harmonize with the UN SNA (2008) data. To our knowledge, this is the first time that the SNA 2008 and SNA 1968 data are harmonized. In country-years where both data sources are available (the late 1970s), the series match well.

[4] 30% of observations come from newly digitized data from the Harvard University Lamont Library, Government Documents section. The remaining 10% comes from online sources and from the IMF GFS (2005) offline historical database.

We follow three principles to create each country's time series. First, we aim to only combine two data sources by country: OECD when it exists, and the alternative source with the best coverage.[5] Archival data is second in priority since it often dis-aggregates tax sources, and goes back in time. Our data hierarchy choice also depends on which source best matches the OECD data over their shared time frame. Second, we only interpolate up to 4 years of gaps in coverage. Finally, we check country-specific policy reports and studies to triangulate across data sources. Appendix B.1 details the data and the assembly of long country panels.

2.3 Data Coverage of Effective Tax Rates

Our final effective tax rates data contains 6,816 country-year observations, in 155 countries. It covers 86% of world GDP in 1965 and 98% by 2018 (Figure A1). The number of countries starts at 78 in 1965 and grows to 110 by 1975 as former colonies gain independence. The key jump in coverage—from 117 to 148 countries— corresponds to the entry of ex-communist countries in 1994, including China when it arguably built a modern tax system (see World Bank (2008) and box in Appendix B.1). Late independence and new countries are other reasons why countries appear later than 1965. The data is effectively composed of two quasi-balanced panels: the first covers 1965-1993 and excludes communist regimes: it accounts for 85-90% of world GDP during those years. The second covers 1994-2018 and includes former communist countries and China; it accounts for 98% of world GDP. Figure A1 also shows coverage separately by development level, with 5198 observations in XX developing countries and 1618 observations in XY developed countries. We use the 2019 World Bank income classification, grouping the low and middle-income categories as developing countries. Compared to existing ETR series which cover OECD countries over limited time periods (notably Mendoza, Razin, and Tesar, 1994; Carey and Rabesona, 2004; McDaniel, 2007), our series are global and cover the past 50 years. They also represent a methodological improvement by covering all tax revenues and all income sources in national accounts.[6]

[5]For payroll and social security we sometimes add a third source: either the UN System of National Accounts or data from Fisunoglu et al. (2011).

[6]Compared to existing measures we integrate all types of capital taxes; we share personal income taxes into labor and capital taxes. and we share mixed income into labor and capital.

3 New Stylized Facts on Global Taxation Trends

3.1 The evolution of effective tax rates on capital and labor

Figure 1 documents the global evolution of effective tax rates on capital and on labor from 1965 to 2018. These time series follow our benchmark assumptions. Aggregates are dollar-weighted, i.e., the global effective tax rate on capital equals worldwide capital tax revenues divided by worldwide capital income. This series can be interpreted as the average tax rate on a dollar of capital income derived from owning an asset representative of the world's capital stock. The top panel shows global trends and the bottom panels separates trends between high vs low and middle income countries.

Globally, effective tax rates on labor and capital converged between 1965 and 2018, due to a rise in labor taxation and a drop in capital taxation. The global ETR_L rose from 16% in the mid-1960s to 25% in the late 2010s, while ETR_K fell from 32% to 26%. The decline in capital taxation is driven by the corporate sector: the global effective tax rate on corporate profits fell from 27% in 1965 to 18% in 2018.

The global trends mask heterogeneity by income levels. While labor taxation rose everywhere, the decline in capital taxation is concentrated in high-income countries, where the effective tax rate on capital dropped from close to 40% in 1965 to about 30% by 2018. In contrast, ETR_K increased in developing countries, albeit from a low base: it rose from 11% to 20%, with the increase happening entirely after 1995. The secular decline in ETR_K in high-income countries has been documented before (Dyreng et al., 2017; Garcia-Bernardo, Janský, and Tørsløv, 2022), but the rise in ETR_K in developing countries starting in the 1990s is novel. We thus need to establish that this result is robust to the assumptions used to construct effective tax rates and to better understand which countries are driving the trend.

3.2 The rise of capital taxation in developing countries

When creating our series, we make four key methodological decisions: (1) how to allocate personal income tax revenue to capital vs labor; (2) how to allocate mixed income to capital vs labor; (3) to present results for a balanced vs. unbalanced panel of countries; (4) how to weight individual countries when aggregating them. Our benchmark series: (1) allocates personal income tax revenues to capital vs. labor for each country-year using data on exemption thresholds of the income tax and on the tax treatment of dividends relative to wages; (2) allocates 25% of mixed income to capital and 75% to labor; (3) captures an unbalanced panel before 1994, and a balanced panel after (when China, Russia and other former command economies enter the sample); and (4) weighs countries using their share of worldwide capital income in each year. We can assess how the results change when varying one, several, or all of these choices at the same time.

Figure 2 tests the robustness of the ETR_K trend in developing countries.[7] Panel (a) varies the allocation of personal income tax (PIT) revenue. We consider two simple scenarios where the share allocated to capital is fixed over time, at either 0% or 30%, which can be interpreted as low and high-end scenarios respectively. Due to high PIT exemption thresholds in developing countries, the benchmark country-specific assignment is closer to the 30% than to the 0% allocation. The reduction of PIT exemption thresholds and the introduction of preferential tax rates for dividends in several countries lowered the capital share of PIT revenues over time (pushing ETR_K down). Since PIT revenue remains limited in developing countries, its split into labor vs. capital makes little difference to our results.

Panel (b) shows that assumptions on the capital share of mixed income (unincorporated enterprises) are somewhat more consequential. Under the upper-bound assumption that all mixed income is labor, the total capital income denominator is reduced, which raises ETR_K. This upper bound ETR_K is particularly high in the early decades of our series (when mixed income is higher), and then declines, to reach a low point in the mid-1990s. After 1995, a large rise is observed, as in the benchmark series. In the low-end scenario, we assign to mixed income the time variant capital share of the corporate sector, which assumes that unincorporated and incorporated enterprises are equally capital intensive. This ETR_K series is slightly below the benchmark in terms of levels but tracks it closely over time.

Panel (c) quantifies the effect of country entry into the panel in 1994. While all developing countries with more than 1 million inhabitants are included in 1994-2018, in our benchmark series, China, Russia, and other former command economies only enter the data in 1994. To balance the panel, we impute missing year observations between 1965-1993 using the observed value of ETR_K for that

[7]Figure A2 shows the same robustness exercises for ETR_L in developing countries, as well as ETR_L and ETR_K in high-income countries.

country in 1994 and the trends in ETR_K observed for developing countries with data over 1965-1993. This imputation somewhat raises capital taxation between 1965-1993, since the new entrants (especially Russia) had relatively high ETR_K when they enter the sample, and a higher global weight when going back in time.

Next, panel (d) aggregates countries using NDP weights (instead of capital income weights in our benchmark), either time varying or fixed in 2010. The figure shows that the weighting procedure has limited impact on the results. Finally, panel (e) considers all 54 combinations of choices (varying assumptions 1 to 4). Some series are more volatile than others, especially between 1965-1993, yet the rise in ETR_K in developing countries between 1994-2018 is clearly apparent in all series. The rise in ETR_K between its low point in 1989 and its high point in 2018 is 10.8% on average across the 54 combinations, with a range of 6.2-13.4%. Our benchmark is slightly towards the lower end of ETR_K in levels, and in the middle of the range in terms of its rise (+10.2% points increase from 1989 to 2018).

3.3 Where has capital taxation risen?

Figure 3 shows the evolution of ETR_K for major developing countries and sub-samples of countries. Panel (a) plots the ETR_K series for the four largest developing countries: Brazil, China, India, Indonesia. All display a marked increase in ETR_K since 1989: from 10% to 26% in Brazil, 5% to 27% in China, 5% to 12% in India, and 6% to 15% in Indonesia. China's global weight implies that it plays an important role in the aggregate rise in ETR_K in developing countries.

Panel (b) plots ETR_K in sub-sample of developing countries: when excluding China, the rise in ETR_K is more muted, going from 10% in 1990 to 14% in 2018. On the other hand, oil-rich countries have volatile corporate tax revenue, and their ETR_K has trended downwards since the 1970s. Removing oil-rich countries (defined as deriving at least 7% of GDP from oil) yields a more pronounced ETR_K rise, from 10% in 1990 to 23% in 2018, and to a flatter ETR_K series pre-1990, as the impact on tax revenue of oil shocks of 1974 and 1979 is removed. If we exclude both China and oil-rich countries, we again observe a substantial rise in ETR_K.

Panel (c) shows that, among non oil-rich countries, the ETR_K rise is stronger in the 19 largest developing countries (population above 40 million) than in the 68 smaller ones. Even when excluding China, the ETR_K of the other 18 most populated countries rose from 9% to 17% between 1989 and 2018, as compared to a rise from 9 to 13% in smaller countries.[8] In sum, the rise in capital taxation in developing countries goes beyond the case of China and appears to be a general pattern in emerging economies.

3.4 Suggestive evidence for the role of globalization

The previous section showed that while ETR_K has fallen in high-income countries, it actually has risen in developing countries. The rise in ETR_K in developing countries is robust to our assumptions, and although driven especially by the largest countries, it is a widespread phenomenon. Importantly, this rise occurred in the late 1990s and early 2000s, during the period of "hyper-globalization" which should have a priori made capital more mobile, and hence harder to tax. Instead, could globalization have caused a rise in ETR_K? In this subsection, we take a first pass at studying the role that trade globalization may have played in impacting the differential trends of capital taxation between developed and developing countries.

We create 5-year growth rates within countries in trade and effective tax rates. We plot binned scatters of each outcome against trade (measured as the share of imports and exports over NDP), after residualizing all variables against year fixed effects. Each dot corresponds to a ventile (20 equal-sized bins) of the residualized trade openness distribution. Figure 4 depicts these medium-run within-country associations, which condition on global time trends. In the full sample of country-years, we observe a positive association between trade openness and ETR_K. Trade openness is also positively correlated with ETR_L, though the magnitude is smaller. Mirroring the heterogeneity in long-run trends, we observe large differences in the association between trade and ETR_K by development levels: trade openness is associated with higher ETR_Kin developing countries, but with lower ETR_K in rich countries.[9] In sum, from a global and historical perspective, the correlational evidence suggests that trade liberalization may have contributed to the newly docu-

[8]The supplementary appendix shows individual countries' ETR_K time series for the 17 most populated developing countries: ETR_K has risen by more than 5 percentage points in twelve of them in the past 30 years, and has only fallen in Russia.

[9]This positive trade and ETR_K association runs deeper: Figure A3 separates developing countries into two groups, based on their trade level pre-1995: early globalized countries saw trade and ETR_K rise in tandem prior to the 1990s and stagnate thereafter. By contrast, countries which participated in the second wave of globalization (post 1990s proliferation of trade agreements) saw a rise in trade and ETR_K in the 1995-2018 period.

mented rise in effective capital taxation in developing countries. In the next sections, we try to causally investigate this hypothesis and study potential mechanisms.

4 Globalization and capital taxation

In this section, we implement two distinct research designs to investigate the impact of trade openness on capital taxation in developing countries.

4.1 Event-studies for trade liberalization

4.1.1 Empirical design

We implement event studies of trade liberalization events in key developing countries. To discern sharp breaks from trends in our outcomes, we analyze events which caused large trade barrier reductions: we focus on the six events studied in the review papers by Goldberg and Pavcnik (2007) and Goldberg and Pavcnik (2016) (Colombia in 1985, Mexico in 1985, Brazil in 1988, Argentina in 1989, India in 1991, Vietnam in 2001), and add the often discussed World Trade Organization accession of China in 2001 (Brandt et al., 2017). These events share two key features. First, they are characterized by large reductions in tariffs, the easiest trade barrier to measure: Brazil lowered average tariffs from 59% to 15% percent, India from 80% to 39%, and China from 48% to 20%. Second, these events have been studied exhaustively: since trade liberalization events are often accompanied by other reforms, we can rely on existing in-depth narratives to discuss threats to identification and results' interpretation.[10] Appendix C.1 details all seven trade liberalization events.

For each of the seven treated countries and outcome, we construct a synthetic control country, as a weighted average over the donor pool of never-treated countries, as in Abadie, Diamond, and Hainmueller (2010).[11] We match on the level of each outcome in the 10 years prior to the event, while minimizing the mean squared prediction error between the event-country and the synthetic control. We then plot event-study graphs showing the average of the outcome variable for treated countries vs. synthetic controls by relative time to the event. We also implement the

[10] The reductions in trade barriers are sometimes implemented over several years. To be conservative, we focus on the earliest start year for each event as defined in published studies.

[11] For each country-event, we can include eventually-treated countries in the donor-pool (excluding those with treatment within 5 years of the event); the results, available upon request, are similar.

event-study design in a regression setting, where we include country and calendar year fixed effects, in the 10 years before and after the events:

$$Y_{it} = \sum_{j=-10, j\neq -1}^{10} \beta_j \cdot \mathbb{1}(j=t)_t \cdot D_i + \theta_t + \kappa_i + \pi_{Year(it)} + \epsilon_{it} \tag{4}$$

where we include fixed effects for event-time θ_t, country κ_i, and year $\pi_{Year(it)}$, which control for common shocks to outcomes that may correlate with reform clusters. D_i is a dummy equal to one if country i is treated. The coefficient β_j captures the difference between treated and synthetic control countries in event time j, relative to the pre-reform year $j = -1$ (omitted period).

Since inference based on small samples is challenging, we plot 95% confidence bounds using the wild bootstrap, clustered at the country-event level (Cameron, Gelbach, and Miller, 2008). We run two additional specifications to attenuate issues with synthetic control event studies. First, in addition to the dynamic model, we estimate a simple difference-in-differences, where we measure the average treatment effect in the 10 years post-liberalization, and use the imputation method of Borusyak, Jaravel, and Spiess (2021) to address estimation issues from two-way fixed effects and heterogeneous event-times. Second, we simultaneously match on all outcomes of interest for each country-event, instead of creating a separate synthetic control for each event and each outcome. This reduces the likelihood of obtaining similar pre-trends, but implies that for a given country-event, the synthetic control countries are the same across outcomes (see Appendix C.2).

4.1.2 Event-study results

Figure 5 display the event studies in levels (left-hand panels) and the dynamic regression coefficients (right-hand panels).[12] The top panels show that, as expected, trade rises in the year of the event and its trend changes in post-reform years compared to pre-liberalization years.[13] Turning to our outcomes of interest, we see that ETR_K sharply rises following liberalization events. Both ETR_K and ETR_L break from the stable pre-trend at the time of liberalization, but the effect on capital taxation is double that on labor. Despite the small sample size, the dynamic post-

[12] Table A3 details the synthetic control matching for each event and outcome.

[13] The absence of a pre-reform dip limits concerns about inter-temporal substitution, although some of the liberalization events may have been predictable, including China's WTO accession.

treatment coefficients are often significant at the 5% level. The p-value for the joint significance of all post-reform dummies are well below 0.05. The liberalization events led to a 10 percentage point rise in trade openness over 10 years, and a 4.8 (2.0) percentage point rise in ETR_K (ETR_L) (Coefficients in Table A2).

We conduct three robustness checks. First, the absence of pre-trends was stronger for ETR outcomes than for trade. Alternatively, we can jointly match on all outcomes for each event to create synthetic controls. Figure A5 shows that this leads to a general deterioration of pre-trends (as expected), but the regression coefficients remain similar. Second, to ensure that the results are not being influenced by one particular event, we remove one treated country at a time: Figure A6 shows robust dynamic treatment effects for all subsets of treated countries. Third, results are similar when we re-estimate the difference-in-differences coefficient following the imputation method of Borusyak, Jaravel, and Spiess (2021) to attenuate issues with two-way fixed effects estimation (last row of Table A2).

Trade liberalization could coincide with unobserved changes in determinants of factor taxation. Two elements ease this concern. First, the stable pre-trends in treated countries imply that any confounding changes would have to sharply coincide with the events. Second, the narrative analyses of the reforms (reproduced in Appendix C), do not suggest obvious confounding shocks.

Naturally, the interpretation of the dynamic coefficients is influenced by the presence of other reforms or confounding economic shocks that occurred in the years following the initial event. For example, Mexico later joined NAFTA and removed capital inflow restrictions, Argentina and Brazil joined MERCOSUR, and India liberalized its FDI rules. These reforms occurred several years after the initial trade liberalization, yet capital taxation sharply rises in the first years. [14] The short-run results showing a swift break from stable pre-trends are thus more likely to be attributable to trade liberalization. We caution, however, that the precise medium-run coefficients might incorporate further reforms.[15]

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[14] Wacziarg and Wallack (2004) study if trade liberalization events in developing countries coincide with domestic reforms. Among our seven events, only Mexico had a confounding domestic reform (privatization) at the time of the liberalization event; Brazil (privatization) and Colombia (market-oriented reforms) implemented reforms in post-liberalization periods; the remaining four countries had no confounding reforms. The results are robust to excluding Mexico (Figure A6).

[15] Spillovers to control countries is an important concern. We verify that none of the main countries in the synthetic control (Table A3) implemented significant international or domestic reforms in the post-event years (using the data in Wacziarg and Wallack, 2004) Consistent with this, the

4.2 Regressions with instrumental variables for trade

4.2.1 Empirical design

Our second design employs instrumental variables for trade. One attractive feature is that the IV provides causal estimates under different identifying assumptions than the event-study. Moreover, while it is harder to directly inspect the identifying assumptions than in the event-study, the IV permits an analysis of mechanisms and heterogeneity by development level (which we turn to in Section 5).

We estimate the following model in developing countries:

$$y_{ct} = \mu \cdot trade_{ct} + \Theta \cdot X_{ct} + \pi_c + \pi_t + \epsilon_{ct} \tag{5}$$

where y_{ct} is the ETR in country c in year t, $trade_{ct}$ is the share of import and exports in net domestic product and π_c and π_t are country and year fixed effects. We cluster the error term at the country level. We also estimate models which include in X_{ct} proxies for confounding factors of ETRs: log GDP per capita, the exchange rate, gross capital formation, log of population, and capital openness (Rodrik, 1997).

The OLS estimation of equation (5) may be biased due to reverse causality and unobservable confounding factors which correlate with changes in trade. To try to address theses issues, we use the two instruments for trade from Egger, Nigai, and Strecker (2019). The first instrument, denoted $Z^{gravity}$, relies on the structure of general equilibrium models of trade. Under the standard gravity model assumptions, it uses the average bilateral trade frictions between exporting and importing countries as variation (aggregated to the country-year level). In our context, this instrument is valid if the distribution (not the level) of trade costs among individual country-trading pairs is not influenced by the level of factor taxation in the import or export country.

The second instrument, denoted $Z^{Oil-Distance}$, exploits time-series variation in global oil prices interacted with a country-specific measure of access to international markets. Access is captured by the variance of distance to the closest maritime port by the three most populated cities. This time-invariant measure captures the internal geography of a country which is an important component of transportation

levels of the outcomes in the synthetic control are relatively stable throughout the event (more so in Figure A5 than in Figure 5). Finally, note that if the spillovers correspond to coordination of policies, then this would likely bias our estimation towards finding null results.

costs: following a global shock to oil prices, transportation costs will be higher in countries with less concentrated access to ports, leading to a larger drop in imports and exports. Conceptually, both instruments capture variation in trade costs driven by exogenous economic forces (details in Appendix D).

Figure A4 shows that the oil-distance instrument has a strong first stage in the 2000s and in richer countries, while the gravity instrument has a stronger first-stage in the earlier periods and in poorer countries. Restricting our analysis to subsamples where one of the instruments has a strong first-stage would introduce bias (Mogstad, Torgovitsky, and Walter, 2020). Instead, we combine the two instruments, which raises statistical power and allows us to estimate a local average treatment effect (LATE) that is representative of developing countries across income levels and time periods. The LATE is a combination of the instrument-specific LATEs weighted by the first-stage strength of each instrument. Table A4 shows the first-stage regression. It also shows other attractive features of the instruments: $Z^{gravity}$ raises trade, while $Z^{Oil-Dist}$ reduces trade; they impact both imports and exports, and both trade in intermediate goods and services (G-S) and final G-S. Thus, our combined IV-estimate reflects the broad impacts of trade through rises and fall in final and intermediate G-S that flow both in and out of the country.

4.2.2 Instrumental variable results

Table 1 presents the results for ETR_K in Panel A, and for ETR_L in Panel B.[16] In column 1, OLS uncovers a positive, significant association between trade and ETR_K. In column 2, we employ the two instruments. The 1^{st}-stage Kleibergen-Paap F-statistic is 24.57. The IV shows that trade causes an increase in both capital and labor effective tax rates, but the magnitude is over twice as large for ETR_K (0.118) than for ETR_L (0.049).

In the remaining columns, we conduct three sets of robustness checks. In the first set, we modify the specification and the inclusion of covariates. Our benchmark IV uses country-year NDP weights, but column (3) shows that our results are robust to removing these weights. Our results also remain similar in column (4) when we include the country-year varying controls contained in X_{ct}. In

[16] There is a 4% drop in sample size relative to ETR coverage (Section 2.3) due to availability of instruments. We also note that, relative to the NBER version, recent access to trade data from Harvard Growth Lab increased the sample size for the instruments and led to updated results.

column (5), our results are robust to allowing oil-rich countries to be on a separate non-parametric time path. This addresses the concern that the estimating variation for $Z^{Oil-Dist}$ is correlated with trends in effective tax rates specific to oil-producing countries (Figure 3). In column (6), we winsorize the trade variable at the 5^{th} and 95^{th} percentiles on a yearly basis; this improves the first-stage F-statistic (34.8), but the IV-estimates remain very similar. In the second robustness set, we implement the alternative $K-L$ assignments from Section 3. Specifically, our results remain similar when we assign the K-share of mixed income using the corporate K-share (column 7) and when we assign the K-share of PIT to be 0% (column 8) and 30% (column 9). In the third robustness set (columns 10-11), we estimate IVs using each instrument separately. The results remain precisely estimated, with 1^{st}-stage F-statistics of 45.2 for $Z^{gravity}$ and 10.8 for $Z^{Oil-Dist}$. The IV estimates are comparable to each other, though the magnitudes are larger for $Z^{Oil-Dist}$

Finally, in Table A4 we study the reduced-form impact of trade on ETRs. Leveraging the fact that the two instruments have opposite sign effects on trade, the reduced form results suggest that the effects of globalization are symmetric: expanded openness increases both ETR_L and ETR_K, while reduced cross-border trade decreases the effective taxation of both factors.

Taking stock Although the identifying assumptions differ, the IV and event-studies yield consistent results showing that openness causes an increase in capital taxation in developing countries.

How much of the rise in ETR_K in developing countries since the 1990s can be accounted for by increased trade? Between 1990 and 2018, the NDP-weighted share of imports and exports in NDP rose from 47% to 64% (81% to 96% unweighted). We can combine this with the IV benchmark estimate (Column 2, Table 1) in a simplified calculation which suggests that 19.7% of the rise in ETR_K can be attributed to trade globalization.[17]

[17]Concretely, the increase in trade openness is 17 percentage points (47% to 64%) and the trade-coefficient for ETR_K is 0.118, hence $17 * 0.118 = 2.01ppt$. The long-run increase in ETR_K is 10.2ppt (Section 3.2), thus yielding $2.01/10.2 = 0.197$

4.3 Impacts of trade openness on overall taxation

We find positive effects of openness on the domestic direct tax bases of capital and labor – what are the implications of these results for trade's impact on overall tax collection? This is a policy-relevant question, as revenue losses arising from trade liberalization remains an important concern amongst practitioners (United-Nations, 2001).

In Table 2, we investigate the impacts on total tax revenue, expressed as a share of NDP, in developing countries, using the IV. Total taxes include direct taxes on capital and labor and indirect taxes (the sum of taxes on domestic consumption and trade).[18] Column (1) shows that openness causes a large and significant increase in total tax collection. The next columns, show that this increase is driven by growth in taxes collected from CIT and social security, the two main sources of effective taxation of capital and labor, respectively. The final column shows an impact of trade on indirect taxes (sum of trade and consumption taxes) which is insignificant and quantitatively small in comparison to the increases in labor and capital taxation.[19] Discuss robustness checks here for the total tax/GDP result

We can also study the impact of the trade liberalization events from Section 4.1 on total tax revenue. Panel A of Appendix Figure A7 shows that the trade liberalization events led to an increase in overall tax collection, with breaks from stable pre-trends that coincide with the timing of the events.

