Evaluating Tax Harmonization

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ABSTRACT

Tax harmonization can address downward rate pressure due to tax competition, but does so by imposing a common rate that may not suit all governments. A second-order Taylor approximation yields the simple rule that tax rate harmonization advances collective government objectives only if tax competition reduces average tax rates by more than the standard deviation of observed tax rates. Consequently, any objective-maximizing harmonized tax rate must exceed the sum of the observed average tax rate and the standard deviation of tax rates. In 2020 the standard deviation of world corporate tax rates weighted by GDP was 4.5%, and the mean corporate tax rate 25.9%, so if competition sufficiently depresses tax rates then governments may find it attractive to harmonize at a corporate tax rate of 30.4% or higher. The minimum tax rate that most effectively advances collective objectives equals the average effect of tax competition plus the average tax rate in affected countries. Hence there are dominated regions: in the 2020 data, there is no degree of tax competition for which a world minimum corporate tax rate between 4% and 27% would be consistent with maximizing collective objectives.

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1. Introduction.

Concern over the effects of tax competition increasingly prompts calls for tax harmonization, minimum tax rules, or other agreements that would limit competition and reduce tax diversity. The most prominent and important recent example is the worldwide corporate minimum tax proposed by the OECD (2021) and approved in concept by more than 100 countries. Other longstanding efforts include tax coordination initiatives by the European Union and minimum tax proposals for subnational jurisdictions such as U.S. states. These initiatives and others reflect ongoing interest in coordinated responses to tax competition pressures.

Tax coordination can address downward rate pressure from tax competition, but does so at the cost of requiring governments to adhere to collective rules that may be insensitive to differences in the situations and needs of individual jurisdictions. Common coordination agreements require countries to relinquish at least a portion of their tax sovereignty in return for collective action to address tax competition. Minimum tax regimes are more flexible than complete harmonization, but nonetheless impose binding constraints on countries that otherwise would choose to impose low tax rates. Furthermore, effective enforcement of a minimum tax agreement may require adoption of rules preventing governments from differentiating their taxation in ways that they would otherwise choose to do, such as by offering favorable taxation of highly valued economic activities or those located in economically depressed regions.

There are many reasons why business tax rates differ between countries. Differences in the industrial composition and level of prevailing economic activity affect the perceived cost of business taxation and the relative attractiveness of alternatives to business taxes, including personal income taxes and VATs. Differences in income distribution and the likely incidence of business taxation will similarly influence choices among tax alternatives. The political appeal of taxing business income differs widely, including among countries with similar economies and income distributions but different national politics. And countries differ in the extent to which their tax choices are influenced by international competition. As a result of these and other factors, there is considerable dispersion in the rates at which business income is taxed.

The purpose of this paper is use observed tax differences to infer the extent to which harmonization initiatives would produce outcomes that are consistent with government objectives. A second-order Taylor approximation to government objective functions yields the simple rule that tax rate harmonization can advance collective government objectives only if the standard deviation of observed tax rates is less than the average amount by which competition reduces tax rates. This rule captures the reality that the diversity of political and economic considerations that determine tax rates in the absence of coordination makes it impossible for a single harmonized tax rate to conform to every government's desired tax policy – and the standard deviation measure reflects the second order nature of the cost of deviating from preferred tax rates. Given the multiplicity of preferred tax rates and effects of tax competition, it is striking that the criterion for objective-enhancing tax harmonization takes the form of a simple standard deviation.

The standard deviation rule emerges from comparing the outcome under uncoordinated taxation with that obtained by objective-maximizing tax harmonization. The common tax rate that maximizes aggregate government objectives is itself the sum of the average observed tax rate and the average amount by which tax competition depresses rates. Since tax harmonization maximizes aggregate government objectives only if tax competition reduces tax rates by more than their observed standard deviation, it follows that an objective-maximizing harmonized tax rate must exceed the average observed tax rate plus the standard deviation of observed tax rates. In 2020 the standard deviation of world corporate tax rates weighted by GDP was 4.5%, and the mean corporate tax rate 25.9%, so if there is an objective-maximizing harmonized corporate tax, its rate must lie above 30.4%.

Minimum tax regimes share many features of tax harmonization while avoiding some of the costs of enforced conformity for the portion of the sample that prefers tax rates above the required minimum. As a result, in a setting in which tax competition systematically reduces tax rates, there is very likely to be a minimum tax rate that advances collective objectives. Furthermore, for any given harmonized tax regime, there exists a minimum tax alternative that more readily advances collective objectives.