In both the event-study and IV, we therefore find a positive net effect of openness on total tax collection. Our emphasis on direct domestic taxes leads to a comprehensive analysis of trade liberalization's impact on overall taxation in developing countries, with findings that run somewhat counter to a dominant policy concern.

[18] Our data does not permit a systematic breakdown into trade and consumption taxes. Long-run trends in taxation by source and development level are in the supplementary appendix.

[19] The instruments create changes in openness based on variation in economic trade-costs; there may be a negative IV-effect on trade taxes if policy-makers endogenously react to these reductions in trade costs by lowering tariff rates. The potential loss in trade taxes may be countered by policy-reforms on the consumption tax base (Buettner and Madzharova, 2018).

5 Mechanisms

5.1 Outlining the tax capacity mechanism

The *tax capacity* mechanism is rooted in the notion that developing countries face constraints in their ability to collect more taxes due to imperfect enforcement. We focus on corporations, where the presence of information trails increases enforceability (Section 1.1). This enables governments to collect higher taxes on corporate profits compared to non-corporate activities with less information coverage. The role of corporations can be seen in the following decomposition of ETR^K:

$$ETR^K = \int_{i \in C} ETR_i^K f(i)\, di + \int_{i \in NC} ETR_i^K f(i)\, di \tag{6}$$

$$= \mu_C^K \cdot \overline{ETR}_C^K + (1 - \mu_C^K) \cdot \overline{ETR}_{NC}^K \tag{7}$$

where μ_C^K is the corporate share of (capital) national income of agents i with density $f(i)$, and $\overline{ETR}_C^K$ and $\overline{ETR}_{NC}^K$ are the average effective tax rates on capital in the corporate (C) and non-corporate (NC) sectors, respectively. In national accounts, $\overline{ETR}_C^K$ corresponds to the average effective tax rate on corporate profits.[20] Consistent with improved enforceability, $\overline{ETR}_C^K$ is on average 50% larger than the overall ETR^K in developing countries (19.9% versus 13.3%). The tax-capacity hypothesis predicts that a rise in the corporate share causes an increase in overall ETR^K.

How can trade openness impact μ_C, the corporate share of national income? A robust prediction from a large class of models is that trade leads to the expansion of large firms relative to small ones (Mrazova and Neary, 2018). Since small firms in developing countries are often informal and formality rises with firm-size (Porta and Shleifer, 2014), this trade-induced expansion increases the national income share of firms that are more likely to be formal and incorporated. This expansion may occur through two distinct channels (Dix-Carneiro, Goldberg, et al., 2021). First, trade openness can lead to increased market opportunities that disproportionately benefit large exporters (Melitz, 2003), causing an increase in the income-

[20] $\overline{ETR}_{NC}^K$ is the average effective tax rate on an admittedly heterogeneous group of non-corporate agents i in the economy, which includes capital-taxes on self-employed and taxes on property and individual wealth. Moreover, our data-base does not permit a systematic breakdown between these tax-sources within the NC-sector. These limitations motivate our empirical focus on μ_C and $\overline{ETR}_C^K$, which are well-defined in national accounts and can be consistently measured.

share of corporate firms that are larger, and a decrease in unincorporated, smaller firms' share (McCaig and Pavcnik, 2018). Second, trade can expand the supply of intermediate goods and lower their prices, which may disproportionately benefit larger firms (for example due to fixed costs as in Kugler and Verhoegen, 2009), and similarly cause an increase in the income-share of larger, incorporated firms.

The tax-capacity hypothesis is not confined to a prediction between the corporate and non-corporate sectors. Openness may also disproportionately benefit the larger firms inside the corporate sector: trade would cause $\overline{ETR}_C^K$ to rise if initially larger corporate firms have higher ETR_i^K (as in Bachas, Brockmeyer, and Semelet, 2020). Finally, we note that the predictions for μ_C and $\overline{ETR}_C^K$ would hold if, rather than disproportionately accruing to initially larger firms, the benefits of trade lead to more uniform growth for firms of different initial sizes.[21]

Trends in corporate sector share To gauge the mechanism's plausibility, Figure 6 plots the evolution since 1965 of the share of domestic product that originates from the corporate sector μ_C (sum of corporate profits and employee compensation). We observe a sizeable uptick in the corporate-share in developing countries in the mid-1990s, from 55% to 65%, which coincides with trade liberalization and the rise in ETR^K. Meanwhile, the share of mixed income (i.e., income of self-employed individuals and unincorporated businesses) sharply falls around that time, consistent with an expansion of formal income at the expense of informal activities. Thus, since the 1990s, a growing fraction of output is produced in corporations in developing countries and the timing of this rise suggests that it could be linked to trade liberalization. In developed countries, μ_C has been stable around 70% since the 1970s.

5.2 Main results on mechanism outcomes

We investigate the tax capacity mechanism, as well as the 'race to bottom' and 'social insurance' mechanisms (Section 1.1), in developing countries in Table 3. OLS is in

[21]If the growth occurs over portions of the size distribution where the likelihood of incorporating and ETR_i^K increase with size. Uniform trade-benefits may arise if the foreign inputs are widely accessible and encourage all firms to become more productive (Nataraj, 2011). Some unincorporated firms would grow sufficiently in size that they decide to incorporate (increasing μ_C), while initially incorporated firms would grow in size and become more enforceable (increasing $\overline{ETR}_C^K$).

Panel A and IV is in Panel B. Consistent with race-to-bottom, in column 1 of Panel B we find that trade causes a decrease in the statutory CIT rate.[22]

The next four columns analyze the effect of trade on the components of national income. We find that trade causes a significant increase in the corporate share of national income (μ_C), and a significant reduction of equivalent size in mixed income. This result is consistent with the tax capacity mechanism, whereby trade disproportionately benefits larger firms and causes an expansion of market income in more productive, formal firms at the expense of smaller, informal firms. Trade also raises the corporate average effective tax rate $\overline{ETR}_C^K$, suggesting this mechanism also operates within the corporate sector.

Table 3 shows that the corporate sector rise is driven by an increase in capital corporate income (corporate profits), while the growth in labor corporate income (employee compensation) is smaller in magnitude and statistically insignificant. These results suggest that trade's expansion of income in the corporate sector in practice benefits capital more than labor. Consistent with this, in the final columns, we find that trade causes an increase in the capital-share, both of national income and inside the corporate sector. This may occur if rising mark-ups is one of the main ways through which the corporate sector's market power grows.[23] It may also occur if trade benefits more capital-intensive production in developing countries.

Table A5 shows that these mechanism results are robust to a battery of tests: they hold when we remove weights; include different controls; winsorize the trade variable; and, estimate IVs separately based on each instrument.

Finally, Figure A7 shows the mechanism-outcomes using the event-study design from Section 4.1. Relative to stable-trends, the trade-liberalization events led to: a decrease in the CIT rate; an expansion of corporate income at the expense of mixed income; an increase in $\overline{ETR}_C^K$; and, a rise in capital-share. Though based on different empirical variation in openness, these event-study mechanism patterns are consistent with the IV results from Table 3 (albeit less precisely estimated).

[22]The outcome is the first-difference tax rate (C. Romer and D. Romer, 2010; Fuest, Peichl, and Siegloch, 2018). Table A5 shows that the result is robust to instead using the level of the CIT rate. We combine data from three sources: Vegh and Vuletin (2015), Egger, Nigai, and Strecker (2019) and Tax Foundation (2019). The combined CIT data-coverage leads to a drop in sample size.

[23]Loecker and Eeckhout (2021) show that mark-ups have risen in most regions around the world over the past 40 years. There is limited evidence to-date on the relationship between trade and firms' mark-ups in developing countries (Loecker, Goldberg, et al., 2016; Goldberg, 2022).

5.3 Heterogeneity: Developing vs developed countries

We expand our sample to high-income countries to test if the mechanisms and trade's ultimate impacts on ETR_K and ETR_L differ across development levels. We conjecture that the tax capacity mechanism is unlikely to operate in high-income countries if enforcement constraints are not as binding in these countries over our sample-period (e.g. Figure 6 showed that the corporate share of output has been stable in rich countries over the past 40 years). In contrast, both the race-to-bottom and demand for social insurance mechanisms are likely to be present in rich countries, given previous research. We take advantage of having two instruments to estimate heterogeneous effects by development level, by including an interaction term between trade openness and a high-income dummy:

$$y_{ct} = \mu \cdot trade_{ct} + \kappa \cdot trade_{ct} \cdot \mathbb{1}(HighIncome)_c + \Theta \cdot X_{ct} + \beta_c + \pi_t + \epsilon_{ct} \qquad (8)$$

The results in the full sample of countries are reported in Table 4, with the 1^{st}-stage regression in Table A4. The IV result in column (1) reveals clear heterogeneity: openness causes ETR_K to increase in developing countries but to decrease in rich countries. The coefficient for developed countries is not statistically significant, however. Column (2) reveals a positive effect of trade openness on ETR_L everywhere, but the magnitude of the increase is almost twice as large in developed than in developing countries. In the remaining columns, we investigate heterogeneous impacts on mechanism outcomes. Column 3 shows that the race-to-bottom effect is present in all countries, but the magnitude of the CIT rate reduction is 75% larger in rich countries, which might have contributed to the overall negative effect of trade on ETR_K, and to the larger rise in ETR_L. In the final columns, we find that the positive impacts of trade on tax capacity outcomes (corporate share of national income, $\overline{ETR}_C^K$) are limited to developing countries, with null effects in high-income countries.[24] While the results in Table 4 reveal qualitative differences in the coefficients between development levels, we cannot statistically reject their

[24]The IV-coefficients for developing countries qualitatively differ between Table 4 and Tables 1 and 3 (though they are not statistically different). This is because the two instruments' strength change in the 1st-stage regression in the expanded sample relative to the developing countries' sample (column 1 versus columns 4-5 in Table A4). Moreover, the overall first-stage strength is weakened in the expanded sample (Kleibergen-Paap F-statistic is 9.67), which impacts the estimated coefficients in both developing and developed countries (Sanderson and Windmeijer, 2016).

equality for several outcomes. This may stem from the 1^{st}-stage strength, where the Kleibergen-Paap F-statistic of 9.67 is close to but below 10.[25]

These results are consistent with the existence of countervailing mechanisms which differ by development level. Trade lowers capital taxation in rich countries due to a race-to-bottom, but in developing countries, this force is counteracted by an increased tax capacity, such that on net the impact on ETR_K is positive. The positive impact of trade on ETR_L in developing countries is likely due to a combination of tax capacity and social insurance.[26] The more pronounced positive impact of trade on ETR_L in rich countries may be due to larger revenue compensation needs following pronounced CIT cuts and larger social insurance demand.

Table A6 provides additional IV-heterogeneity results on mechanisms in the full sample. Panel A shows that the trade-induced reduction in CIT rate is strongest in countries that are less populous and that have fewer capital restrictions – settings where capital flight concerns are more pronounced (Wilson, 1999; Alesina and Wacziarg, 1998). Mirroring this result, Panel B shows that the positive trade-effect on ETR_K only occurs in countries that are larger and have more capital restrictions. These results support the conjecture that the tax capacity and the race-to-the bottom effects occur simultaneously: countries that have larger market size and limit capital mobility are better situated to reap the positive tax capacity effects of trade.

5.4 Firm-level analysis of tax-capacity mechanism and discussion

In this subsection we provide a firm-level analysis of the tax-capacity mechanism, and a discussion of how it relates to the trade-formalization literature.

Firm level analysis in Rwanda Our tax capacity mechanism derives from firm-level heterogeneity in (i) enforceability of taxes and (ii) benefits from trade openness. In this sense, a firm-level investigation of the mechanism is meaningful. However, a firm-level analysis would have to account for network linkages, given evidence both

[25]With multiple endogenous regressors, the Kleibergen-Paap F-statistic is a test of the overall strength of the first stage, which depends on whether the instruments generate sufficiently distinct variation in the endogenous regressors. In table A4, we also report the Sanderson-Windmeijer weak multiple instrument F-statistic, which is above conventional levels. Unlike for individual endogenous regressors, effective first-stage F-statistics have not yet been developed in the case of multiple endogenous regressors (Andrews, Stock, and Sun, 2019).

[26]Corporations serve as third-party reporters and withholding agents for employees' income, which increases the enforceability of labor income taxes on employees relative to self-employed workers.

on the existence of domestic firm-network linkages in developing countries (recent studies include Almunia et al. (2023) and Gadenne, Nandi, and Rathelot (2022)) and the role of these linkages in propagating trade-shocks to domestic firms that transact with importing and exporting firms (Javorcik, 2004; Fieler, Eslava, and Xu, 2018). In our mechanism, there may be market expansions of firms indirectly impacted by trade openness through their domestic transaction linkages to directly impacted firms.

In Appendix F.1 we implement a firm-level analysis in Rwanda, by merging several administrative micro-datasets to measure each formal firm's direct imports as well as domestic transaction linkages between all formal firms. To measure firms' total trade exposure in a network setting, we follow the methodology in Dhyne et al. (2021) who use similar data-sets to measure Belgian firms' exposure to trade. The data reveals that while under 30% of firms import directly, 93% of Rwandan firms obtain foreign inputs either directly or indirectly through domestic suppliers that use imports in their production process. Thus, most formal firms in Rwanda are dependent on imports, but a significant share of this dependence comes from the domestic linkages to directly-importing firms. The share of input costs spent on goods that are imported directly or indirectly (our measure of total import trade exposure) is 48% for the median Rwandan firm.

We analyze the impact of a formal firm's total trade exposure on the effective corporate income tax rate, corresponding to corporate ETR_i^K in equation (6). We use both OLS and IV in firm-level panel regressions. The IV strategy generates firm-level variation in trade exposure through the shift-share design from Hummels et al. (2014): the identifying variation is trade shocks from changes in world export supply of specific country-product combinations in which a firm had a previous import relationship. We find that both direct trade shocks to a firm's own imports and indirect shocks to a firm's network of suppliers cause significant changes to the firm's total trade exposure, generating a strong 1^{st}-stage. Using the IV, we find that higher exposure to trade causes an increase in the individual firm's ETR^K. The IV also reveals that trade increases firm size (proxied by sales), while the OLS shows a positive association between size and ETR^K. These results are consistent with the tax-capacity mechanism, where enforceability is increasing with firm size and trade's impact on ETR_K is mediated by its positive effect on size.

This firm-level exercise comes with two caveats. First, the network linkage measures are derived from administrative data which, by construction, only exists for tax registered firms. This sample restriction, present in most recent network studies in developing countries (Atkin and Khandelwal (2020) and Appendix F.1), implies that the firm-level regression will only capture impacts on corporate ETR^K between firms within the formal sector, which omits the important re-allocation channel from the informal sector that impacts overall ETR^K (equation 6). Second, estimation strategies within country deliver relative impacts and by design cannot speak to the net impacts of trade on formality. Recent theoretical work by Dix-Carneiro, Goldberg, et al. (2021) highlights how trade's relative impacts (in partial equilibrium) and net impacts (in full equilibrium) may differ, due to interactions between labor markets and firms' output-markets and sectoral and geographical re-allocations. For these reasons, we consider the Rwandan firm-analysis to be complementary to the country-level analysis in Tables 1-4 which estimates the economy-wide, net impacts of globalization on effective taxation and output formalization.

Discussion: Links to trade-formality literature We find positive effects of trade on outcomes linked to formalization. Recent trade studies have focused on the number of formal versus informal firms, formal versus informal workers or formal worker wages and found mixed evidence that trade liberalization increases formality (see review in Engel et al., 2021). One way to reconcile our results with the literature is to note that our focus is on the value of output produced in formal versus informal firms: the expansion of output-share in larger, formal firms may occur without significant changes to the number of formal or informal firms, and does not necessarily imply an increase in the number of formal workers, since informal workers may work in formal firms and contribute to their output (Ulyssea, 2018).

Moreover, the trade literature highlights that formality-impacts depend on the nature of the trade shock. To further investigate our hypothesis, we therefore study in Appendix F.2 if the mechanism impacts differ along two dimensions of trade shocks (Dix-Carneiro, Goldberg, et al., 2021). First, increased *exports* represent a pure positive demand shock for export-oriented firms, while increased *imports* may constitute a negative demand shock for purely domestic firms, disproportionately affecting larger ones. Through these simplified 'Melitz-type' demand-effects, exports may increase the formal output-share while imports may decrease it. Second, the increased availability of *intermediate* goods may benefit initially larger firms; by contrast, the increased availability of *final* goods may constitute a negative domestic demand shock, particularly for larger, formal firms. Through these simplified effects, concentrated on the import side, trade in intermediate goods-services (G-S) may raise the formal market-share while trade in final G-S may reduce it.

Using our two instruments, we find that exports increase ETR_K while imports decrease it. In a separate IV, we find that trade in intermediate G-S increases ETR_K while trade in final G-S decreases it. We also find that exports increase the corporate income-share, while imports decrease it; trade in intermediate G-S increases the corporate income-share while final G-S trade decreases it. Taken all together, the coefficients are consistent with imports of intermediate G-S increasing formality, and imports of final G-S decreasing it. These results suggest that the tax-capacity impacts on formality and ETRs depend on the nature of the trade shock.

5.5 Capital openness

We complete the analysis by noting that our focus throughout the paper has been on one key dimension of globalization: trade openness. Given our interest in capital taxation, another relevant dimension is capital openness (Ilzetzki, Reinhart, and Rogoff, 2019; Patten, 2022). However, due to differences in countries' reporting requirements, data on capital openness is not as available and comparable as trade data. Finding credibly exogenous variation for capital openness is also challenging.

Notwithstanding these challenges, in Appendix E, we try to investigate the impact of capital openness on ETRs. We rely on the capital inflow liberalization events for 25 developing countries from Chari, Henry, and Sasson (2012), which capture the first time when foreign investment in the domestic stock market is allowed. Employing the same event-study design as Section 4, we find that the events lead to both increased capital openness and higher ETR_K, qualitatively consistent with the trade-liberalization patterns. This suggests that the positive impact of globalization on ETR_K in developing countries may be robust to using capital instead of trade openness. However, given the limitations with the measurement of capital flows, we consider that our results based on trade provide more meaningful and robust insights into globalization's impacts on effective taxation.

6 Conclusion

In this paper, we provide evidence on trends and causal effects of globalization on tax structures. We make two main contributions. The first is to build and analyze a global macro-historical database of effective tax rates on labor and capital, starting in 1965 when possible. The main novel fact is the asymmetric evolution of capital taxation by development level in the era of hyper-globalization: while the effective tax rate rate has fallen in high-income countries, it has strongly risen in developing countries since the 1990s. Our second contribution is to formulate and test a hypothesis that sheds light on this asymmetric evolution. Across multiple research designs, we find evidence of a pro-tax capacity effect of international trade: openness causes a rise in effective capital (and labor) taxation, by expanding larger, formal firms relative to smaller, informal firms, and concentrating economic activity in corporations where tax enforcement is stronger. The pro-tax capacity effect prevails in developing countries, while the well-known negative race-to-bottom effect on capital taxation has dominated in developed countries.

This paper's findings has implications for public finance and globalization in developing countries. By positively impacting domestic direct taxes, we find that trade openness causes an increase in overall taxation. This result runs somewhat counter to a persistent concern amongst practitioners over tax revenue losses from trade liberalization, while previous academic work has largely abstracted from investigating the effects on capital and labor taxes. By incorporating these direct tax bases, we provide a comprehensive analysis of the revenue consequences of globalization. Our focus is on a specific enforcement mechanism, but many links remain to be explored between trade, firm structure, and domestic tax collection.

Moreover, across our research designs we find that the positive effect of trade is larger for capital than for labor taxation. Since capital income is more concentrated than labor income, this result is a first step towards understanding whether trade-induced changes in taxation have reinforced or attenuated the distributional effects of globalization on pre-tax income. While we have adopted a macroeconomic perspective on tax systems and inequality, a next step could be to combine our macroeconomic tax rates with individual-level estimates of the progressivity of labor and capital taxes. This would allow a comparison of the distributional effects of globalization on the pre-tax versus post-tax income distributions.

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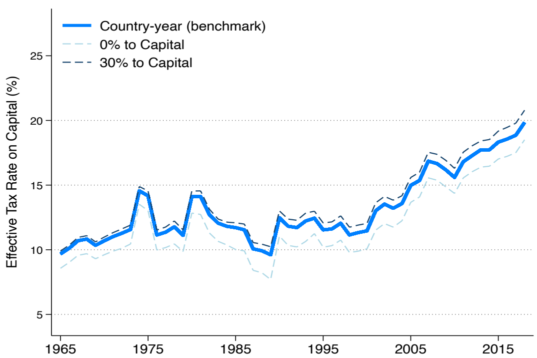
Figure 1: Effective Taxation of Capital and Labor

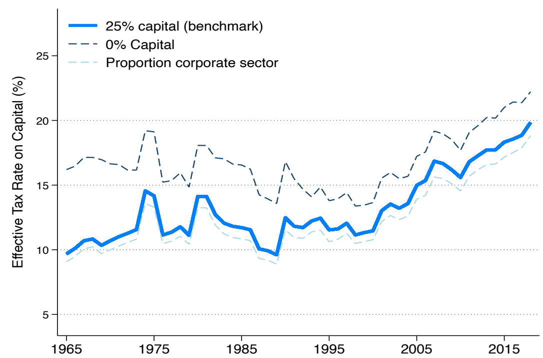
Notes: This figure plots the time series of average effective tax rates on labor (red) and capital (blue), as well as the effective tax rate on corporate profits (red dashed line). The top-left panel corresponds to the global average, weighting country-year observations by their share of that factor in that year's total, in constant 2019 USD (N=155). The bottom-left panel shows the results for high-income OECD countries (N=37), and the bottom-right panel for low- and middle-income countries (N=118). High-income countries are OECD countries that meet the World Bank's income threshold of high-income. The dataset is composed of two (quasi) balanced panels: the first covers the years 1965-1993 and excludes communist regimes. It accounts for 85-90% of World GDP during those years. The second, covers 1994-2018 and integrates former communist countries, and in particular China and Russia, and accounts for 98% of World GDP. This figure is discussed in Section 3.1.

Figure 2: Robustness of Effective Capital Taxation in Developing Countries

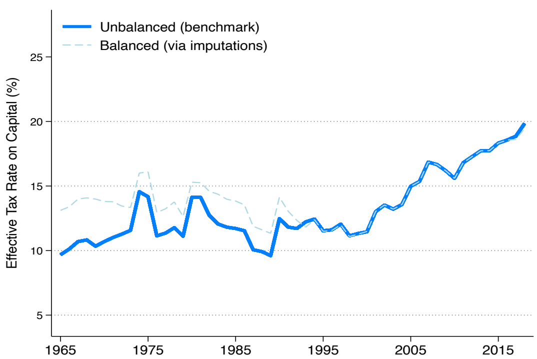
(a) PIT revenue allocation



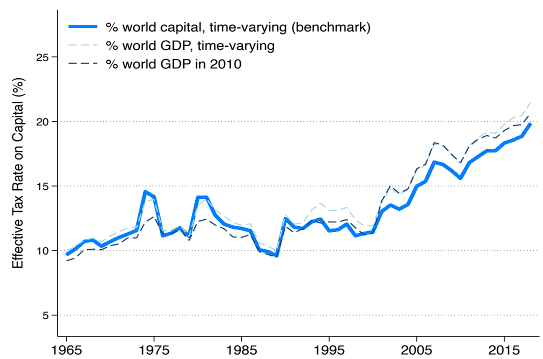
(b) Mixed-income allocation



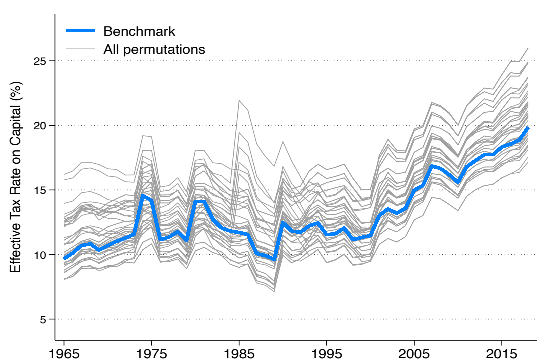
(c) Panel balancedness



(d) Weights for Aggregation



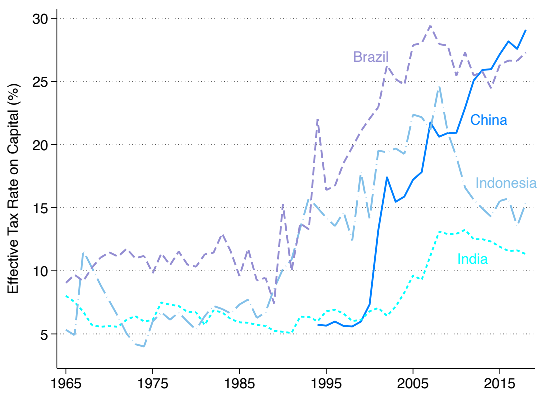
(e) All Alternatives



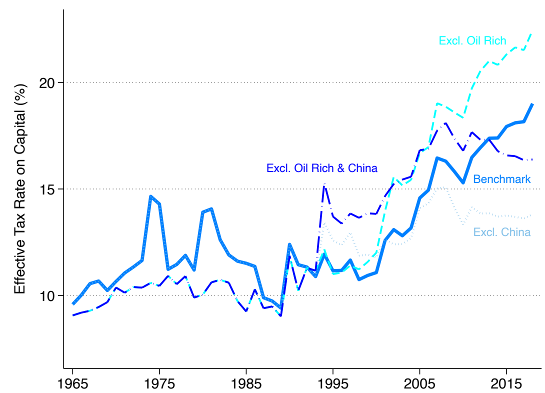
Notes: These panels show trends in the effective taxation of capital in the 118 developing countries in our sample, varying our four key methodological choices: The allocation of personal income tax revenue to capital vs labor (panel a); The allocation of mixed income to capital vs labor (panel b); presenting results for an unbalanced panel of countries vs a balanced one via imputations (panel c); and how to weight individual countries' series when aggregating them (panel d). Panel (e) shows all 54 possible series that could have been constructed by combining those choices, with our benchmark series in blue. This figure is discussed in Section 3.2.

Figure 3: Heterogeneity of Effective Capital Taxation in Developing Countries

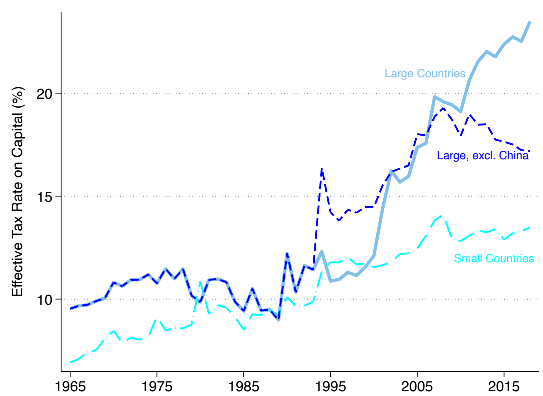
(a) Four largest countries



(b) Oil rich countries and China



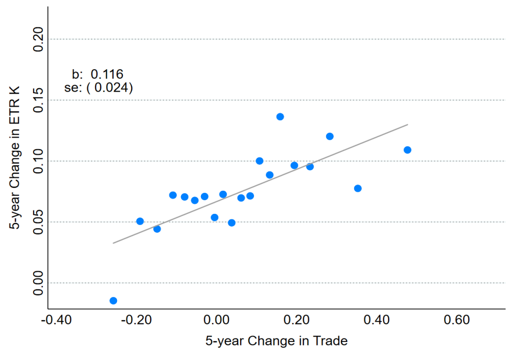
(c) Large vs small countries (40 Mil. inhabitants)



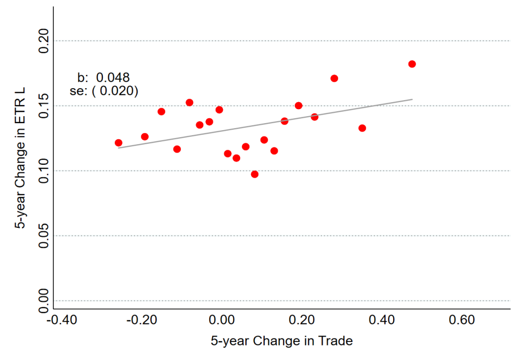
Notes: This figure shows the evolution of the effective taxation of capital for major developing countries and sub-samples of developing countries. Panel (a) plots the ETR_K series for the four largest developing countries: Brazil, China, India, Indonesia. Panel (b) compares the benchmark series to a series without China, without oil-rich countries (countries with more than 7% of GDP from oil), and without both China and Oil rich countries. Within the sample of non-oil rich developing countries, panel (c) compares large to small countries. This figure is discussed in Section 3.3.

Figure 4: Change in Factor Taxation vs. Change in Trade

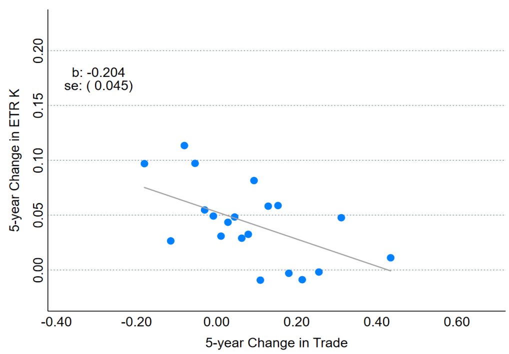
(a) ETR K: All Countries



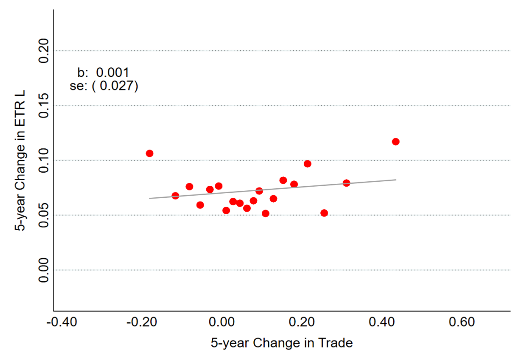
(b) ETR L: All Countries



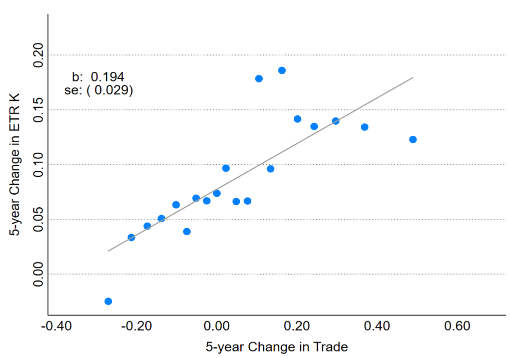
(c) ETR K: High-Income



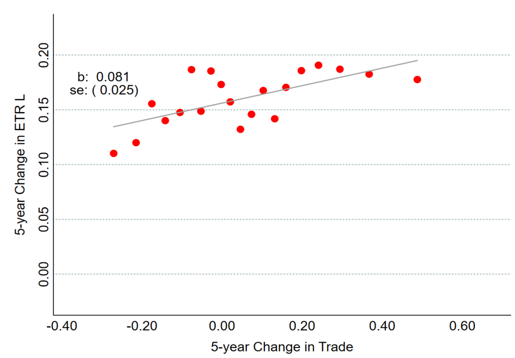
(d) ETR L: High-Income



(e) ETR K: Low & Middle-Income

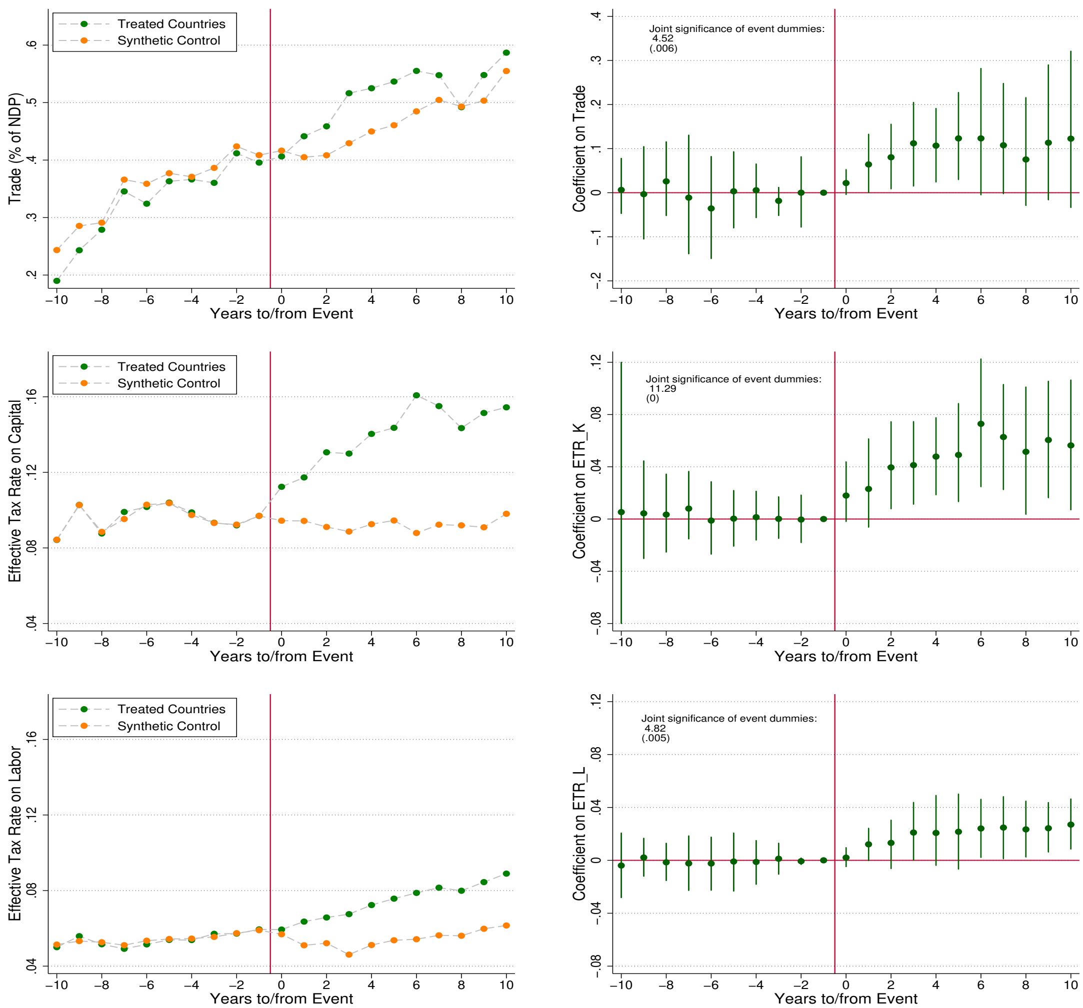


(f) ETR L: Low & Middle-Income



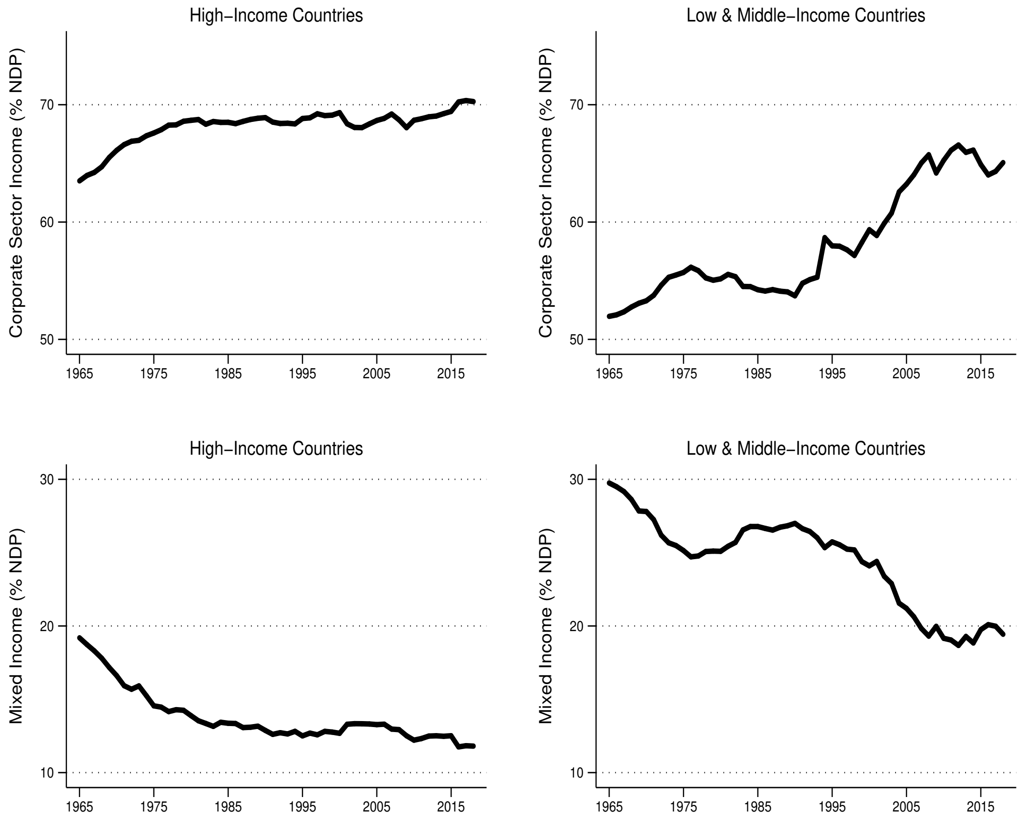
Notes: These panels shows the associations between trade and effective tax rates. The outcome is the effective tax rate on capital, ETR_K, and on labor, ETR_L, in the left-side and right-side panels, respectively. The top panels show the associations in all countries; the middle panels show the associations in high-income countries; the bottom panels show the associations in low and middle-income countries. Trade is measured as the sum of import and exports as a share of NDP. Both the x-axis and y-axis are measured as within-country percent changes over 5 years. Each graph shows binned scatter plots of each outcome against trade, after residualizing all variables against year fixed effects. Each dot corresponds to a ventile (20 equal-sized bins) of the residualized trade variable. In each graph, the line represents the best linear fit based on the underlying country-year data, with the corresponding slope-coefficient and standard error reported in the top-left corner. For more details, see Section 3.4.

Figure 5: Event Study of Trade Liberalization Reforms



Notes: These figures show event-studies for trade liberalization in seven large developing countries: Argentina, Brazil, China, Colombia, India, Mexico and Vietnam. The panels correspond to different outcomes: trade; effective tax rate on capital; effective tax rate on labor. The left-hand graphs show the average level of the outcome in every year to (since) the event for the treated group and for the group of synthetic control countries. The right-hand graphs show the coefficients on the 'to' ('since') dummies, in a regression with country fixed effects, year 'to' ('since') fixed effects, and calendar year fixed effects. The bars represent the 95% confidence intervals. Standard errors are clustered at the country-reform level and estimated with the wild bootstrap method. The top-left corners report the F-statistic on joint significance of the post-reform dummies, with the p-value in parentheses below. Details on methodology in Section 4.1.1 and Appendix C.2.

Figure 6: Corporate-sector Income and Mixed Income, by Development Level



Notes: This figure plots the time series of corporate-sector income and of mixed income (both expressed as percentages of factor-price net domestic product; weighted by NDP in constant 2019 USD), in high-income vs. in low- and middle-income countries, from 1965-2018. The left panels show the results for high-income OECD countries (N=37), and the right panels for low- and middle-income countries (N=119). The data-set is composed of two quasi-balanced panels. The first covers the years 1965-1993 and excludes communist regimes, covering 85-90% of world GDP during those years. The second covers 1994-2018 and includes former communist countries, notably China and Russia, and accounts for 97-98% of world GDP. For more details on sample compositions, see Section 2.2.

Table 1: Trade Impacts on Effective Taxation of Capital and Labor

	Benchmark		Robustness: Specification and covariates				Robustness: $K-L$ assignment to taxes and factor shares			Robustness: Individual instruments	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: ETR_K											
Trade	0.040***	0.118***	0.099**	0.129**	0.103**	0.124***	0.100**	0.116***	0.124***	0.114***	0.324***
	(0.013)	(0.041)	(0.040)	(0.057)	(0.040)	(0.041)	(0.039)	(0.039)	(0.042)	(0.041)	(0.113)
Panel B: ETR_L											
Trade	0.007	0.049***	0.038**	0.041**	0.051***	0.052***	0.053***	0.052***	0.045***	0.046***	0.207***
	(0.005)	(0.015)	(0.016)	(0.019)	(0.016)	(0.015)	(0.016)	(0.016)	(0.015)	(0.015)	(0.066)
Specification	OLS	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV
1^{st} stage Kleibergen-Paap F-statistic		24.57	25.05	14.24	23.09	34.83	24.57	24.57	24.57	45.17	10.80
Modifications to IV in col. (2)			Remove GDP weights	Include country-year controls	Include **1**(oil-rich)*year fixed effects	Winsorize trade at 5%-95%	Assign based on corp. K-share	Assign 0% of PIT to capital	Assign 30% of PIT to capital	Only use $Z^{gravity}$ instrument	Only use $Z^{Oil-Dist}$ instrument
N	4970	4970	4970	3984	4970	4970	4970	4970	4970	4970	4970

Notes: This table presents results from estimating the effect of trade on factor taxation in developing countries. The outcome is the effective tax rate on capital, ETR_K, in Panel A and the effective tax rate on labor, ETR_L, in Panel B. Trade is measured as the sum of exports and imports divided by NDP. Column (1) presents the OLS results from estimating equation (5). All other columns use IV; at the bottom of each column, we report the 1^{st}-stage Kleibergen-Paap F-statistic. The benchmark IV specification is in Column (2), with the corresponding 1^{st}-stage regression reported in Table A4. The remaining columns modify the benchmark specification of Column (2). In Column (3), we remove the country-year NDP weights. In Column (4), we include the country-year controls described in Section 4.2.1. In Column (5), we include interactive fixed effects between a dummy for oil-rich countries and year dummies. In Column (6), we use the trade variable which is winsorized at the 5%-95% percentile on a yearly basis. In Column (7), we modify the assignment rule for factor tax rates, by using the capital share in the corporate sector as the assignment for the capital share of mixed income. In Columns (8)-(9), we assign respectively 0% and 30% of personal income taxes (PIT) to capital taxes. In Columns (10)-(11), we estimate the IV using the individual instruments $Z^{gravity}$ and $Z^{Oil-Distance}$, respectively. For more details, see Section 4.2. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Table 2: Trade Impacts on Tax Sources (% of NDP) in Developing Countries

	Total taxes (1)	CIT (2)	Property and Wealth (3)	PIT (4)	Social Security (5)	Indirect (6)
Trade	0.098***	0.047***	0.004	0.001	0.024***	0.011
	(0.033)	(0.013)	(0.003)	(0.005)	(0.006)	(0.024)
1^{st}-stage Kleibergen-Papp F-statistic	24.57	24.57	24.57	24.57	24.57	24.57
N	4970	4970	4970	4970	4970	4970

Notes: This table presents results from estimating the effects of trade on sources of taxation, expressed as percent of NDP, in developing countries. Trade is measured as the sum of exports and imports divided by NDP. All regressions are based on the IV model described in Section 4.2. At the bottom of each column, we report the 1^{st}-stage Kleibergen-Paap F-statistic. The corresponding 1^{st}-stage regression is reported in Table A4. The outcome differs across columns: Column (1) is total taxes, which is the sum of direct taxes on capital and labor and indirect taxes on trade and domestic consumption; Column (2) is corporate income taxes (CIT); Column (3) is taxes on property, wealth and inheritance; Column (4) is personal income taxes (PIT); Column (5) is social security and payroll (both employer and employee); Column (6) is indirect taxes, which combines trade taxes and domestic consumption taxes. For more details on these sources of taxes, see Appendix **??**. For more details on the IV, see Section 4.2. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Table 3: Trade Impacts on Mechanism Outcomes

		National income components					Factor shares	
	First-diff. CIT rate (1)	Corporate totl. income (2)	Household mixed income (3)	Corporate profits (4)	Employee compensation (5)	Corporate ETR_K (6)	Capital share natl. income (7)	Capital share corp. sector (8)
Panel A: OLS								
Trade	0.002	0.040***	-0.017	0.027***	0.006	0.056***	0.021***	0.031**
	(0.003)	(0.013)	(0.011)	(0.009)	(0.010)	(0.020)	(0.007)	(0.012)
Panel B: IV								
Trade	-0.035*	0.183***	-0.193***	0.184***	0.014	0.377***	0.161***	0.206***
	(0.020)	(0.043)	(0.041)	(0.036)	(0.032)	(0.098)	(0.034)	(0.048)
1^{st} stage Kleibergen-Paap F-Statistic	38.47	24.57	24.57	24.57	24.57	24.57	24.57	24.57
N	3451	4970	4970	4970	4970	4970	4970	4970

Notes: This table presents results from estimating the effects of trade on mechanism outcomes in developing countries. Trade is measured as the sum of exports and imports divided by NDP. Panel A presents OLS results and Panel B presents the IV results, based on the instruments described in Section 4.2. At the bottom of each column in Panel B, we report the we report the 1^{st}-stage Kleibergen-Paap F-statistic. Across the columns, the outcomes differ: Column (1) is the first-differenced statutory corporate income tax (CIT) rate; Column (2) is the corporate share of national income, which is the sum of corporate profits and corporate employee compensation; Column (3) is the mixed income share of national income; Column (4) is the corporate profit's share of national income; Column (5) is the employee compensation's share of national income; Column (6) is the average effective tax rate on corporate profits; Column (7) is the capital share of national income; Column (8) is the capital share of corporate income. For more details on the outcomes, see Section 2.1 and Section 5.1. For more details on the instrumental variables, see Section 4.2. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Table 4: Heterogeneous Impacts of Trade by Development Level