The minimum tax rate that most effectively advances collective objectives approximately equals the sum of the current average tax rate of affected jurisdictions – those for whom the minimum tax rate would be a binding constraint – and the average amount by which competition reduces tax rates for all jurisdictions. For example, a world 15% minimum corporate tax rate has the potential to maximize collective objectives if tax competition reduces average tax rates by 6% and the average tax rate of countries directly affected by the 15% minimum tax is 9% in the absence of a minimum tax. An important feature of this tax rate rule is that, depending on the distribution of observed tax rates, there may be multiple solutions for any given effect of tax competition on tax rates. In the previous example with tax competition reducing average tax rates by 6%, if the world instead imposed a minimum tax rate of 25%, and the average tax rates of countries directly affected by the 25% minimum tax rate were 19%, then a minimum tax of 25% also satisfies the condition for maximizing collective objectives.

More than one minimum tax rate can satisfy the same tax rule for maximizing collective objectives because minimum taxes directly affect only certain countries, those that would otherwise choose rates below the minimum. A minimum tax rate of 15% could advance collective objectives by requiring low-rate countries to impose at least 15% rates, even though a 20% minimum tax rate might do a much less good job, given how large a change would be required for very low-rate countries. In this scenario, if there are many countries with tax rates of 20% whose rates are depressed by tax competition, then it is possible that a world minimum tax of 25% would also advance collective objectives, notwithstanding the resulting significant impairment to the objectives of low-tax countries. The effect of a 25% minimum tax on collective objectives depends on how heavily the world weighs the potential gains from increasing the tax rates of countries that would otherwise choose rates of 20%, and requires a sufficient mass of these countries that these gains exceed the loss of objective satisfaction for low-rate countries. If there are enough countries with tax rates of 20%, then a 25% minimum tax rate may satisfy the same tax rate rule as a 15% rate while producing greater objective satisfaction. If this were the case, it would follow that there is a dominated rate of minimum tax rates, in that no tax rate between 15% and 25% would be consistent with maximizing objectives, regardless of the effect of tax competition on tax rates.

The distribution of world corporate tax rates in 2020 produces a wide range of dominated minimum tax rates. Weighting national tax rates and country outcomes by GDP, there is no tax competition scenario in which a world minimum tax rate between 4% and 27% is consistent with maximizing collective objectives. If tax competition depresses (GDP-weighted) average tax rates by less than 4%, then a minimum tax rate below 4% advances collective objectives, whereas if tax competition depresses average tax rates by 4% or more, then a minimum tax rate of 27% or higher maximizes collective objectives. Weighting countries by population instead of GDP produces a very similar range of dominated minimum tax rates.

While it is convenient to treat countries and states as though they impose scalar tax rates on all business income, the reality is that different business activities within the same jurisdiction are taxed at widely differing rates. The impact of a minimum tax rule or other potential harmonization measure depends, therefore, on exactly how the reform measure would treat these within-country differences. One possibility is that international tax harmonization or minimum taxation would simply require countries to modify their statutory tax rates without changing any of their other tax provisions – and the framework analyzed here directly addresses this scenario. If instead countries would be required to modify every aspect of their tax systems, then a more comprehensive analysis would be required, one that incorporates the additional costs that countries incur, from the standpoint of their national objectives, in complying with a requirement that they tax each of their business activities in a common fashion.

Minimum tax rules and other tax harmonization measures have the potential to address important concerns about the effects of tax competition. While harmonization measures may also affect opportunities that taxpayers have for tax avoidance, the fundamental function of tax harmonization or minimum taxation lies in their impact on competition. Countries could, if they wish, adopt strong unilateral measures to protect their tax bases,[1] including those contained in the OECD (2021) blueprint – but countries that might otherwise be inclined are deterred from doing so on a unilateral basis out of concern for their anticompetitive effects, as well as reactions from other countries and the domestic politics of deviating from world norms. This is why it is important to consider tax harmonization and minimum taxation in the context of tax competition.

This paper analyzes international business taxation, but the second order Taylor approximation that is the basis of the analysis appears to apply more generally to any competitive context. This includes subnational taxation and many other government policies with competitive implications, such as environmental and other business regulations, minimum

[1] See, for example, Dharmapala (2021).

wages, school curricula, and others. The extent to which harmonizing any of these policies is consistent with advancing collective objectives should be a function of the standard deviation of the policies that jurisdictions choose when left on their own – and common minimum requirements may have the feature that there are broad ranges of dominated rates, as there are with business taxes.