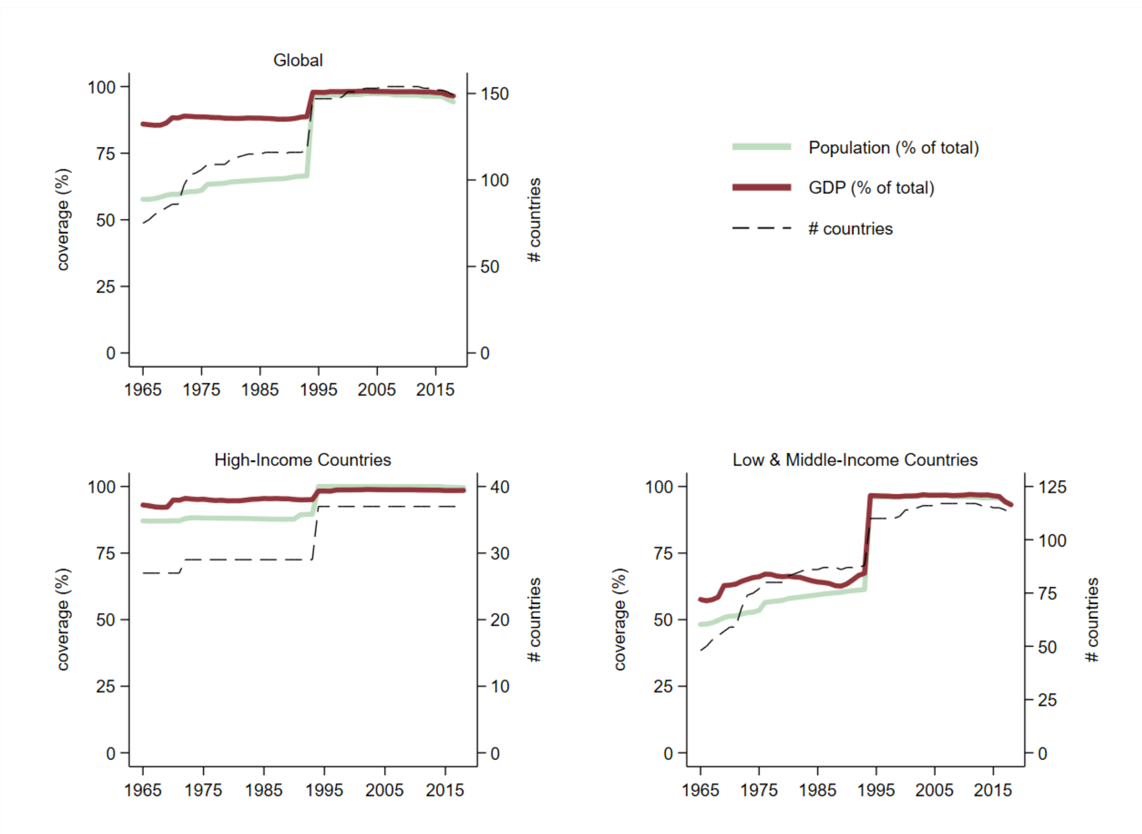
	ETR_K (1)	ETR_L (2)	First-diff. CIT Rate (3)	Corp. Totl. Income (4)	Mixed Income (5)	Corp. Profits (6)	Employee Comp. (7)	Corp. ETR_K (8)	Natl. K-Share (9)	Corp. K-Share (10)
Trade	0.327**	0.154***	-0.053**	0.301***	-0.215**	0.185***	0.087	0.420***	0.115***	0.136***
	(0.158)	(0.054)	(0.023)	(0.086)	(0.092)	(0.042)	(0.066)	(0.153)	(0.037)	(0.038)
Trade$*\mathbb{1}$(High-inc.)	-0.430	0.116	-0.038	-0.482	0.451***	-0.292***	-0.274**	-0.376	-0.189***	-0.182**
	(0.317)	(0.120)	(0.050)	(0.156)	(0.160)	(0.083)	(0.124)	(0.359)	(0.070)	(0.088)
Implied coef. for Trade in High-inc.	-0.103	0.270***	-0.092**	-0.181	0.236	-0.107	-0.187	0.044	-0.074	-0.045
	(0.236)	(0.096)	(0.037)	(0.152)	(0.161)	(0.070)	(0.127)	(0.231)	(0.054)	(0.079)
1^{st}-stage Kleibergen-Papp F-statistic	9.67	9.67	8.73	9.67	9.67	9.67	9.67	9.67	9.67	9.67
N	6536	6536	4069	6536	6536	6536	6536	6536	6536	6536

Notes: This table presents results from estimating the effects of trade on ETR and mechanism outcomes in the full sample of developing and developed countries. Trade is measured as the sum of exports and imports divided by NDP. We estimate the IV described in equation 8. The first-stage regression is reported in Table A4. At the bottom of each column, we report the implied coefficient and estimated standard error based on the linear combination of the $Trade$ and the $Trade$*1$(High-inc.)$ coefficients. We also report the 1^{st}-stage Kleibergen-Paap F-statistic. Across the columns, the outcome differs: Column (1) is the effective tax rate on capital; Column (2) is the effective tax rate on labor; Column (3) is the first-differenced statutory corporate income tax (CIT) rate; Column (4) is the corporate share of national income, which is the sum of corporate profits and corporate employee compensation; Column (5) is the mixed income share of national income; Column (6) is the corporate profit's share of national income; Column (7) is the employee compensation's share of national income; Column (8) is the average effective tax rate on corporate profits; Column (9) is the capital share of national income; Column (10) is the capital share of corporate income. For more details on the outcomes, see Section 2.1 and Section 5.1. For more details on the instrumental variables, see Section 4.2. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Appendix

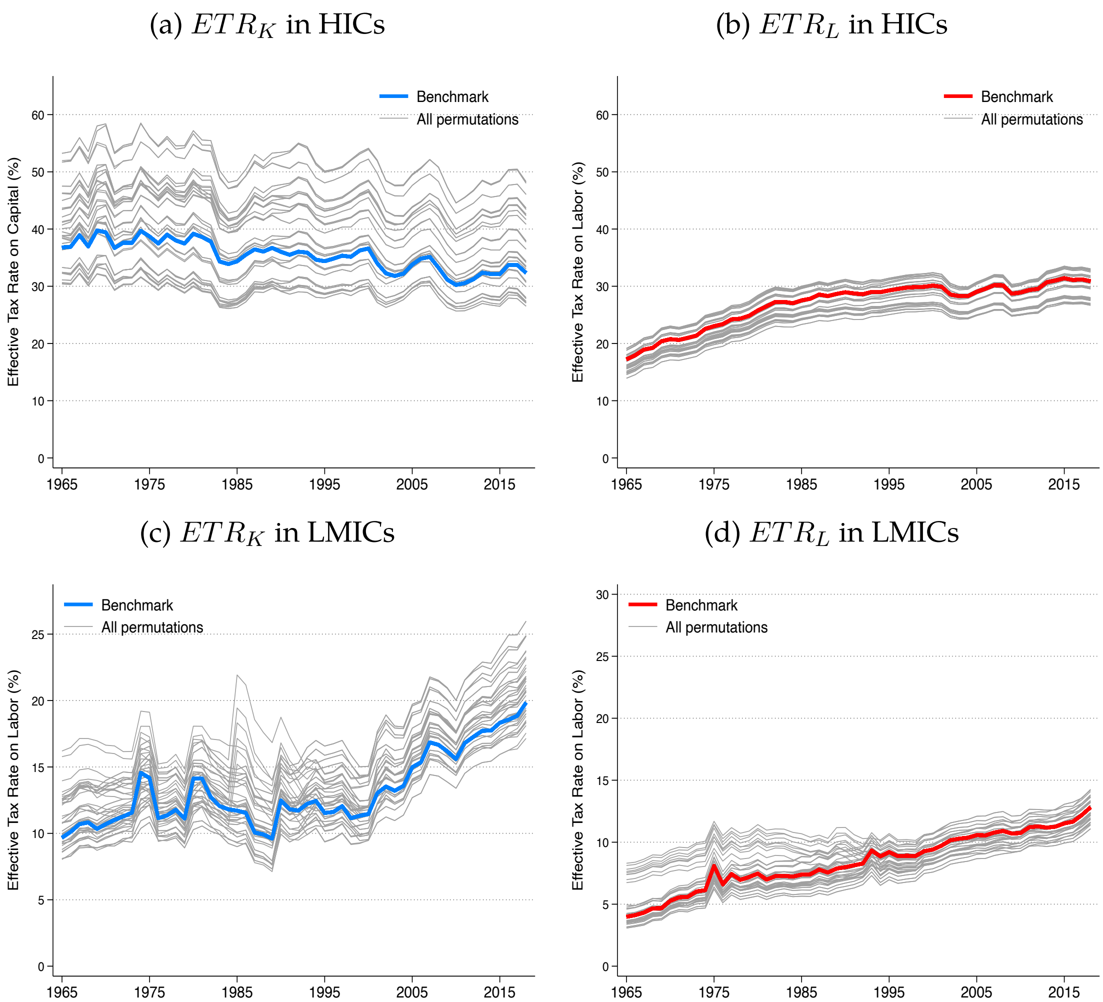
Appendix A Additional Figures and Tables

Figure A1: Data Coverage of Effective Tax Rates



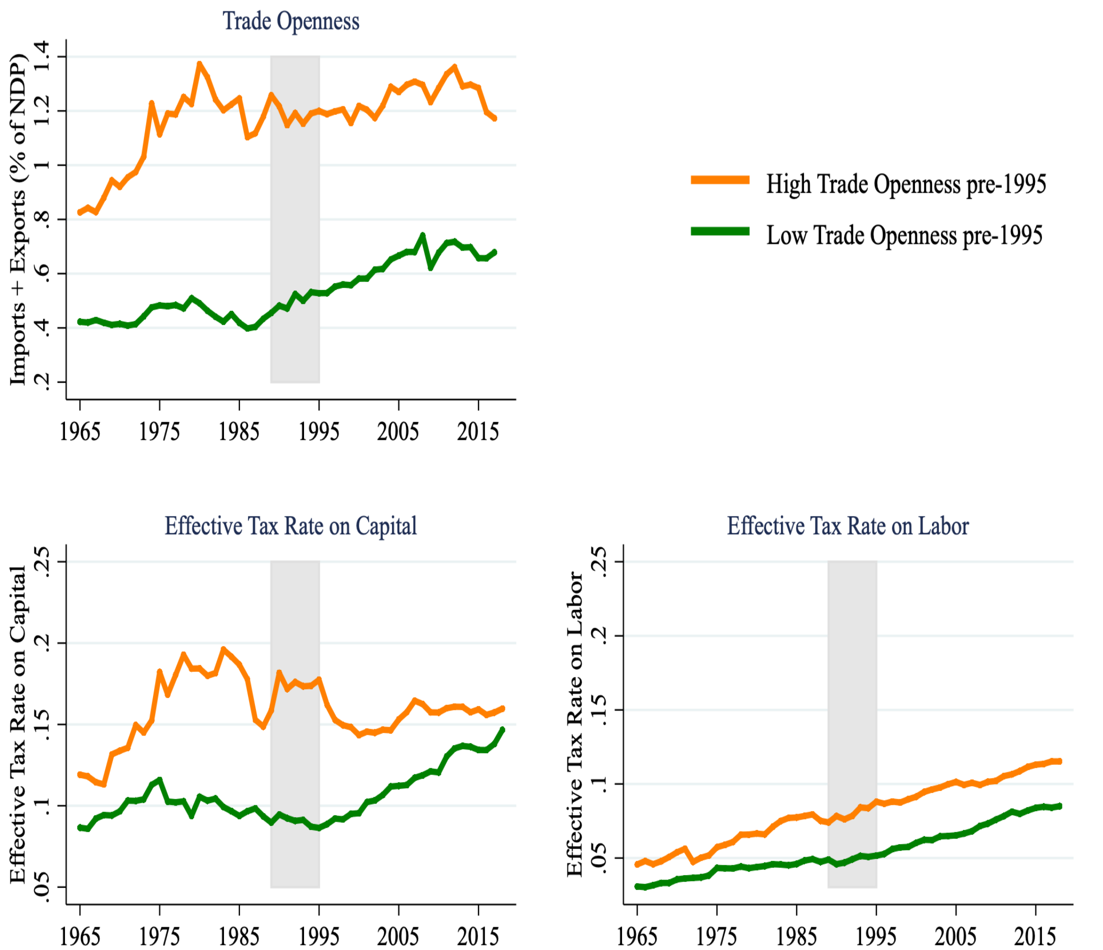
Notes: This figure shows the coverage of our effective tax rate data between 1965 and 2018, globally and for high vs. low- and middle-income countries. The solid lines plot the percentage of total population and GDP that is covered in our data (left axis). The dashed lines show the number of countries in the data (right axis). The missing 'missing' income (and population) prior to the 1990s corresponds to communist countries, particularly China, Russia and the ex-Soviet republics, and Vietnam. In addition to limited data on public revenue, communist country present a conceptual mismatch with our framework for factor income taxation (see Supplementary Appendix). Other missing country-years correspond to conflicts, independence post 1965, and in a few cases to missing data.

Figure A2: Robustness of ETR_K and ETR_L Trends by Development Levels



Notes: These panels show trends in the effective taxation of capital and labor for high-income countries (top) and low and middle-income countries (bottom). The benchmark series are denoted by the thick colored line and the grey lines denote all 54 possible permutations of the series when varying the four key methodological choices (detailed in section 3.2): The allocation of personal income tax revenue to capital vs labor; The allocation of mixed income to capital vs labor; presenting results for an unbalanced panel of countries vs a balanced one via imputations; and how to weight individual countries' series when aggregating them. Panel (c) corresponding to the ETR_K for LMICs is further decomposed in Figure 2.PB: come back and change axis in c and d.

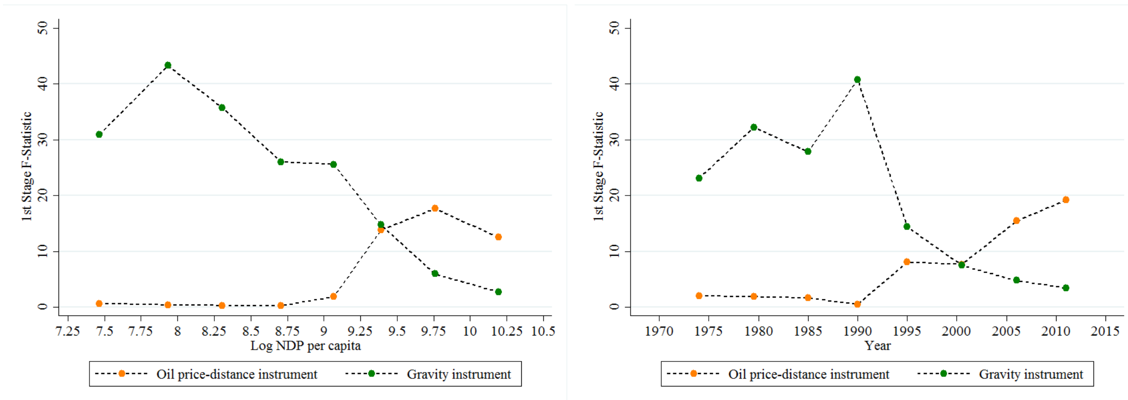
Figure A3: Factor Taxation Trends by Initial Trade Openness, Developing Countries



Notes: This figure plot the time series of trade openness (top-left panel), average effective tax rates on capital (top-right panel) and labor (bottom-left panel). The sample is limited to low- and middle-income countries. Within each panel, the green line (orange line) traces the evolution of the group of developing countries which had relatively high (low) trade openness prior to 1995. Specifically, high (low) trade openness is defined as having average yearly trade openness which lies above (below) the global yearly average between 1965 and 1995. Trade openness is measured as the share of imports and exports in national domestic product; note that this share can exceed a value of 1.Each line plots the year fixed effects from an unweighted OLS regression, in the relevant sub-sample of the outcome, on country and year fixed effects. The inclusion of country fixed effects eliminates the influence of countries entering and leaving the sample. The fixed effects are normalized to equal the level of the outcome variable in the relevant sub-sample in 1965. The shaded area highlights the notable 1990-1995 period, which marks the beginning of the 'second wave' of globalization, featuring a proliferation of bilateral and multilateral trade agreements (Egger, Nigai, and Strecker, 2019).

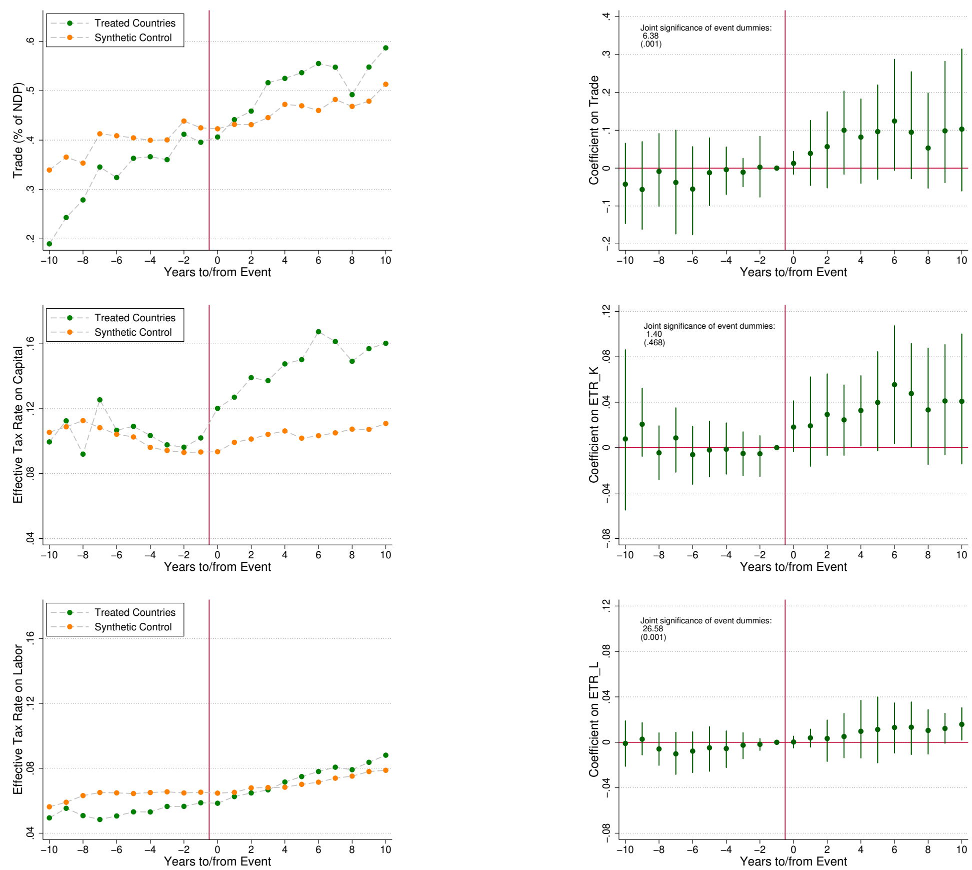
Figure A4: Strength of Individual Instruments Across Subsamples

(a) Sub-samples of NDP per capita (b) Sub-samples of time-periods



Notes: These figures show the individual statistical strength of the two instruments, $Z^{Oil-Distance}$ and $Z^{gravity}$. The outcome is the first-stage F-statistic from a regression of trade openness on each individual instrument in developing countries (see Section 4.2). The outcome is shown across subsamples of log GDP per capita (Panel A) and years (Panel B). To construct each figure, the x-axis is first partitioned into ten deciles. The first-stage F-statistic is then separately estimated in samples centered on each decile. The estimation is done in increments of one decile, and the bandwidth uses one decile of data on either side of the decile-center. To maintain an equal size in all estimation samples, estimation centered on the first and the tenth decile are dropped. Each estimation sample contains approximately 1491 observations (corresponding to 3 deciles of the sample of 4970 observations in developing countries).

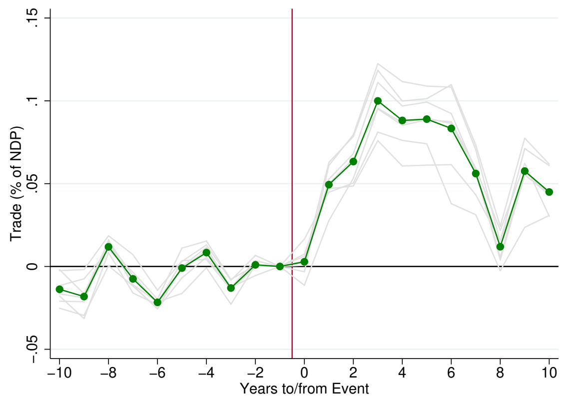
Figure A5: Event Studies of Trade Liberalization, Simultaneous Matching on Outcomes



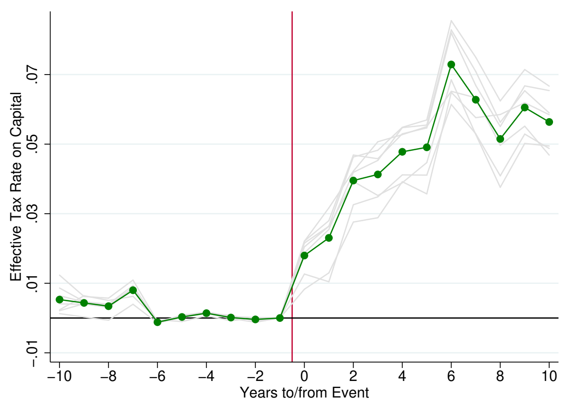
Notes: These figures show event-studies for trade liberalization reforms in seven countries, over three outcomes: trade (as a percentage of domestic product); effective tax rate on capital; effective tax rate on labor. The left-hand graphs show the average level of the outcome in every year relative to the event, for the treated group and for the group of synthetic controls. The right-hand graphs show the coefficients on the 'to' ('since') dummies, in a regression model with country fixed effects; year 'to' ('since') fixed effects; and calendar-year fixed effects. The bars represent the 95% confidence intervals for 'to' ('since') reform coefficients, while standard errors are clustered at the country-reform level and estimated using the wild bootstrap method. In the top-left corner, we report the F-statistic on joint significance of the post-reform dummies, with the p-value in parentheses below. These graphs are constructed similar to Figure 5, with the exception that the synthetic control for each event-country is based on matching simultaneously on all outcomes.

Figure A6: Robustness of Trade Liberalization to Changing Sample of Event Countries

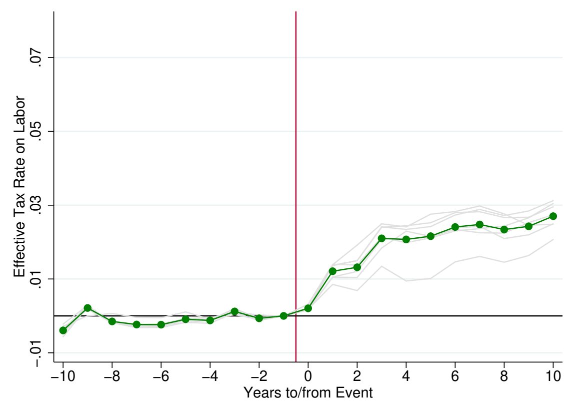
(a) Trade as % of NDP



(b) Effective Tax Rate on Capital



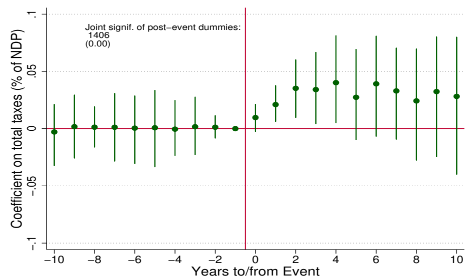
(c) Effective Tax Rate on Labor



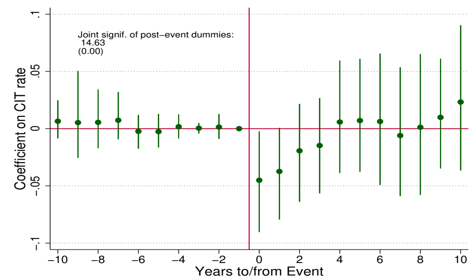
Notes: These figures show event studies for trade liberalization reforms in seven countries, over three outcomes: trade (as a percentage of domestic product); effective tax rate on capital; effective tax rate on labor. In each figure, the solid green line displays the estimated coefficients for the interaction between a treatment dummy and a year 'to' ('since') dummy [note the omitted period is $t-1$], corresponding to the graphs displayed in the right column of Figure 5. Each lightly-shaded gray line repeats the estimation procedure based on a sample that removes one of the seven treated countries, one at a time. All the gray lines thus represent the dynamic treatment effects but for different subsets of the treated countries. More details can be found in Appendix C.2.

Figure A7: Mechanism Impacts in Trade Liberalization Event Studies

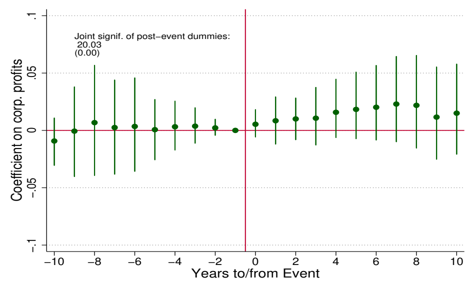
(a) Total taxes (% of NDP)



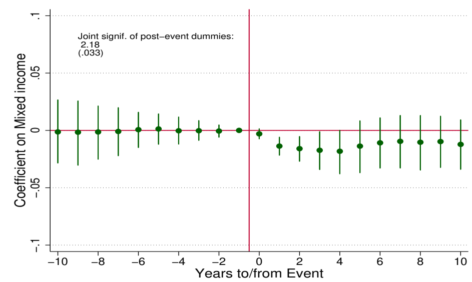
(b) Corp. Income Tax Rate (first-diff.)



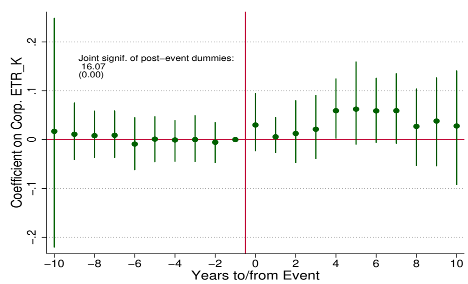
(c) Corporate Income (% of NDP)



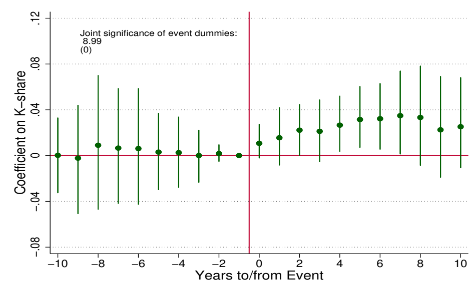
(d) Mixed Income (% of NDP)



(e) Corporate ETR_K



(f) Capital Income (% of NDP)



Notes: These panels show the the impacts of the trade liberalization events on mechanism outcomes. The panels are constructed using the method in Section 4.1. Across panels, the outcomes differ: Panel a) is total tax collection, as a % of NDP; Panel b) is the first-differenced statutory corporate income tax rate; Panel c) is the corporate income share of national income, where corporate income is the sum of corporate profits and employee compensation; Panel d) is the mixed income share of NDP; Panel e) is the average effective tax rate on corporate profits; Panel f) is the capital share of national income. In each panel, the top-left corner reports the F-statistic for the joint significance of post-event dummies, with the p-value reported in parentheses below. Additional details on methodology in Appendix C.2.

Table A1: Allocation of Taxes to Factor Incomes (Benchmark)

Type of tax	Series	Allocation to labor (λ_τ)
Panel A: Direct Taxes		
Personal income tax (PIT)	1100	Share λ [70,100%] to L
Corporate income tax (CIT)	1200	0% to $L \Rightarrow$ all CIT to K
Other (unallocable) income tax	1300	50% to L, 50% to K; rare
Social security & payroll taxes	2000	100% to L
Property & wealth taxes	4000	0% to L $\Rightarrow$ all asset taxes to K
Panel B: Indirect Taxes & Other Revenue		
Indirect taxes	5000	excluded, assumed proportional
Other taxes	6000	excluded; minor
Non-tax revenue	7000	excluded; non-tax

Notes: This table shows our benchmark assignment of statutory tax incidence λ_τ on labor (where the assignment to capital is $1 - \lambda_\tau$), for each of the types of taxes in our modified OECD (2020) classification. For the purposes of assigning tax incidence onto factor incomes (see 2.1), we consider here only direct taxes, and implicitly assume that indirect taxation falls proportionally onto labor and capital factor incomes (cf. Browning, 1978; Saez and Zucman, 2019). We treat 'other taxes' similarly (these are rare and insignificant), and ignore non-tax revenue. For income tax revenues whose provenance cannot be understood as either personal income tax (PIT) or corporate income tax (CIT), we assign them as a 50-50% split between the two; these 'unallocable' income tax revenues are rare in occurrence and small in magnitude. Taxes in the 4000 series (largely property taxes) also include wealth and financial transaction taxes.

Table A2: Synthetic Difference-in-Difference of Trade Liberalization

	Trade	ETR_K	ETR_L
Panel A Synthetic control for each outcome separately			
Post*Treat	0.064	0.0457***	0.020**
	(0.047)	(0.015)	(0.009)
Imputed treatment effect	0.070*	0.047***	0.020***
	(0.039)	(0.009)	(0.005)
Panel B Synthetic control for all outcomes jointly			
Post*Treat	0.092*	0.033*	0.012
	(0.044)	(0.016)	(0.008)
Imputed treatment effect	0.101***	0.033***	0.012***
	(0.028)	(0.006)	(0.004)
N	284	282	290

Notes: This table shows the result from the difference in difference regression of our outcomes on interest in event countries (treated), compared to synthetic control countries. Panel A shows the results when the synthetic control matching is done for each event-country and outcome separately. Panel B shows the results when the synthetic control matching is done jointly on all outcomes (but still separately for each event-country). In practice we run the following regression: $Y_{it} = \beta^{DiD} * \mathbb{1}(j \geq 0)_t * D_i + \theta_t + \kappa_i + \pi_{Year(it)} + \epsilon_{it}$ Where, the β^{DiD} coefficient is the difference-in-difference estimate, representing the average treatment effect from period 0 through 10 post the trade liberalization event. We also present an additional difference-in-difference estimate proposed by Borusyak, Jaravel, and Spiess (2021). This estimate is imputed by first estimating country and time fixed effects, using non-treated countries as well as treated countries before their respective event. Those unit and year specific estimates are then used to impute the treatment effect for every treated country, and the imputed coefficient is then the average of the individual treatment effects. Due to the small sample size, we present wild bootstrap standard errors in parentheses (Cameron, Gelbach, and Miller, 2008), except for the imputed treatment effect according to Borusyak, Jaravel, and Spiess (2021), where we report the default standard errors produced by the Stata command *did_imputation*. * p<0.10 ** p<0.05 *** p<0.01.

Table A3: Weights in Synthetic Control for Trade Liberalization Events

Country	Event Year	Trade Openness	Weight	ETR_K	Weight	ETR_L	Weight	Reference
Argentina	1989	Bangladesh	97.3	% Bangladesh	41.6 %	Chile	35.9 %	Goldberg and Pavcnik (2006)
		United States	2.7 %	Haiti	14.1 %	Togo	31.6 %	
		.	.	Bolivia	13.4 %	Jordan	16.8 %	
		.	.	...	...	...	...	
Brazil	1988	Bangladesh	59.8 %	Jordan	35.7 %	Panama	25.7 %	Goldberg and Pavcnik (2006), Dix-Carneiro and Kovak (2017)
		United States	32.2	% Sudan	21.2 %	Guyana	21.7 %	
		Japan	6.1 %	Zimbabwe	12.7 %	Chile	14.5 %	
		...	...	...	...	...	...	
China	2001	United States	36.2 %	Congo	41.8 %	Kuwait	31.1 %	Brandt et al. (2006)
		Bangladesh	36.0 %	Nicaragua	26.3 %	Pakistan	22.9 %	
		Dominican Rep.	12.2 %	Gabon	14.2 %	Uganda	20.2 %	
		...	...	...	...	...	...	
Colombia	1985	Bangladesh	50.7 %	Kuwait	67.9 %	Paraguay	45.5 %	Goldberg and Pavcnik (2006; 2016)
		Iran	22.6 %	Gabon	14.6 %	Sudan	15.0 %	
		Guatemala	12.5 %	Sierra Leone	12.6 %	Cameroon	11.5 %	
		...	...	...	...	...	...	
India	1991	United States	76.4 %	Uganda	41.4 %	Lebanon	37.9 %	Goldberg and Pavcnik (2006, 2016); Topalova et al. (2009)
		Bangladesh	23.6 %	Bolivia	14.0 %	Oman	17.6 %	
		.	.	Haiti	4.6 %	Jordan	16.2 %	
		.	.	...	...	...	...	
Mexico	1985	Bangladesh	72.0 %	Sierra Leone	33.2 %	Tunisia	31.1	Feenstra and Hanson (1997); Goldberg and Pavcnik (2006, 2016)
		Uruguay	9.6 %	Bahrain	23.6 %	Zimbabwe	25.8 %	
		Spain	8.0 %	Bolivia	14.7 %	Uruguay	15.9 %	
		...	...	...	...	...	...	
Vietnam	2001	Thailand	42.4 %	Korea	45.8 %	Bangladesh	72.8 %	Goldberg and Pavcnik (2016), McCaig and Pavcnik (2018)
		Ghana	22.6 %	Luxembourg	19.2 %	Myanmar	22.6 %	
		Venezuela	21.7 %	Trinidad & Tob.	17.3 %	Haiti	4.6 %	
		...	...	...	...	.	.	

Notes: This table shows the seven treated countries and the three countries with the largest weight in the synthetic control group for each treated country and each outcome (trade, ETR_K, ETR_L). For each outcome, the pool of possible donor countries consists of 103 countries, with the exception of the trade variable, where we have only 90 countries with a balanced panel over the period considered. Note that the synthetic control method requires the panel of possible donor countries to be strictly balanced in all 'pre' periods that are used in the matching procedure. One additional restriction applies with respect to this sample. For the outcomes on trade and ETR_K, the extrapolation of Vietnam to the years 1991-93 lead to outlier values in those years, so we do not use these imputed values. This results in the panel for these outcomes to be slightly unbalanced in the years $t-10$ to $t-8$.

Table A4: First-Stage and Reduced Form Regressions

	1^{st}-stage	Reduced form		1^{st}-stage		Reduced form	
	Trade	ETR_K	ETR_L	Trade	Trade$*\mathbb{1}$(High-inc.)	ETR_K	ETR_L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Z^{Gravity}$	0.069***	0.007***	0.003***	0.046***	0.024**	-0.034***	-0.022***
	(0.010)	(0.002)	(0.001)	(0.014)	(0.012)	(0.010)	(0.007)
$Z^{Oil-Distance}$	-0.111***	-0.031***	-0.019***	-0.108***	-0.029*	0.007***	0.004***
	(0.035)	(0.008)	(0.005)	(0.014)	(0.015)	(0.002)	(0.001)
1^{st}-stage F-statistic	24.57			27.27	6.24		
1^{st}-stage Sanderson-Windmeijer Weak Instruments F-statistic	24.57			25.24	16.60		
1^{st}-stage Kleibergen-Paap F-statistic	24.57			9.67			
Sample	Developing countries only			Developing and developed countries			
N	4970	4970	4970	6536	6536	6536	6536

Notes: This regression table shows the first stage and the reduced form results that relate the two instruments $Z^{gravity}$ and $Z^{Oil-Distance}$ to trade and ETRs. Columns (1)-(3) focus on the sample of developing countries ($N = 4970$), and the remaining Columns (4)-(7) focus on the full sample of developing and developed countries ($N = 6536$). Trade is measured as the sum of exports and imports divided by NDP. Column (1) corresponds to the first-stage in developing countries, used in Tables 1-2-3. Columns (4)-(5) correspond to the first-stage in the full sample, which estimates heterogeneous effects by development level, and which is used in Table 4. We report several 1^{st}-stage statistics: the F-statistic of excluded instruments; the Sanderson-Windmeijer multivariate F-test of excluded instruments; and, the Kleibergen-Paap F-statistic. Note that in Column (1), where there is only one endogenous regressor, these three F-statistics are identical. In Columns (4)-(5), where there are two endogenous regressors, the F-statistics differ. Note also in Columns (4)-(5) that there is only one Kleibergen-Paap F-statistic, which evaluates the overall strength of the first-stage, even though there are two first-stage regressions. Columns (2)-(3) and (6)-(7) report the reduced form regressions of the instruments on the effective tax rates for capital, ETR_K, and labor, ETR_L, in developing countries and in the full sample, respectively. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Table A5: Robustness of Mechanism Results

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: CIT rate (first-diff.)						
Trade	-0.045**	-0.065**	-0.050**	-0.034*	-.048*	-0.021
	(0.021)	(0.030)	(0.025)	(0.019)	(0.025)	(0.036)
1^{st} stage K-P F-stat	40.45	25.98	28.81	52.99	47.50	10.33
N	3451	2855	3451	3451	3451	3451
Panel B: $log(1 + CITrate)$						
Trade	-0.034**	-0.049**	-0.062**	-0.027*	-0.036**	-0.024
	(0.015)	(0.022)	(0.026)	(0.013)	(0.018)	(0.020)
1^{st} stage K-P F-stat	40.45	25.98	28.81	52.99	47.50	10.33
N	3451	2855	3451	3451	3451	3451
Panel C: Corp. income						
Trade	0.211***	0.210***	0.180***	0.193***	0.183***	0.181**
	(0.037)	(0.046)	(0.043)	(0.044)	(0.044)	(0.090)
1^{st} stage K-P F-stat	25.05	14.24	23.09	34.83	45.17	10.80
N	4970	3984	4970	4970	4970	4970
Panel D: HH mixed income						
Trade	-0.212***	-0.175***	-0.194***	-0.201***	-0.191***	-0.212
	(0.041)	(0.041)	(0.039)	(0.038)	(0.041)	(0.218)
1^{st} stage K-P F-stat	25.05	14.24	23.09	34.83	45.17	10.80
N	4970	3984	4970	4970	4970	
Panel E: K share						
Trade	0.121***	0.112**	0.157***	0.170***	0.163***	0.111**
	(0.033)	(0.043)	(0.033)	(0.032)	(0.034)	(0.050)
1^{st} stage K-P F-stat	25.05	14.24	23.09	34.83	45.17	10.80
N	4970	3984	4970	4970	4970	4970
Panel F: Corp. ETR_K						
Trade	0.370*	0.496***	0.221**	0.400***	0.375***	0.380**
	(0.187)	(0.128)	(0.106)	(0.095)	(0.115)	(0.185)
1^{st} stage K-P F-stat	25.05	14.24	23.09	34.83	45.17	10.80
N	4970	3984	4970	4970	4970	4970
Modifications to IV in Panel B of Table 3	Remove GDP weights	Include country-year controls	Include **1**(oil-rich)*year fixed effects	Winsorize trade at 5%-95%	Only use $Z^{gravity}$ instrument	Only use $Z^{Oil-Dist}$ instrument

Notes: This table presents robustness checks for trade's impacts on mechanism outcomes in developing countries. Trade is measured as the sum of exports and imports divided by NDP. The outcome differs across panels, and the specification differs across columns: each cell is the coefficient from a separate IV regression. We report the 1^{st}-stage Kleibergen-Paap F-statistic separately for each IV regression. Panel A is the first-differenced corporate income tax (CIT) rate; Panel B is the log of $(1 + CITrate)$; Panel C is the corporate share of national income; Panel D is the mixed income share of national income; Panel E is the capital share of national income; Panel F is the average effective tax rate on corporate profits. Across columns, the specification varies from the benchmark IV (Panel B of Table 3): in Column (1), we remove the country-year NDP weights; in Column (2), we include the country-year controls described in Section 4.2.1; in Column (3), we include interactive fixed effects between a dummy for oil-rich countries and year dummies; in Column (4), we use the trade variable which is winsorized at the 5%-95% percentile on a yearly basis; and, in Columns (5)-(6), we estimate the IV using the individual instruments $Z^{gravity}$ and $Z^{Oil-Distance}$, respectively. For more details on the outcomes, see Section 2.1 and Section 5.1. For more details on the instrumental variables, see Section 4.2. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Table A6: Additional Heterogeneity Impacts of Trade

Heterogeneity H_c :	Small population (1)	Capital openness (2)
Panel A: CIT rate		
Trade	-0.061***	-0.053
	(0.017)	(0.036)
Trade$*H_c$	-0.059	-0.034
	(0.087)	(0.059)
Implied coef. for Trade in H_c	-0.120	-0.087**
	(0.083)	(0.038)
1^{st}-stage Kleibergen-Papp F-statistic	5.74	14.36
N	4069	4069
Panel B: ETR_K		
Trade	0.259**	0.549***
	(0.116)	(0.152)
Trade$*H_c$	-0.567	-0.581*
	(0.504)	(0.306)
Implied coef. for Trade in H_c	-0.308	-0.032
	(0.476)	(0.212)
1^{st}-stage Kleibergen-Papp F-statistic	6.93	8.34
N	6536	6536
Panel C: ETR_L		
Trade	0.153**	0.187
	(0.074)	(0.134)
Trade$*H_c$	0.316	0.137
	(0.328)	(0.230)
Implied coef. for Trade in H_c	0.470*	0.325**
	(0.282)	(0.130)
1^{st}-stage Kleibergen-Papp F-statistic	6.93	8.34
N	6536	6536

Notes: This table presents results from estimating heterogeneous effects of trade on outcomes in the full sample of developed and developing countries. Trade is measured as the sum of exports and imports divided by NDP. We estimate an IV similar to equation 8, but where the interaction term H_C changes to be an indicator for small population (Column 1), or an indicator for capital openness (Column 2). Small population takes a value of 1 if the country's population in 2018 was below 40 million. Capital openness takes a value of 1 if the country's average value of the Chinn-Ito index (Chinn and Ito, 2006) lies above the median value in all country-years. Both of these heterogeneity dimensions are therefore country-specific but time-invariant. The panels differ by outcome: Panel A) is the first-differenced corporate income tax rate; Panel B) is the effective tax rate on capital, ETR_K; Panel C) is the effective tax rate on labor, ETR_L. At the bottom of each column and panel, we report the implied coefficient and estimated standard error based on the linear combination of the $Trade$ and the $Trade$*H_c coefficients. We also report the 1^{st}-stage Kleibergen-Paap F-statistic. For more details on the IV, see Section 4.2 and 5.3. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level.

Appendix B Data & Construction of Effective Tax Rates

This appendix provides an overview of the data sources used to obtain disaggregated tax revenue and national income series (summarized in Table B1). These two components form the numerator and denominator of effective factor income tax rates. Additionally, we discuss the concepts that underpin our methodology.

B.1 Data sources

Tax revenue data Our tax revenue data draws from three key sources:

(i) **OECD online Government Revenue Statistics** (OECD, 2020): OECD revenue statistics take precedence in our data hierarchy as it contains all types of tax revenues already arranged in the OECD taxonomy of taxes. While it covers all OECD countries it only covers a subset of developing countries (29 countries), and typically only starting in the 2000s.

(ii) **ICTD Government Revenue Dataset** (ICTD/UNU-WIDER, 2020): ICTD data covers most developing countries, but only begins in the 1980s, at times does not separate income taxes into personal vs. corporate taxes, often misses social security contributions and payroll taxes, as well as subnational tax revenues.

(iii) **Archival data**: The main archival data collection corresponds to the digitization of the Government Documents section of the Lamont Library at Harvard University. For each country, we scanned, tabulated and unified official data from the public budget and national statistical yearbooks, to retrieve official tax revenue statistics. To complement hard-copy archival data, we retrieved countries' online datasets, usually published by their national statistical office or finance ministry. We filled some gaps using individual country studies detailing tax revenue collection which helped corroborate and harmonize levels and trends of tax revenue across sources. These sources and their harmonization are detailed country-by-country in a forthcoming case studies guide. We also used complementary sources, including offline archival IMF GFS (2005) covering the period 1972-1989, and additional scholarly sources. For social contributions, we relied on two complementary sources: the 'D61' statistic on social contributions in the household sector in UN SNA (1968) and UN SNA (2008), and data from Fisunoglu et al. (2011), who digitized offline IMF archives.

Constructing long panels of tax revenue series across sources required choices. We maintained the following rules, as guidelines to harmonize data across sources:

1. We first rely on the OECD data where it exists, then on the ICTD data if it provides a long time series and separates income taxes, and last on the archival data. We often need to combine sources to construct long time series but aim to use no more than two different data sources per country, with rare exceptions. If discrepancies arise across data sources when they are observed for the same country-year, we try to verify the accuracy of the source using scholarly sources.

2. We exclude from the data country-years under communist/command economies. In practice, this implies that our panel size jumps from 116 to 148 countries in 1994, and China and Russia first appear in the data then. The year 1994 a few years removed from the dissolution of the Soviet Union and arguably corresponds to China's establishment of a modern tax system (World Bank, 2008), which we discuss further in the text box below.

3. When none of the data source separate individual (PIT) vs corporate (CIT) income tax revenue (ascribes revenues to a generic total income tax), we turn to local scholarly sources that discuss the legislation to separate PIT from CIT.

4. In older data sources, social security contributions and payroll taxes are sometimes absent (especially in the ICTD data). We then use the complementary sources on social security contributions listed above.

5. To verify that we are not missing significant decentralized tax revenues, we use the recent OECD database on subnational government finance (link) to find the countries with significant state and local public finance revenue, and collected further data for these countries where necessary.

6. We linearly interpolate data when a given tax type is missing, in between observed values. However, we never interpolate more than four years without data during a time series and do not extrapolate beyond the observed values. We check for important regime change, political conflict, and other macroeconomic crises that could cast doubt on the continuity (and credibility) of tax revenue series, and we do not interpolate between years characterized by such events.

China's establishment of a modern tax system in 1994

Under the rules we establish here, we only include formerly communist economies into our data starting in 1994. Given China's weight in the global economy, it is worth reviewing the reason for that choice.

The tax revenue data for China covers most of our sample period although its quality improves markedly in the 1980s. (Official statistics are available online at https://data.stats.gov.cn/english/index.htm.) Prior to the 1980s, China had a command economy model of 'profit delivery,' in which the state directly received (and spent) the revenues of profitable SOEs, and subsidized unprofitable ones. As part of the decade of economic reforms beginning in 1978, a corporate income tax appears in China in 1983-84. A decree from the State Council in 1983 put a new 55% tax on the profits of enterprises, which were still almost entirely state-owned. Starting in 1985, we observe CIT revenue in the data, although it appears implausibly high (as a percentage of NDP, or of capital income). In addition, not long after, the tax system was further reformed into a 'fiscal contracting' system whereby firms negotiated a fixed tax payment (regardless of economic outcomes) to local governments, who in turn delivered a share to the central government. This system resembles a firm 'poll' tax, and subsumed all types of tax types, including CIT, VAT and payroll, making it impossible to assign taxes to capital or labor. For these reasons, we exclude this sort of 'pseudo'-CIT revenue dating from 1985 through 1993.

Rather, we consider that China's modern tax system began in 1994. The World Bank (2008) shows that, in 1994, China established for the first time a central tax administration; reformed the 'fiscal contracting' system; unified the PIT; created a VAT; and reduced 'extra budgetary' (non-tax) revenues. Thus from 1994 onward we can categorize tax revenue precisely by source, understand if they apply to capital or labor, and estimate meaningful ETRs.

National income (factor shares) data To compute factor shares of net domestic product, we combine two datasets from the United Nations Statistics Division. The first is the 2008 System of National Accounts (SNA) online data repository. The second is the 1968 SNA archival material. To our knowledge, this is the first dataset to harmonize the two national income reporting standards: the UN SNA (2008) online data with the UN SNA (1968) offline (archival) data. This allows us to expand our coverage of factor shares of national income, the denominator in effective tax rates. While the accounting frameworks slightly differ between the earlier UN SNA (1968) standard and the present UN SNA (2008) one (increased complexity), the key components of factor incomes can be harmonized.[27] Table B1 shows that we add substantial sample coverage by adding the historical SNA1968 data. yet, 'Complete' observations, which include a split of basic factor income concepts into 'compensation of employees' vs. 'operating surplus.' still only represent 56% of our sample of tax revenue data by country-year. To cover the remaining missing data, we follow the imputation procedure from Blanchet et al. (2021) in the World Inequality Data national income series.

When values for a national income component variable are missing after we harmonize the two UN data sources, we apply a simple imputation procedure. Blanchet et al. (2021), used to impute consumption of fixed capital (depreciation) when missing, in the World Inequality Data national income series. This is relevant in particular for mixed income (OS_{PUE}), which we model as a function of log national income per capita (at PPP), with a random effect to capture constant country characteristics:

$$OS_{PUE_{it}} = \beta_0 + \beta_1 NNIpc_{it} + u_i + \varepsilon_{it}$$

where u is the random-effect term for country i, and ε is the error term for country-year it. To account for persistence, we model the error term ε_{it} as an AR(1) process:

$$\varepsilon_{it} = \rho\varepsilon_{i,t-1} + \eta_{it}$$

where η_{it} is i.i.d. white noise. When we know part of the OS_{PUE} series for a given country (observing it in years before or after the missing year[s]), we estimate the country's random effect u_i and use it in the imputation. When no later value of

[27] Concepts of employee compensation and gross (or net) operating surplus are similar, but a new distinction in the later standard is the introduction of mixed income as distinct from imputed rent. Historically these concepts were subsumed under 'entrepreneurial income' of 'private unincorporated enterprises' in the household sector, and 'household operating surplus' was not considered separately. We used disaggregation in the later standard to fit the earlier standard, and impute the distinction between OS_{PUE} and OS_{HH} where necessary.

OS_{PUE} is observed, we assume $u_i = 0$. OS_{PUE} returns to its expected long-run value at a rate of ρ^t.

Mixed income is the most frequently missing national income component in the data, but when other components are missing, we run the same imputation procedure for those. Via imputations we generate estimates of factor shares for every country-year in which we have data on total national income.

Table B1: Main Data Sources

	country-year obs.	%
Panel A: Tax Revenue Data		
OECD	2866	42.3%
Harvard/archives	2681	39.3%
ICTD	1249	18.3%
N	*6816*	*100%*
Panel B: Factor Share Data		
SNA2008	2463	36.1%
SNA1968	1362	20.0%
composite/imputed	2991	43.9%
N	*6816*	*100%*

Notes: For the *N*=6816 country-year observations in which we estimate effective tax rates on capital and labor income, Panel A presents the sources our tax revenue data (on total revenues disaggregated by type of tax), while Panel B presents the sources of our factor share data (on national income components). In the former, we draw tax revenue data from sources including OECD (2020), ICTD/UNU-WIDER (2020), and IMF GFS (2005), as well as extensive archival research in the Harvard University Library, online sources, and IMF historical data. In the latter, we use online data from UN SNA (2008) and archival data from UN SNA (1968). 'Composite/imputed' refers to data that may draw from both UN SNA (1968) and UN SNA (2008) sources, and may have important national income components missing (especially the distinction between compensation of employees and corporate operating surplus; or the distinction between these and mixed income)—components which we would then impute using known information on current values of other variables, and earlier or later values of the same variables.

B.2 Construction of ETRs

By combining the disaggregated tax revenues and national income components data, we construct effective tax rates on capital and on labor (equations 1 and 2 in Section 2.1). Here we provide further details on the definitions of ETRs. Computing ETR_L and ETR_K requires the following information for country i, in year t:

$$ETR_L^{it} = \frac{T_L^{it}}{Y_L^{it}} = \frac{\lambda_{PIT}^{it} \cdot T_{1100}^{it} + \lambda_{soc.sec.} \cdot T_{2000}^{it}}{CE^{it} + \phi \cdot OS_{PUE}^{it}}$$

$$ETR_K^{it} = \frac{T_K^{it}}{Y_K^{it}} = \frac{(1-\lambda_{PIT}^{it}) \cdot T_{1100}^{it} + (1-\lambda_{CIT}) \cdot T_{1200}^{it} + (1-\lambda_{assets}) \cdot T_{4000}^{it}}{(1-\phi) \cdot OS_{PUE}^{it} + OS_{CORP}^{it} + OS_{HH}^{it}}$$

For each type of tax τ, there is a λ_τ allocation of the tax to labor (and $1-\lambda_\tau$ is the allocation to capital) - see Table B2. In our benchmark assignment, these allocations are time- and country-invariant for all types of taxes, except for the personal income taxes (λ_{PIT}^{it}) which we discuss in detail below. Further, in our benchmark assumption, we assume that the labor share of mixed income, ϕ, is fixed at $\phi = 75\%$ in all country-years (discussed in section 2.1 with further detail in the supplementary appendix). In robustness exercises we let ϕ vary at the country-year level, based on the country-year varying labor share in the corporate sector. In our benchmark assignment, replacing the invariant parameters with their fixed numerical values, we therefore have:

$$ETR_L^{it} = \frac{T_L^{it}}{Y_L^{it}} = \frac{\lambda_{PIT}^{it} \cdot T_{1100}^{it} + T_{2000}^{it}}{CE^{it} + 0.75 \cdot OS_{PUE}^{it}}$$

$$ETR_K^{it} = \frac{T_K^{it}}{Y_K^{it}} = \frac{(1-\lambda_{PIT}^{it}) \cdot T_{1100}^{it} + T_{1200}^{it} + T_{4000}^{it}}{0.25 \cdot OS_{PUE}^{it} + OS_{CORP}^{it} + OS_{HH}^{it}}$$

We describe the parameter values in detail in Table B2, both for the tax revenue numerator and the national income denominator. We finish by providing more details on two key parameters: λ_{PIT}, the share of personal income tax revenue assigned to labor; and ϕ, the labor share of mixed income.

Table B2: Main Tax Revenue and National Income Concepts

Panel A: Tax Revenue Concepts

	type of tax τ	incidence λ_τ on labor	notes
1100	personal income tax (PIT)	$70\% < \lambda_{PIT} < 100\%$	taxes on individuals (wages, capital income, capital gains). λ^{it}_{PIT} empirically computed and varies by country-year; see below for its estimation
1200	corporate income tax (CIT)	$\lambda_{CIT} = 0\%$	
2000 / 3000	social contributions & payroll taxes	$\lambda_{soc.sec.} = 100\%$	
4000	property & wealth taxes	$\lambda_{assets} = 0\%$	
5000	indirect taxes	excluded	includes taxes on goods and services, including tariffs and trade taxes, value-added taxes, sales taxes, excises, and other forms of consumption taxes and taxes on production—we consider these taxes as prior to factor income returns, such that they can be attributed proportional to factor incomes in the total economy, or (equivalently) excluded from consideration of factor income taxation
6000	other taxes	excluded	
7000	non-tax revenue	excluded	

Panel B: National Income Concepts

	national income component	allocation	notes
CE	compensation of employees	labor	includes wages and salaries, employer and employee social contributions, and all payments from employers to their employees
OS_{PUE}	mixed income	$\phi = 75\%$ labor	'operating surplus of private unincorporated enterprises' includes income from self-employment, household business owners, and informal or unincorporated enterprises
OS_{HH}	imputed rent	capital	'operating surplus of households' is imputed rental income accruing to homeowners who live in their own home
OS_{CORP}	corporate profits	capital	'operating surplus of corporations' includes all corporate income after paying employees and expenses, and can also be thought of as corporate-sector capital income
OS_{GOV}	government operating surplus	—	$OS_{GOV} = 0$, by construction
NIT	net indirect taxes	excluded (proportional)	'indirect taxes, net of subsidies' (closely related to τ_{5000}, above) usually comprise 8-15% of national income: assumed to be factor-neutral, i.e., levied on the returns to capital and labor proportional to each factor's share in the corresponding production process
NFI	net foreign income	—	we treat domestic income, without balancing the accounts to foreign earned income: most countries tax income earned domestically, regardless of citizenship, whereas net foreign income is taxed only with difficulty
CFC	depreciation	excluded	Y_K (and ETR_K) expressed net of 'consumption of fixed capital'

Labor share of personal income taxes: λ_{PIT} As discussed in Section 2.1, we rarely observe the level of PIT revenue that derives from capital income and gains versus labor income.[28] Thus, within personal income tax (PIT) revenues, an important parameter we need to estimate is the share of revenue assigned to labor, denoted λ_{PIT} (as in Table A1). In the United States, Piketty, Saez, and Zucman (2018) find that approximately 85% of PIT revenue is from labor and 15% from capital. To construct country-year specific λ_{PIT}, we start from the US benchmark ($\lambda_{PIT} = 85\%$), to which we make two country-year specific adjustments:

(a) First, the location of the PIT exemption threshold in the income distribution impacts λ_{PIT}, since the capital income share is higher for richer individuals. We retrieve PIT exemption thresholds from Jensen (2022). We assume that countries with a higher PIT exemption threshold have a higher λ_{PIT}. Since the US has a low exemption threshold and $\lambda_{PIT} = 85\%$, we similarly assign an 85% value to countries for which the PIT covers half or more of the population (high-income countries). For countries where the PIT covers 1% or less of the population, we assign a maximum capital share of 30%. For PIT thresholds with a coverage between 1 to 50% of the population, we do a linear extrapolation assigning a λ parameter between 70 and 85%.

(b) Second, we assume that countries where a dual PIT system is in place have a larger λ_{PIT}. Dual PIT systems set capital income taxation to a lower—often flat—rate, while labor income is taxed with progressive marginal tax rates. We compute the measure of the percent difference between the tax rate on dividends and the top marginal tax rate on labor income. Data on dividend vs wage income tax rates are taken from OECD Revenue Statistics and country-specific tax code documents. Since we only have dividend rates, we assume that 50% of capital income in PIT benefits from the lower rate (e.g., capital gains might not benefit). For this 50%, we multiply λ_{PIT} by the percent difference in dividend versus top marginal tax rates.

[28] The subtotal of PIT revenue from capital income includes: taxes on dividends; on the capital share of self-employment income; and on capital gains. OECD data on statutory income tax rates tell us about dual-income tax systems where the rate on dividends differs from the rate on salaries (used in our adjustments below). OECD (2020) revenue data occasionally reports on PIT revenue from capital gains. From 2010-18, among 27 countries that report some capital gains tax revenue within PIT revenue, this revenue averages just under 4% of PIT revenue. In the US, that number is 7.5%.

Labor share of mixed income: ϕ Section 2.1 notes the difficulty of estimating the labor share of mixed income (unincorporated enterprises). We assume a benchmark measure of $\phi = 75\%$, and set upper and lower bounds at: (i) $\phi = 100\%$, such that all mixed income is considered labor income; and (ii) $\phi_{it} = \frac{CE_{it}}{CE_{it}+OS_{CORPit}}$, which sets the labor share of mixed income equal to that of the corporate sector, at the country-year level.

Why might $\phi = 75\%$ represent an appropriate assumption for the labor share of unincorporated enterprises ...

As further robustness check, we implemented a method developed in ILO (2019)—first proposed by Gollin (2002)—to impute shadow wages to the self-employed. For each country-year and for three types of self-employed workers[29] for which data is available in ILO labor force surveys, we estimate what the self-employed workers would have earned in employee compensation, given their observable characteristics. Total labor income for a given country-year is then:

$$Y'_L = CE + \sum \frac{CE}{s_{emp}} \cdot \gamma_i s_i$$

where CE is the total compensation of employees in national accounts; s_{emp} is the share of employees in the workforce (whose collective earnings equal CE), such that $\frac{CE}{s_{emp}}$ is the average employee wage; and s_i denotes the share in the workforce of each type of self-employed worker. Each self-employment category i corresponds to a specific earnings coefficient γ_i relative to the average employee compensation.[30,31]

However, it is worth considering whether the ILO (2019) approach is appropriate for our work: In more than half of observations, we retrieved an implicit value of $\phi > 100\%$, i.e., an estimated labor share of mixed income greater than the value of mixed income (*including* its capital share) observed in SNA. In these cases, the method is actually revising national accounts values. If $\phi > 100\% \implies \sum \frac{CE}{s_{emp}} \cdot \gamma_i s_i > OS_{PUE}$, then to estimate Y'_L by simply adding the revised measure of self-employed income to compensation of employees (as in the equation above, and holding national income Y constant) is to revise downward the estimates of corporate operating surplus OS_{CORP} or imputed rent OS_{HH} (the non-OS_{PUE} ele-

[29]Three types: self-employed employers; own-account workers; and contributing family members.
[30]For country-years missing these concepts s_i and γ_i in raw ILOSTAT data—particularly for the era prior to 1991—we imputed observations using the same procedure as in Section B.1 above.
[31]Capital income $Y'_K = Y - Y'_L$

ments of capital income Y_K'). *A priori*, when $\phi > 100\%$, it is not clear that capital incomes OS_{CORP} or OS_{HH} would be the appropriate national accounting concepts to revise—as it would seem at least equally plausible that CE was overestimated.[32]

In any case, even when we used this alternative method to estimate ϕ, our results for the impact of trade on factor taxation remained robust.[33]

However, a version of the ILO (2019) approach may make some sense for China.

Mixed income in China and the US We make minor mixed-income adjustments to the benchmark series for China and for the United States. First, for China, we adjust our benchmark factor share estimates with an application of the above ILO (2019) method. This follows Piketty, Yang, and Zucman (2019), who show that for China in the UN SNA (2008) data, the income of many (self-employed) agricultural workers is attributed to employee compensation and not to mixed income (as it should be, and as in other countries). We refer to ILOSTAT data on the total share of employees vs. self-employed in the workforce. Given a share of employees that has never exceeded 55% (and was below 40% until 2003), we conclude that Chinese national accounts underestimate mixed income and overestimate compensation of employees. We thus revise our estimate of mixed income in China according to the ILO (2019) method described above, but subtract the corresponding increase from employee compensation, such that the sum of employee compensation and mixed income remains the same.

Second, for the United States, we use estimates of factor shares in NDP from Piketty, Saez, and Zucman (2018), who incorporate a granular treatment of mixed income to reflect the specificity of the US non-corporate business sector. In the US, some large businesses (including listed firms) are organized as partnerships (as opposed to corporations) and are classified as non-corporate businesses, while they would be treated as corporations in most other countries. Their income is counted as mixed income in the US National Income and Product Accounts, while it would be recorded as corporate profits elsewhere. Since 1986, a growing number of businesses are organized as partnerships for tax reasons. The series we use take these facts into account by: (i) assuming a higher capital share of income for

[32]Among statistical anomalies in SNA, that some self-employment income may be occasionally included among compensation of employees, would not be unprecedented (Guerriero, 2019).

[33]This is because, on average levels and trends, the *à la* ILO (2019) factor shares are not very different from those calculated with a benchmark $\phi = 75\%$ labor share of mixed income.

partnerships vs. other non-corporate businesses (sole proprietorships); and (ii) factoring in the rising capital intensity of partnerships since the 1980s.

Appendix C Trade Liberalization Event studies

C.1 Description of trade events

Our selection of trade events is determined by three criteria: (i) the event is related to measurable policy reforms; (ii) the policy reforms induced large changes in trade barriers; and (iii) the event has been studied in peer-reviewed academic publications. The first criterion improves the transparency of the event-study design, which rely on changes in outcomes around a well defined policy event. The second criterion increases the likelihood of observing sharp breaks in trend in our macroeconomic outcomes at the time of the event. The third criterion permit comparison to previous work, and to rely on prior the established positive effects of the reforms on cross-border trade.

Selection of events These criteria lead us to focus on the six trade liberalization events referenced in review articles by Goldberg and Pavcnik (2007) and Goldberg and Pavcnik (2016), GP henceforth, to which we add China's WTO accession event (studied in Brandt et al., 2017). These events all feature reductions in tariffs, the most commonly studied component of globalization, which is easier to measure consistently across space and time than other trade barriers. These events also reduced non-tariff barriers which are harder to measure (e.g. number of products subject to import licences and quotas). Fortunately, tariff and non-tariff barrier reductions seem highly correlated (Goldberg and Pavcnik, 2007).

All selected events feature very large cuts in tariff rates: since most of these countries did not participate in the early GATT/WTO negotiation rounds, their tariffs remained high prior to the events, such that reductions in tariffs remained an available policy lever. These trade liberalization events were drastic: Brazil cut tariff rates from 58.8 percent to 15.4 percent; India reduced rates from 80 percent to 39 percent; China reduced tariffs from 48% on average to 20%; Mexico reduced tariff rates from 23.5% to 11.8%, while import licence requirements went from covering 92.5% of national production to 25.4%; Colombia's tariffs were reduced from 27% to 10% and import requirements dropped from 72% of national production coverage to 1.1%. In the selected countries, "tariff reductions constitute a 'big part' of the globalization process" (Goldberg and Pavcnik, 2016). The timing of these events and references to papers which study the events in detail are provided in Table A3.

Timing of events Most studies discuss in detail the context surrounding the events. We reproduce the rationale cited for the liberalization events and discuss why these events could be exogenous to the country's economic context at the time.

- **Brazil** The liberalization event of 1988 is detailed in Dix-Carneiro and Kovak (2017). The authors note that the high pre-reform average level of tariffs was driven by large cross-industry variation in protectionism and that the reform was unexpected: "In an effort to increase transparency in trade policy, the government reduced tariff redundancy by cutting nominal tariffs... Liberalization effectively began when the newly elected administration suddenly and unexpectedly abolished the list of suspended import licences and removed nearly all of the remaining special customs regimes." (Dix-Carneiro and Kovak, 2017)

- **Columbia** Similarly to Brazil, tariff reductions in Colombia in 1985 were driven by the country's commitment to impose uniform rates across products and industries under the negotiation commitments to the WTO. In Colombia's case, Goldberg and Pavcnik (2007) note that the reform objective was to reduce cross-industry dispersion under WTO negotiations, thereby making "the endogeneity of trade policy changes less pronounced here [in Colombia] than in other studies."

- **China** Brandt et al. (2017) note that trade openness reforms had gradually been implemented in China prior to the country's WTO accession in 2001, but that the tariff reductions implemented upon accession were large, "less voluntary" and largely complied with the WTO accession agreements. Importantly, the potential accession to WTO contributed to the timing of privatization initiatives, in which the Chinese government restructured and reduced its ownership in state-owned enterprises. While the privatization efforts began in 1995 and were gradual, it is possible that additional sell-offs in the immediate post-WTO years contribute to the observed break in trends in our outcomes.

- **India** The 1991 event in India occurred as a result of an IMF intervention that dictated the pace and scope of the liberalization reforms. Under the IMF program, the tariff rates had to be harmonized across industries, which, like in Brazil and Colombia, led to a large average reduction in tariffs. Topalova and

Khandelwal (2011) provide an extensive discussion of the Indian reform, arguing that it "came as a surprise" and "was unanticipated by firms in India." The reforms were implemented quickly "as a sort of shock therapy with little debate or analysis." The IMF program was in response to India's balance of payment crisis, which was triggered by"the drop in remittances from Indian workers in the Middle East, the increase in oil prices due to the Gulf War, and political uncertainty following the assassination of Rajiv Gandhi".

- **Vietnam** The 2001 reform in Vietnam was implemented as a broad trade agreement that did not involve negotiations over specific tariffs (McCaig and Pavcnik, 2018). The reform was driven by the American government's decision to reclassify Vietnam from 'Column 2' of the US tariff schedule to the 'Normal Trade Relations' schedule. Column 2 was designed in the early 1950s for the 21 communist countries, including Vietnam, with whom the US did not have normal trading relations. McCaig and Pavcnik (2018) show that there are no differential trends between Vietnamese exports to the US relative to exports to other high-income countries. Vietnam's case is compelling since the liberalization even was triggered by a foreign party, rather than by its own government.

These descriptions of reform context do not argue that liberalization events were triggered by taxation. This narrative analysis complements the absence of pre-trends (Figure 5), and help alleviates endogenity concerns in the timing of events.

Post-event reforms Yet, even if the reform timing is uncorrelated with confounding trends, the interpretation of the event studies depends on whether other reforms and macroeconomic shocks occurred in the immediate post-reform years. The detailed review in (Goldberg and Pavcnik, 2007) is very helpful, as it notes major further events which followed the initial liberalization events. Argentina's 1989 event and Brazil's 1988 event were followed by accession to Mercosur in 1991; India's 1991 event was followed by foreign direct investment liberalization in 1993; and Mexico's 1985 WTO accession was followed by a removal of capital inflow restrictions in 1989.

Their discussion suggests that other reforms occurred, often a few years after the trade liberalization event; and, that these reforms reduced other non-tariff barriers.

Thus, while the immediate post-event impacts may more likely be attributed to trade liberalization, the medium-run impacts should be interpreted as the reduced-form effects of globalization more generally, which includes an increase in the flow of goods, services, and capital, as well as further policy responses.

C.2 Event study methodology

Sample Construction Our sample is constructed by applying a synthetic matching procedure to every treated country, for each outcome of interest. The donor pool (the set of all control countries from which to chose the synthetic control group) has to be fully balanced in all pre-event periods. Thus, we discard countries with data gaps pre-1976. This gives us a sample of 103 countries. We then pool together all seven treated countries and their synthetic control units.

Empirical Strategy Using this panel, we estimate the following event study:

$$Y_{it} = \sum_{j=-10, j\neq -1}^{10} \beta_j \cdot \mathbb{1}(j=t)_t \cdot D_i + \theta_t + \kappa_i + \pi_{Year(it)} + \epsilon_{it}$$

where θ_t and κ_i are, respectively, time relative to/from the event and country fixed effects, and $\pi_{Year(it)}$ are calendar year fixed effects. D_i is a dummy equal to one if i is a treated country. Hence, β_j captures the difference between treated and synthetic control countries across event time, with year t-1 as the reference period.

In addition to the event study regressions, we also use this setting to estimate a simple difference-in-difference coefficient:

$$Y_{it} = \beta^{DiD} \cdot \mathbb{1}(j \geq 0)_t \cdot D_i + \theta_t + \kappa_i + \pi_{Year(it)} + \epsilon_{it}$$

Here, μ^{DiD} can be interpreted as an average treatment effect over the first 10 years post treatment. We run both regressions—the event study and the DinD regression—on the set of main outcomes, and cluster standard errors at the country level. Statistical inference based on small sample size should be approached with caution (Abadie, Diamond, and Hainmueller, 2010): we also report standard errors from the wild bootstrap (Cameron, Gelbach, and Miller, 2008) in Table A2.

Moreover, we use the imputation method by Borusyak, Jaravel, and Spiess (2021) to report average treatment effects comparable to β^{DiD} with a technique that deals with issues with two-way fixed effects and heterogeneous event timing. The approach provides a transparent alternative method to the difference-in-difference equation specified above. The average treatment effect τ is calculated in three steps:

1. We use untreated countries as well as treated countries in the years before treatment, to estimate unit and (relative) year fixed effects:

$$Y_{it} = \theta_t + \kappa_i + \pi_{Year(it)} + \epsilon_{it}$$

   if $t < 0$ or $D_i = 0$. To bring us closer to the approach developed by Borusyak, Jaravel, and Spiess (2021), we include year and relative time fixed effects.

2. With the fitted values $\hat{\theta}_t$ and $\hat{\kappa}_i$, we now impute unit specific treatment effects:

$$\hat{\tau}_{it} = Y_{it} - \hat{\theta}_t - \hat{\kappa}_i - \hat{\pi}_{Year(it)}$$

3. The final step is to average over those coefficients to produce a treatment effect. We report unweighted averages, but heterogeneity in treatment effects could be accounted for by specifying weights.

Simultaneously Matching on Main Outcomes As we perform the synthetic matching procedure for each event and outcome based on the outcome, we have a different 'synthetic' control for each country in every outcome. This means that while the treated countries we use are always the same, the set of control countries contributing to the synthetic control varies across outcomes. We test that our results hold up with a more restrictive synthetic control. Specifically, we use our four main outcomes—trade (% of NDP); capital share of domestic product; and ETR_K and ETR_L—to predict one synthetic control group per treated country. This still allows us run separate regressions for each outcome, but with the same composition of the control group in each regression. Level and event study graphs for each outcome are shown in Figure A5. While the pre-trends are more pronounced for some outcomes, the treatment impacts remain similar to Figure 5 and suggest that our main findings do not hinge on the specific construction of our synthetic control.

Appendix D Instrumental variables for trade

In this section, we outline the construction of the two instrumental variables.[34]

Instrument based on quantitative trade models The first instrument leverages the structure of gravity models in general equilibrium. These models permit calibration of country pair-year-specific trade costs from trade data, relying on three key assumptions: (i) producers are perfectly competitive and make zero profits or charge a constant markup; (ii) trade costs take the iceberg form; and (iii) aggregate expenditure and its allocation across products are separable. These assumptions imply that bilateral consumption shares towards country j by consumers in country i in year t, denoted π_{ijt}, are multiplicative components that are exporter-year-specific (e_{jt}), importer-year-specific (ι_{it}) and pair-year-specific (β_{ijt}):

$$\pi_{ijt} = \quad e_{jt} \quad \times \quad \iota_{it} \quad \times \quad \beta_{ijt}$$

The component e_{jt} is proportional to country j's supply potential and captures production costs and gross-of-tax factor income—and might be influenced by both capital and labor taxation. The component ι_{it} depends on the consumer price index, which varies across years and countries.[35] β_{ijt} captures trade frictions across country-pairs and time.[36] The product of the normalized shares gives the bilateral fractions of importing-exporting country-pairs at a point in time:

$$\frac{\pi_{ijt}}{\pi_{iit}} \cdot \frac{\pi_{jit}}{\pi_{jjt}} = \beta_{ijt} \cdot \beta_{jit}$$

Finally, the sum of these costs measures total trade frictions for country i in year t, and constitutes the instrument:

$$Z_{it}^{gravity} = \sum_{j \neq i} [\beta_{ijt} \cdot \beta_{jit}]$$

[34] Both instruments are drawn from Egger, Nigai, and Strecker (2019), who provide further details.

[35] The intuition is that both e_{jt} and ι_{it} may capture country-year-specific factors, but the country pair-specific component β_{ijt} is free of any country-year specific factor.

[36] Egger, Nigai, and Strecker (2019) exploit the multiplicative model structure about π_{ijt} to recover measures of β_{ijt}. They assume that transaction costs between domestic sellers and customers are constant, such that $\beta_{iit} = 1$. Both the importer-year component and exporter-year components can then be eliminated by normalizing import and export trade shares by the importer and exporters' consumption from domestic sellers.

Note that all exporter-year and importer-year factors are removed from the instrument. This instrument is valid so long as the *distribution* of trade costs among country-pairs (not its level) is not influenced by changes in factor income shares or domestic factor taxation. Constructing this instrument requires data on country-pair trade flows: we use UN COMTRADE[37] to construct a large sample of bilateral consumption shares. First-stage regressions with $Z_{it}^{gravity}$ are shown in Table A4.

Instrument based on global oil prices & transport distances The second instrument exploits spatial heterogeneity across countries in a way that responds to oil price shocks. This instrument requires two parameters: global oil prices over time, and within-country transportation distances.[38] These distances vary when a country is far from a port, and when cities are far from one another.

We take the variance of oil price $p_t^{oil} \times$ distance d_i^k for city k, country i, year t:

$$Z_{it}^{pricedist} = \frac{1}{2}\sum_{k=1}^{3}[(p_t d_i^k - p_t \overline{d_i})^2]$$

This variance increases in countries whose main population centers are far from the nearest port *and* far from each other, which implies a larger shock to transportation costs in spread-out (and far from the port) countries than in countries with concentrated populations (and close to the port). It is this transportation-cost (iceberg) shock to trade that our instrument captures.[39]

This second instrument does not hinge on theoretical assumptions. Instead it relies on the assumption that the distribution of trade-costs induced by global oil price shocks is not correlated with contemporaneous changes in factor shares and tax revenues. First-stage results for $Z_{it}^{pricedist}$ are presented in Table A4.

[37] We augment our raw data from COMTRADE with data from Bustos and Yildirim (2022), whose team at Harvard University (2019) harmonized importer- and exporter-reported trade flows to expand the coverage and improve the precision of country-partner-year trade flow estimates. To our raw data download, we add any country-partner-year trade flow that is missing in ours but nonmissing in the dataset of Bustos and Yildirim (2022).

[38] For the former, we retrieve the OPEC Reference Basket benchmark world price of crude oil. For the latter, we measure road distances from the three largest cities (according to UN population statistics) to their nearest ports, using SeaRates international shipping logistics calculators.

[39] Alternatively, one could measure the variance in distance and then multiply it by the global price. The distribution of the variance instrument $Z_{it}^{pricedist}$ across country-years would not change; the only impact would be a level-shift in factor p. We consider the main approach to more closely capture the sensitivity of spatial concentration to shocks in transportation costs.

Appendix E Capital liberalization events

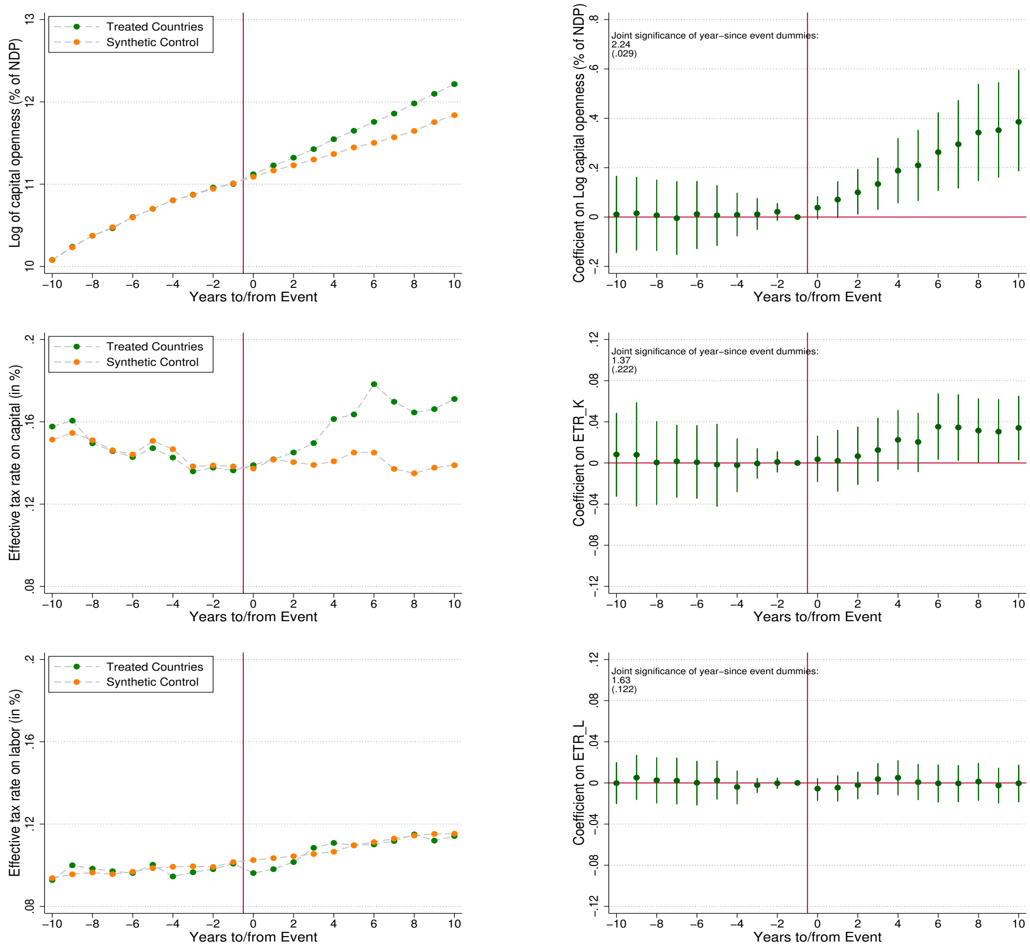
To attempt to investigate the impact of capital liberalization on factor taxation, we follow Chari, Henry, and Sasson (2012), who identify capital liberalization events in 25 developing countries, as the date when foreign investment in the domestic stock market is first allowed. They show that these events significantly expand foreign capital inflows, including foreign direct investment (FDI) and import of capital goods.[40] Compared to other policies aimed at lifting FDI restrictions, liberalizing the domestic stock market occurs at a precise point in time, is not marked by policy-reversal or net capital outflow, and, is unambiguously related to capital liberalization (Eichengreen, 2001). We employ the empirical design of Section 4 and create a synthetic control for each treated country and outcome of interest. We measure capital openness as the sum of foreign assets and liabilities divided by GDP (Gygli et al., 2019). Our measure of capital openness is the sum of foreign assets and liabilities, as a percent of GDP. We find similar results when using alternative measures of capital openness, including portfolio equity assets and liabilities (% of GDP) and the KOF financial globalization index (Gygli et al., 2019).

Figure D1 reports the results. Starting from a stable pre-trend, we observe a sustained rise in capital openness precisely at the time of the event. ETR_K also increases, with a few years lag relative to the event: in the medium-run, the effect is precisely estimated and significant at the 5% level. There is no discernible effect on ETR_L. Following a similar reason as for the trade tax-capacity mechanism, the foreign inflow of capital, as well as any subsequent increase in capital goods import and aggregate investment, may positively impact ETR_K by contributing to the growth of firms and/or by causing an expansion of income in initially larger firms. Consistent with this interpretation, we find that the capital liberalization events led to an increase in the corporate income-share and increased effective taxation of K inside the corporate sector (in results available upon request).

One important limitation is that the events considered here remove restrictions on capital *inflows* and are not informative of the impacts of increased capital *outflows*. In general, more work is needed to understand the determinants of policies which impact capital flows in developing countries and their effects on ETRs.

[40]FDI includes green field investments (building plants from scratch) and cross-border mergers and acquisitions (M&A). M&A is directly impacted by stock market liberalization, makes up 40-60% of FDI in developing countries, and may trigger subsequent green field investments.

Figure D1: Event Study of Capital Liberalization Reforms



Notes: These figures show event-studies for trade capital reforms in the 25 developing countries of Chari, Henry, and Sasson (2012). The panels correspond to different outcomes: capital openness; effective tax rate on capital; effective tax rate on labor. Capital openness is the log of total foreign assets and liabilities as a share of GDP. The left-hand graphs show the average level of the outcome in every year to (since) the event, for the treated countries and for the synthetic control countries. The right-hand graphs show the coefficients on the 'to' ('since') dummies, in a regression with fixed effects for countries; year 'to' ('since') event; and calendar years. The bars represent the 95% confidence intervals. Standard errors are clustered at the country level and estimated with the wild bootstrap method. The top-left corners report the F-statistic on joint significance of the post-reform dummies, with the p-value in parentheses below. Details are in Appendix E.

Appendix F Additional Analyses of Tax Capacity

F.1 Firm-Level Analysis in Rwanda

In this section, we investigate the relationship between trade exposure and the effective tax rate for formal firms in Rwanda.

Data Our analysis draws on three administrative data sources from Rwanda, accessible at the Rwanda Revenue Authority (RRA), for the years 2014-2016. These data-sources can be linked through unique tax identifiers for each firm, assigned by the RRA for the purpose of collecting customs, corporate income and value-added taxes. The first data-source is the customs records, which contains information on international trade transactions made in each year by each firm. We use this data to measure each firm's direct imports. The second data-source is the firms' corporate income tax declarations merged with the firm registry. These data contain detailed information on firms' profits, income and costs, as well as information on industry codes and geographical location. We use these data to measure firms' effective tax rate on profits. The third data-source is the business-to-business transactions database. These data are retrieved through the electronic billing machines (EBM) that all firms registered for VAT are legally required to install and use (Eissa and Zeitlin, 2014). For a given seller, EBMs record the transactions to each buyer identified by the tax firm-ID. We use this data to measure buyer-seller relationships.

When combined, these data allow us to construct the buyer-supplier relationship of the Rwandan formal economy and document firms' direct and indirect trade exposure. Importantly, since the network data is based on tax-IDs to link firms, this data-requirement implies that we cannot observe production linkages with informal, non-registered firms. Most recent studies on firm networks in developing countries also feature this sample selection on formal firms, by virtue of using tax-administrative data to build networks, including in Costa Rica (Alfaro-Urena et al.); Ecuador (Adao et al., 2022); Chile (Huneeus, 2020); Uganda (Almunia et al, 2021); Turkey (Demir et al., 2021); India (Gadenne et al., 2022).

Exposure to trade To measure a firm's total exposure to trade, we follow Dhyne et al. (2021) who use similar administrative data-sets as ours to measure trade exposure of Belgian firms. We define firm i's total foreign input share as the share of inputs that it directly imports (s_{Fi}), plus the share of inputs that it buys from its domestic suppliers j (s_{ji}), multiplied by the total import shares of those firms (s_{Fj}):

$$s_i^{Total} = s_{Fi} + \sum_{j \in Z_i^D} s_{ji} \left[s_{Fj} + \sum_{r \in Z_j^D} s_{rj} (s_{Fr} + ...) \right] \tag{9}$$

where Z_i^D is the set of domestic suppliers of firm i, and Z_j^D is the set of domestic suppliers of firm j. The denominator of the input shares is the sum of purchases from other firms and imports. Note that the definition of the total foreign input share in equation (9) is recursive: a firm's total foreign input share is the sum of its direct foreign input share and the share of its inputs from other firms, multiplied by those firms' total foreign input shares. We limit the calculation to the inputs from a firm's immediate suppliers j as well as the suppliers to their suppliers r (adding more network-levels only marginally increases s_i^{Total}). In other words, s_i^{Total} reflects the direct import share of firm i's suppliers and the suppliers' suppliers, each weighted by the share of inputs that each firm buys from other domestic firms. We focus on Rwandan firms' exposure to international imports through their supply network; a similar exercise can be conducted to measure the exposure to exports through the firm's client network.

Figure E1 displays a histogram of s_i^{Total} and s_{Fi} for all formal Rwandan firms. While under 30% of firms import directly, 93% rely on trade either directly or indirectly through suppliers which use foreign inputs in their production process. Indeed, most formal firms are heavily dependent on foreign trade, but only a limited number show that dependence through the direct foreign inputs observed in customs data: in the median firm, for example, the total foreign input share is 48% (compared to 39% for the median Belgian firm, Dhyne et al. (2021)).

We construct the corporate effective tax rate, following the methodology in Bachas, Brockmeyer, and Semelet (2020). This outcome corresponds to corporate ETR_i^K in equation (6). Almost all firms that pay corporate income tax are also registered for VAT. We can also include the effective tax rate for turnover-tax firms. Since only a limited number of these firms appear in the business-to-business transactions data, possibly due to their smaller structure and partially segmented networks (Gadenne, Nandi, and Rathelot, 2022), the inclusion of those firms does not meaningfully alter the results.

Impacts of trade exposure on ETR^K and size To visualize the association between trade and effective capital taxation, we follow the same methodology as in Section 3.4. Specifically, we plot binned scatters of the variables against each other, after residualizing both s^{Total} and ETR^K against year fixed effects. In Figure E2, the dots correspond to equal sized bins of the residualized trade exposure variable. The line corresponds to the best linear fit regression on the underlying firm-level data ($N = 9765$). Figure E2 reveals a positive and strongly significant association: firms that are more exposed to international trade, through both direct imports and through indirect links to importers in the production network, have higher effective taxes on corporate profits.

We investigate the robustness of this association in Panel A of Table E1, where we estimate regressions of the form

$$ETR^K_{itg} = \mu * s^{Total}_{it} + \Theta * X_{it} + \pi_t + \pi_g + \epsilon_{itg} \tag{10}$$

where ETR^K_{itg} and s^{Total}_{it} are corporate effective taxation and trade exposure of firm i in year t in industry-geography group g and π_t and π_g are fixed effects for year and industry-geography. The error, ϵ_{itg}, is clustered at the industry-geography level (robust to clustering at firm-level). Column 1 corresponds to the association in Figure E2. Column 2 adds interactive fixed effects between 20 industry categories and 279 geographical locations. In column 3, we add time-varying controls, including firm age, number of employees, and total number of clients and suppliers. In column 4, we leverage the panel-nature and include firm fixed effects; this leads to a drop in sample size from 9765 to 7051. The variation in trade exposure is now within-firm over time and can come, for example, from new linkages created with suppliers that import directly or themselves rely significantly on foreign inputs. In this column, we cluster the standard error at the firm level.

In column (5), we employ an instrumental variable that creates trade shocks from changes in world export supply of country-product combinations in which the firm had a previous import relationship. This strategy has been used in past studies, which argue that the shocks are plausibly exogenous and vary significantly across firms because firms do not have all inputs in common. Specifically, we follow the design in Dhyne et al. (2021) thats extend the shift-share approach of Hummels et al. (2014) to a setting with shock pass-through via network linkages. To construct the direct import shock for firm i, we use information about the firm's product-country-level imports in year $t-1$ (the share variable capturing firm-specific exposure) and the aggregate shift in world export supply for each country and product:

$$logM_{it}^{D} = log \sum_{k,c} s_{ic,t-1}^{k,M} * WES_{k,c,t} \tag{11}$$

where $s_{ic,t-1}^{k,M}$ is the share of imports of firm i in the initial year $t-1$ that falls on product k from country c, and $WES_{k,c,t}$ is the world export supply (excluding sales to Rwanda) of country c for product k. For firm i's suppliers, we construct the weighted average of their import shocks, using i's input share from each supplier in the previous year as the weights. We also construct the weighted average of the trade shocks of the suppliers to the suppliers of firm i, using the recursive formulation in equation (9). This gives us three instruments, namely import trade shocks direct to firm i, $logM_{it}^{D}$, as well as trade shocks to its suppliers, $logM_{it}^{S}$, and the suppliers to its suppliers, $logM_{it}^{SS}$. The 1^{st}-stage regression is then:

$$s_{it}^{Total} = \beta_1 logM_{it}^{D} + \beta_2 logM_{it}^{S} + \beta_3 logM_{it}^{SS} + \kappa_t + \kappa_g + \iota_{it} \tag{12}$$

and the 2^{nd}-stage is equation (10). Standard errors are clustered at the firm-level.

In Column 5, we find that increases in trade exposure, when instrumented by the import shocks, cause an increase in formal firms' effective tax rate on profits. The instruments are relevant, with a 1^{st}-stage Kleibergen-Paap F-statistic of 18.17.[41]

In Section 5, we argued that trade may positively impact ETR^{K} through its disproportionate effects on firms that are more productive, complex and larger. We investigate this in Panels B and C of Table E1. In Panel B, we find, across the various specifications including IV, that formal firms in Rwanda with greater exposure to international trade are larger in size. We proxy for size with total annual revenue. Panel C reveals a positive association between size and firms' effective corporate tax rate in the different specifications, though we cannot employ the IV strategy due to the exclusion restriction.

[41]Our results are robust to controlling for two additional types of trade shocks. First, we can control for shocks to the potential suppliers of firm i, defined as the set of firms that operate in the same industry and geographical area as i's current suppliers but that are not currently supplying to i. Second, we can control for shocks to firm i's horizontal suppliers, defined as the set of firms that are suppliers to firm i's current clients.

These firm-level findings are consistent with our tax-capacity prediction (Section 5) and country-level results (Tables 1-3), whereby trade increases ETR_K in developing countries by disproportionately benefiting larger, more productive firms where effective taxation is more easily enforced.

F.2 Type of Trade Analysis

In this sub-section, we study whether openness has differential impacts on effective tax rates and formalization-outcomes depending on the nature of the trade shock. As discussed in the main text, we use our two instruments to investigate the impacts of: (i) imports versus exports (of trade in both intermediate goods and services, G-S, and final G-S); (ii) trade in intermediate G-S versus final G-S (summed across imports and exports). We use UN's Broad Economic Categories (Rev.5) to classify final versus intermediate G-S, combining capital goods with the latter category.

For the imports versus exports IV analysis, the two 1^{st}-stage regressions are

$$log(imp_{it}) = \beta_1 * Z_{it}^{gravity} + \beta_2 * Z_{it}^{Oil-Distance} + \mu_i + \mu_t + \epsilon_{it}$$
$$log(exp_{it}) = \pi_1 * Z_{it}^{gravity} + \pi_2 * Z_{it}^{Oil-Distance} + \eta_i + \eta_t + \iota_{it}$$

where $log(imp_{it})$ and $log(exp_{it})$ are the logs of the ratio of total imports to NDP and total exports to NDP, respectively. We use the log-transformation for trade-components because it improves the strength of the 1^{st}-stage (results without logs are qualitatively similar, but less precisely estimated). The 2^{nd}-stage in the IV is

$$y_{it} = \theta_1 * log(imp_{it}) + \theta_2 * log(exp_{it}) + \kappa_i + \kappa_t + \phi_{it}$$

The set-up is similar for the second IV (intermediate G-S vs final G-S) where we replace $log(imp_{it})$ and $log(exp_{it})$ with logs of intermediate G-S import and export share of NDP and final G-S import and export trade share of NDP.

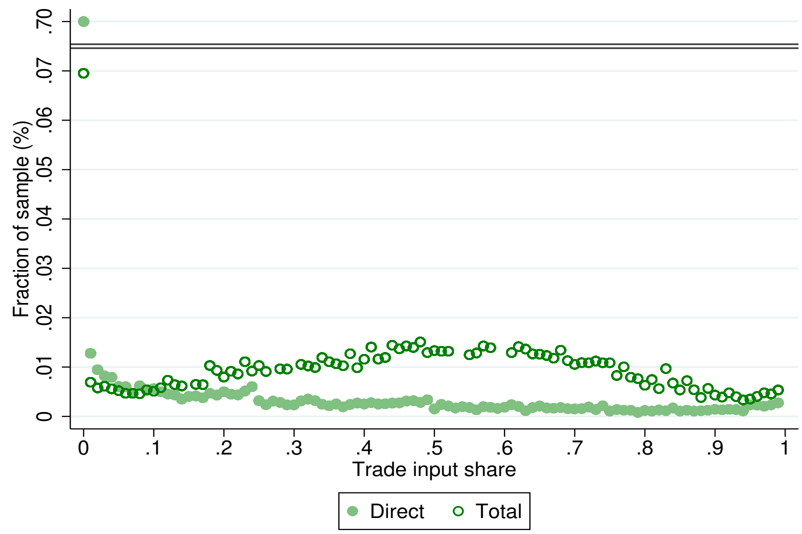
Two comments are in order. First, the two IVs might impact both imports and exports, and both trade in final G-S and intermediate G-S (Bergstrand and Egger, 2010). A priori, it is unclear if the instruments generate a strong overall first-stage: we gauge this by reporting the Kleibergen-Paap F-statistic. The Kleibergen-Paap F-statistics in Panel B of Table E2 are close to but below conventional levels. Given this challenge, we limit the scope of this exercise to studying whether the signs of the coefficients for the different types of trade are consistent with our simplified predictions (and whether they are statistically different from each other). Second, the exclusion restriction requires that the endogenous regressors always add up to total trade openness. Thus we cannot implement an IV which focuses on the impacts of final versus intermediate G-S for, say, imports exclusively. This also implies that, for a given outcome, the hypotheses in our two IVs (final versus intermediate G-S; imports versus exports) will be correlated. We accordingly adjust the p-values for multiple hypotheses testing using the Romano-Wolf method.

The IV results are reported in Panel A of Table E2, with 1^{st}-stage regressions in Panel B. Focusing on Panel A, Columns (1)-(2) show that exports cause an increase in ETR_K while imports decrease it; at the same time, trade in intermediate G-S increases ETR_K while trade in final G-S decreases ETR_K. In each IV, the coefficients imply a positive overall effect of trade openness on ETR_K even if the two trade-types had equal shares of GDP. In practice, many developing countries run trade surpluses (UNCTAD, 2014) and trade more in intermediate G-S than final G-S (Miroudot, Lanz, and Ragoussis, 2009). We can statistically reject that the different types of trade have the same impact on ETR_K. Similar patterns hold for ETR_L (Cols. 3 and 4). The remaining columns in Panel A uncover similar differential impacts on formalization-outcomes. Consistent with Melitz-style demand effects, exports cause a reallocation of output-share away from non-corporate income to corporate income (μ_C in equation 6), while imports lead to a decrease in the corporate income-share. Trade in intermediate G-S increases the corporate income-share while final G-S trade decreases it. Results are similar for the average corporate effective tax rate ($\overline{ETR}_C^K$ in equation 6).

Since we only have 2 instruments, a limitation of this exercise is that we cannot decisively conclude on the impacts for the four types of trade (intermediate imports, intermediate exports, final imports, final export). Notwithstanding, the signs of the four coefficients are consistent with imports of final G-S decreasing formality, and import of intermediate G-S increasing formality.

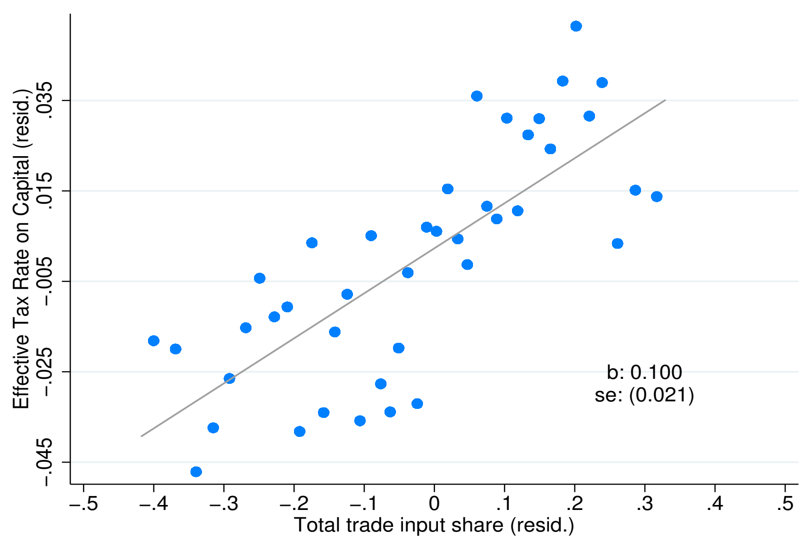
The 1^{st}-stages in Panel B reveal $Z^{Gravity}$ significantly predicts all types of trade, while $Z^{Oil-Dist}$ significantly predicts imports and intermediate G-S but not exports or final G-S. The Kleibergen-Paap overall first-stage statistics are 8.06 for import and export, and 8.90 for intermediate and final G-S. Thee Sanderson-Windmeijer weak instrument F-statistics are above conventional levels.

Figure E1: Rwandan Firms' Direct and Total Exposure to Trade in Imports



Notes: This figure shows the distribution of direct foreign input share, s_{Fi}, and total foreign input share, s_i^{Total}, for all formal firms in Rwanda between 2014 and 2016. The measures are calculated annually, and the histogram pools all firm-year observations. The horizontal line represent a scale break in the vertical axis. More details in Section F.1.

Figure E2: Total Trade Exposure and Corporate Effective Tax Rate



Notes: This graph shows the association between total foreign input share, s_i^{Total}, and the corporate effective tax rate, ETR_i^K. The graph plots binned scatters of the variables against each other, after residualizing both variables against year fixed effects. The dots correspond to equal sized bins of the residualized trade exposure variable. The line corresponds to the best linear fit regression on the underlying firm-level data ($N = 9765$), which is also reported in Column (1) of Table E1.

Table E1: Firm-Level Regressions in Rwanda: ETR^K, Trade and Size

	(1)	(2)	(3)	(4)	(5)
Panel A outcome: ETR^K					
S^{Total}	0.100***	0.087***	0.075***	0.025*	0.133**
	(0.021)	(0.017)	(0.017)	(0.014)	(0.060)
Panel B outcome: Log sales					
S^{Total}	1.362***	1.351**	1.078**	0.202*	1.444***
	(0.466)	(0.542)	(0.475)	(0.107)	(0.233)
Panel C outcome: ETR^K					
Log sales	0.040*	0.092***	0.077**	0.029***	-
	(0.023)	(0.029)	(0.027)	(0.003)	-
Estimation	OLS	OLS	OLS	OLS	IV
1^{st}-stage Kleibergen-Paap F-statistic					18.17
Year FEs	Y	Y	Y	Y	Y
Industry-Geography FEs		Y	Y		
Firm controls			Y	Y	
Firm FEs				Y	Y
N	9765	9600	9600	7051	6784

Notes: This table presents regression results from a sample of formal firms in Rwanda between 2014 and 2016. Outcomes differ across panels: Panels A) and C) is the effective tax rate on corporate profits, ETR^K; Panel B) is log of annual sales. In Panels A)-B), the reported regression coefficient is for total foreign input share, S^{Total}; in Panel C), it is for log annual sales. Columns (1)-(4) present OLS results from estimating variations of equation (10): Column (1) includes year fixed effects; Column (2) adds 279 industry-geography fixed effects; Column (3) adds firm-year controls (firm age, number of employees, and total number of clients and suppliers); Column (4) adds firm fixed effects. Column (5) is the IV estimation, where the total foreign input share (S^{Total}) is instrumented with trade-shocks to firms and their supplier network based on the shift-share design of Hummels et al. (2014). The instruments are described in detail in equation (11) and Section F.1. In Column (5), we also report the 1^{st}-stage Kleibergen-Paap F-statistic, from estimating the 1^{st}-stage in equation (12). * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the industry-geography level in Columns (1)-(3), and at the firm-level in Columns (4)-(5).

Table E2: Type of Trade Analysis in Developing Countries

Panel A: IV	ETR_K		ETR_L		Corporate Income		Mixed Income		Corporate ETR_K	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Export of G-S	0.509**		0.245*		0.271**		-0.197**		0.446**	
	(0.194)		(0.128)		(0.124)		(0.099)		(0.184)	
	[0.039]		[0.087]		[0.046]		[0.079]		[0.037]	
Import of G-S	-0.364***		-0.197***		-0.202***		0.100		-0.308**	
	(0.122)		(0.060)		(0.078)		(0.068)		(0.121)	
	[0.026]		[0.013]		[0.042]		[0.132]		[0.035]	
Intermediate G-S		0.378**		0.199**		0.236**		-0.177**		0.341**
		(0.152)		(0.089)		(0.093)		(0.087)		(0.140)
		[0.044]		[0.019]		[0.031]		[0.052]		[0.029]
Final G-S		-0.310***		-0.174**		-0.180***		0.098		-0.267***
		(0.107)		(0.068)		(0.066)		(0.064)		(0.079)
		[0.038]		[0.022]		[0.034]		[0.158]		[0.019]
F-test: Equality of coefficients [p-value]	8.12 [0.005]	7.27 [0.008]	5.56 [0.020]	5.75 [0.018]	5.74 [0.018]	7.09 [0.008]	3.38 [0.068]	3.39 [0.068]	6.59 [0.011]	7.86 [0.006]
N	4572	4572	4572	4572	4572	4572	4572	4572	4572	4572

Panel B: 1^{st}-stage	Import of G-S	Export of G-S	Intermediate G-S	Final G-S
	(1)	(2)	(3)	(4)
$Z^{Gravity}$	0.286***	0.275***	0.291***	0.311***
	(0.032)	(0.061)	(0.038)	(0.046)
$Z^{Oil-Distance}$	-0.103***	-0.016	-0.027	-0.126***
	(0.020)	(0.027)	(0.021)	(0.033)
1^{st}-stage F-statistic	82.25	21.15	49.42	63.00
1^{st}-stage Sanderson-Windmeijer Weak Instrument F-statistic	23.02	22.21	13.07	13.48
1^{st}-stage Kleibergen-Papp F statistic	8.06		8.90	
N	4572	4572	4572	4572

Notes: Panel A presents IV results, while Panel B presents 1^{st}-stage results. In Panel A: in odd-numbered columns, imports and exports are the endogenous regressors; in even-numbered columns, trade in intermediate goods and services (G-S) and trade in final G-S are the endogenous regressors. The outcomes differ across columns in Panel A: in Cols. (1)-(2), effective tax rate on capital, ETR_K; in Cols. (3)-(4), the effective tax rate on labor, ETR_L; in Cols. (5)-(6), the corporate share of national income; in Cols. (7)-(8), the mixed income share of national income; in Cols. (9)-(10), the average effective tax rate on corporate profits. For more details on the outcomes and the instruments, see Table 1 and Table 3. In brackets, we report the p-values which correct for multiple hypotheses testing, using the Romano-Wolf method. Multiple hypothesis testing is accounted for within each outcome between the two IV estimations (exports and imports; final G-S and intermediate G-S). At the bottom of each column in Panel A, we report the F-test for the equality of the reported coefficients. In Panel B, Cols. (1)-(2) correspond to the first-stage regression that instruments simultaneously for imports and exports; Cols. (3)-(4) is the first-stage regression which instruments simultaneously for intermediate G-S and final G-S. In Panel B, we report several $1st$-stage statistics: the F-statistic of excluded instruments; the Sanderson-Windmeer multivariate F-test of excluded instruments; and, the Kleibergen-Paap F-statistic. * p<0.10 ** p<0.05 *** p<0.01. Standard errors in parentheses are clustered at the country level. For more details, see Section F.2.

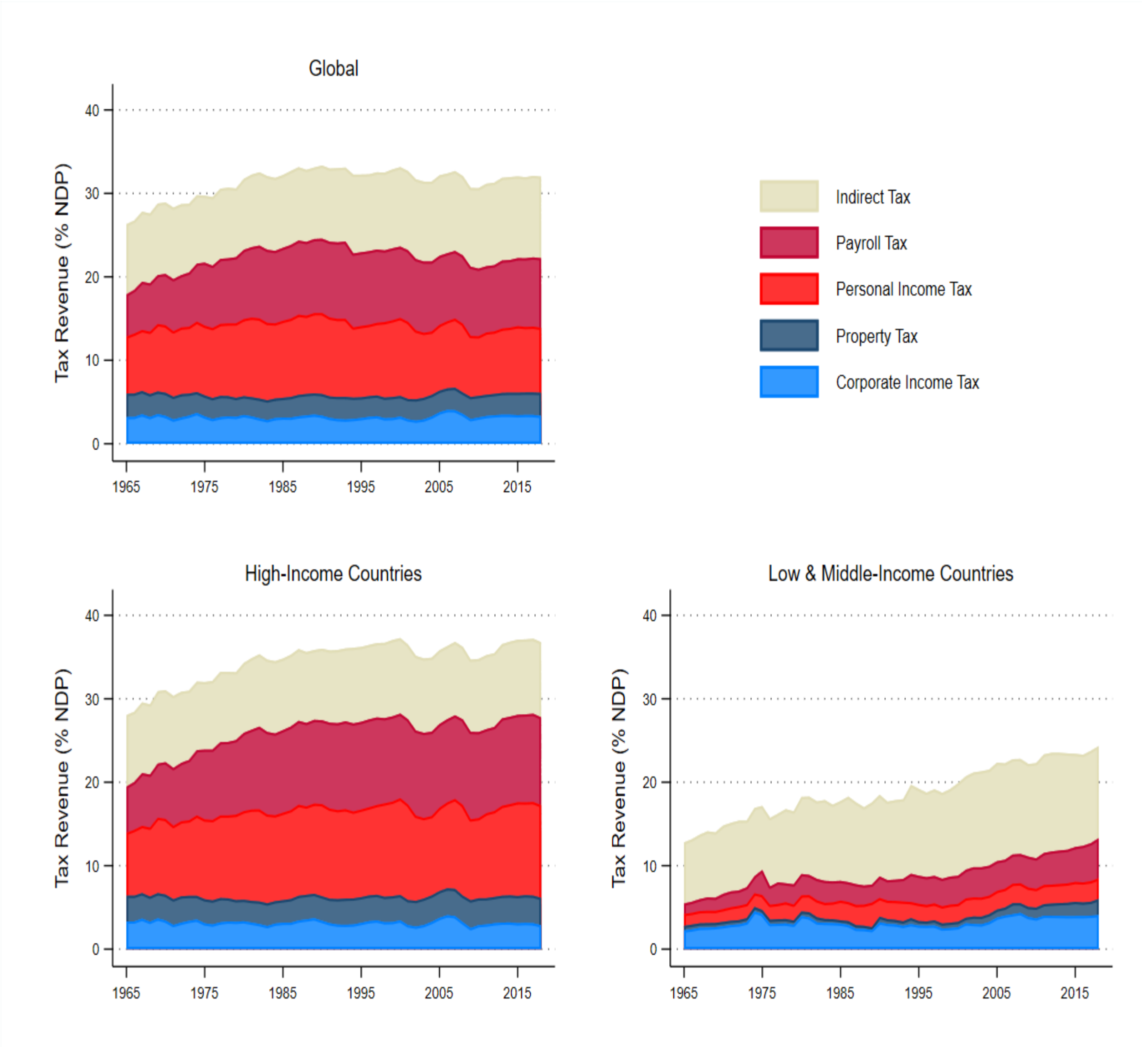
Appendix

Supplementary Online Appendix, Not for Publication
"Globalization and Factor Income Taxation"

by Pierre Bachas, Matthew-Fisher Post, Anders Jensen and Gabriel Zucman

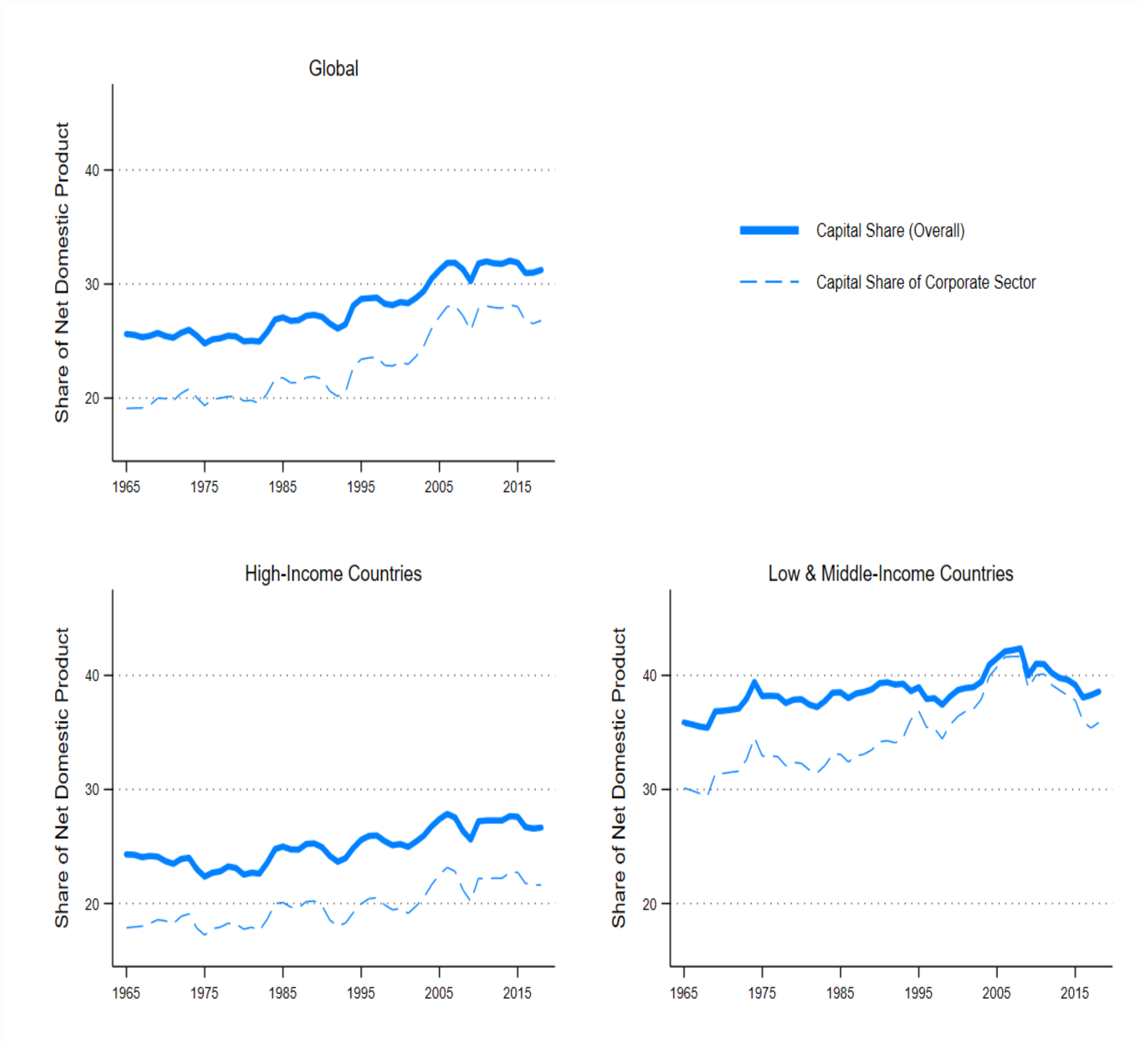
Additional Figures and Tables

Figure F1: Tax Revenue as a Share of Domestic Product



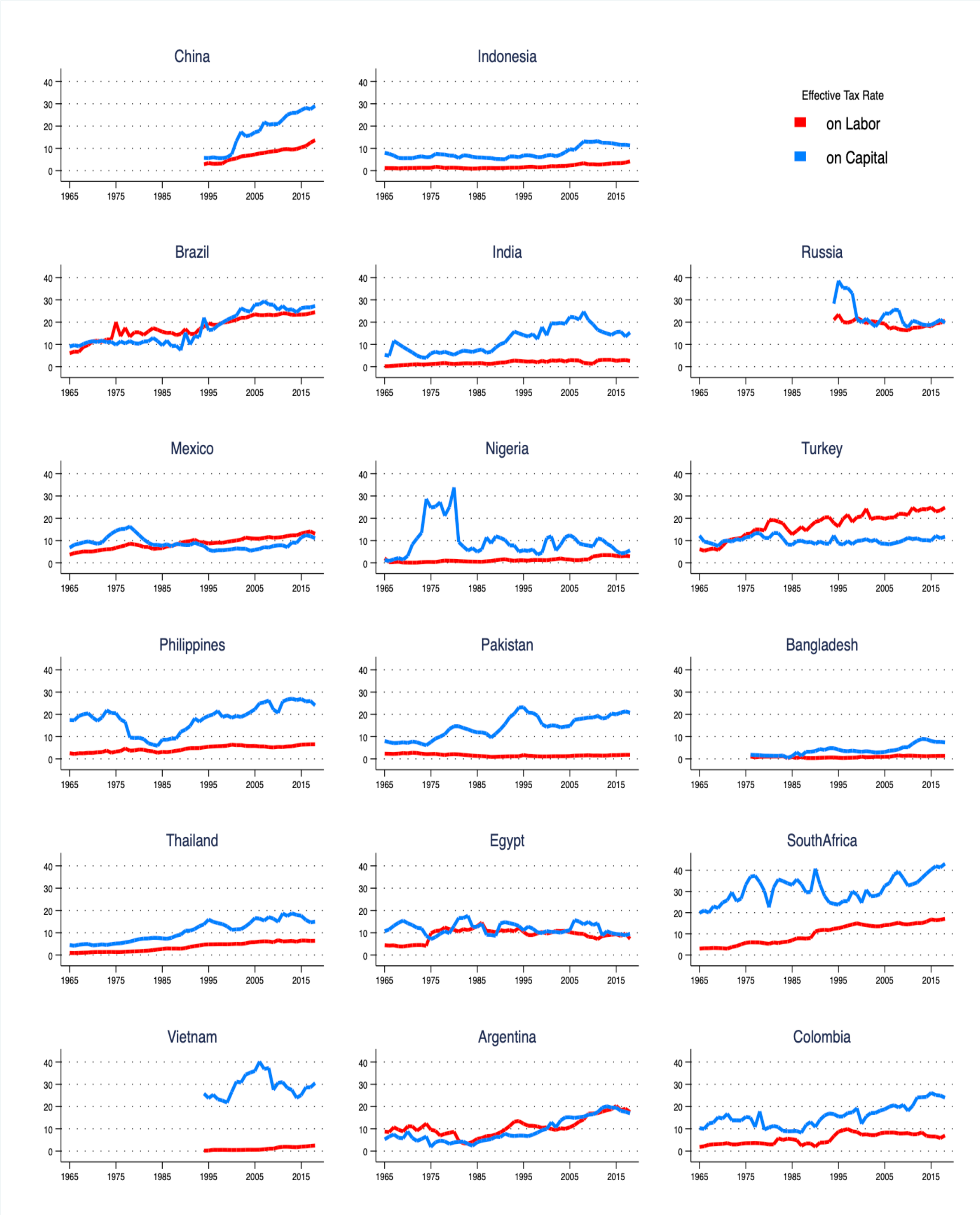
Notes: This figure plots the time series of tax revenue as a share of net domestic product (NDP), separated into five revenue sources. The top left panel corresponds to the global average, weighting country-year observations by their share in that year's total NDP, in constant 2019 USD (N=156). The bottom-left panel shows the results for high-income countries, and the bottom right for low- and middle-income countries. We consider as high-income all countries that meet the World Bank's classification of high-income in 2019. Tax revenues are separated into five main categories: indirect taxes (including domestic consumption taxes, excises, and tariffs), payroll taxes, taxes on personal income, taxes on property and wealth, and taxes on corporate income. The dataset is composed of two (quasi) balanced panels: the first covers the years 1965-1993 and excludes communist regimes. It accounts for 85-90% of World GDP during those years. The second, covers 1994-2018 and integrates former communist countries, and in particular China and Russia, and accounts for 98% of World GDP.

Figure F2: Capital Share of Domestic Product



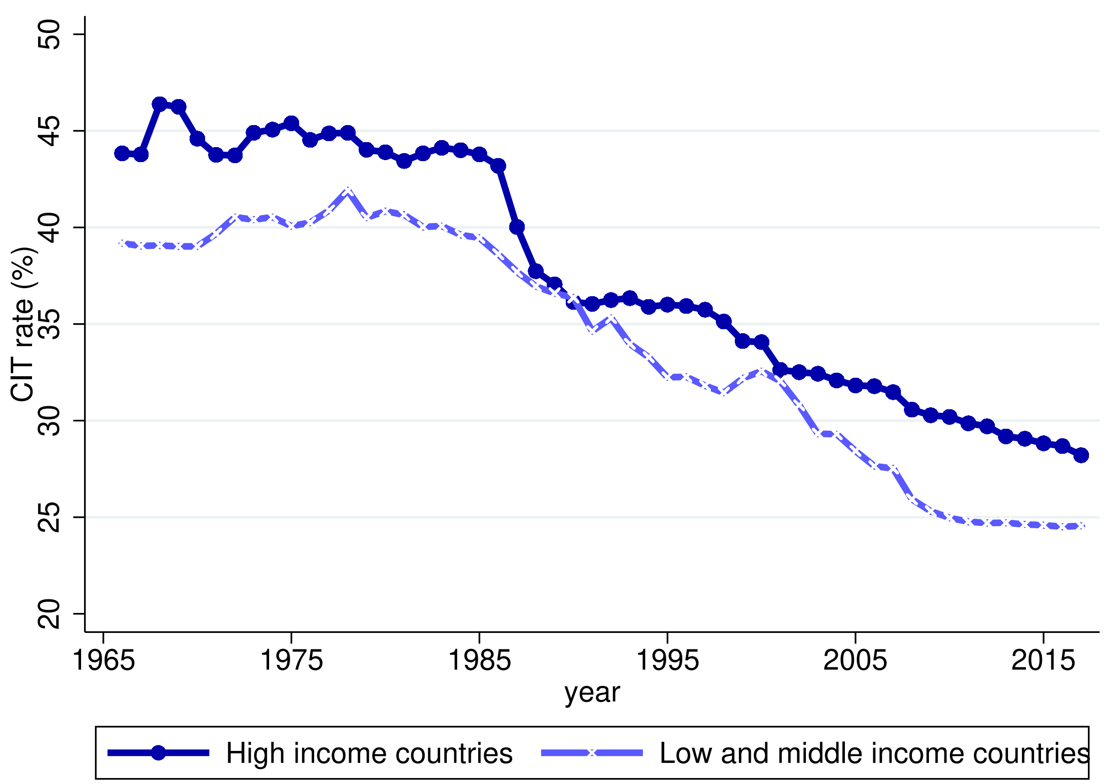
Notes: This figure plots the time series of the capital share as a percentage of net domestic product (NDP). The solid line corresponds to the overall capital share, and the dotted line to the capital share within the corporate sector. The top left panel corresponds to the global average, weighting country-year observations by their share in that year's total NDP, in constant 2019 USD (N=156). The bottom-left panel shows the results for high-income countries, and the bottom right for low- and middle-income countries. We consider as high-income all countries that meet the World Bank's classification of high-income in 2019. The dataset is composed of two (quasi) balanced panels: the first covers the years 1965-1993 and excludes communist regimes. It accounts for 85-90% of World GDP during those years. The second, covers 1994-2018 and integrates former communist countries, and in particular China and Russia, and accounts for 98% of World GDP.

Figure F3: Effective Tax Rates in the Largest Developing Countries



Notes: This figure shows the evolution of effective tax rates on labor and capital for the 17 largest low and middle income countries. Countries are displayed when they rank in the top 20 both in terms of population and GDP in 2018.

Figure F4: Trends in Corporate Income Tax Rates



Notes: This figure plot the time series of the statutory corporate income tax rate, separately for high income countries and for middle and low-income countries. Each line plots the year fixed effects from an OLS regression of the CIT rate on country and year fixed effects in the relevant sub-sample. The inclusion of country fixed effects helps alleviate the influence of countries entering and leaving the sample. The fixed effects are normalized to equal the level of the CIT rate in the relevant sub-sample in 1965. Country observations are weighted by their share in the year's total NDP in constant 2019 USD.