2. Tax Harmonization and Government Objectives.

This section considers a setting in which each country's government chooses its corporate tax rate while balancing economic and political considerations that include not only the economic costs of different taxes, and its preferred distribution of tax burdens between business and individual taxes, but also competition with other governments. These economic and political preferences can be summarized by a function of a country *i*'s own tax rate and the tax rates of other countries, or equivalently, a function $O_i\left(\tau_i, d_i\right)$ of country *i*'s own tax rate τ_i and the difference $d_i = \tau_i - \overline{\tau}$ between country *i*'s tax rate and the weighted average tax rate of all countries $\overline{\tau} = \sum \tau_i v_i$, with $\sum v_i = 1$. The weights used to construct $\overline{\tau}$ reflect the relative importance of the tax rates of different countries; these weights might vary with GDP or other measures of relative size, but they need not, and might indeed all be equal. Importantly, the relevant weighted average tax rate is taken to be the same for all countries, a specification that entails common weights v_i and excludes the possibility that governments compare their tax rates to others chosen on idiosyncratic bases such as geographic or characteristic proximity. For analytical convenience, $O_i\left(\tau_i, d_i\right)$ is taken to be continuous and twice continuously differentiable in its arguments, with higher values of $O_i\left(\tau_i, d_i\right)$ corresponding to greater satisfaction of government objectives.

2.1. An approximation.

It is useful to consider the tax rate that maximizes country *i*'s objectives in the absence of international tax differences, and to denote this tax rate by τ_i^*, chosen so that

$O_i(\tau_i^*, 0) \geq O_i(\tilde{\tau}_i, 0), \forall \tilde{\tau}_i$. The tax rate τ_i^* is that which the government of country *i* would choose to maximize its objectives if it knew that it were a Stackelberg leader that all other countries would follow exactly. In this sense, τ_i^* is the tax rate that country *i* would choose in the absence of international competition, and reflects domestic considerations such as desire for economic development and preferences over the distribution of tax burdens.

In practice, most countries do not impose tax rates that they would select in the absence of international competition; and tax rates certainly differ. Country *i*'s objective level $O_i(\tau_i, d_i)$ can be evaluated using a Taylor expansion around $O_i(\tau_i^*, 0)$, the second-order approximation of which is

(1)

$$O_i(\tau_i, d_i) \approx O_i(\tau_i^*, 0) + (\tau_i - \tau_i^*)\gamma_{0i} - (\tau_i - \tau_i^*)^2 \gamma_{1i} - (\tau_i - \overline{\tau})\gamma_{2i} - (\tau_i - \overline{\tau})^2 \gamma_{3i} - (\tau_i - \tau_i^*)(\tau_i - \overline{\tau})\gamma_{4i},$$

with $\gamma_{0i} = \frac{\partial O_i(\tau_i^*, 0)}{\partial \tau_i}$, $\gamma_{1i} = \frac{-1}{2}\frac{\partial^2 O_i(\tau_i^*, 0)}{\partial \tau_i^2}$, $\gamma_{2i} = \frac{-\partial O_i(\tau_i^*, 0)}{\partial d_i}$, $\gamma_{3i} = \frac{-1}{2}\frac{\partial^2 O_i(\tau_i^*, 0)}{\partial d_i^2}$, and

$\gamma_{4i} = \frac{-\partial^2 O_i(\tau_i^*, 0)}{\partial \tau_i \partial d_i}$.

Since τ_i^* is the objective-maximizing tax rate in the absence of tax differences, it follows that $\frac{\partial O_i(\tau_i^*, 0)}{\partial \tau_i} = \gamma_{0i} = 0$; and since τ_i^* corresponds to a maximum it must be the case that $\frac{-1}{2}\frac{\partial^2 O_i(\tau_i^*, 0)}{\partial \tau_i^2} = \gamma_{1i} > 0$. The sign of γ_{2i} depends on how country *i* evaluates differences in world average tax rates, holding its own tax rate constant – if, as is commonly assumed to be the case in models of tax competition, a country feels that it is costly to have a tax rate exceeding the world average, and beneficial to have one below the world average, then $\gamma_{2i} > 0$. Alternatively, a country may feel that it benefits from the opportunities created by lower foreign tax rates, and is hurt by higher foreign taxes, in which case $\gamma_{2i} < 0$; and the sign of γ_{2i} may differ between countries. Similarly, models of tax competition commonly assume that there are convex costs of deviating from world average tax rates, which implies that $\gamma_{3i} > 0$; but it is also entirely possible that $\gamma_{3i} < 0$, particularly for countries with lower than average tax rates. Tax competition theory currently has little to say about the sign of γ_{4i}. Consequently, it is reasonable to expect the coefficients γ_{1i}, γ_{2i}, γ_{3i}, and γ_{4i} all to be positive, though with declining certainty: it is clear that $\gamma_{1i} > 0$, and likely that $\gamma_{2i} > 0$, whereas the signs of γ_{3i} and γ_{4i} are far less certain.

The second-order Taylor expansion in (1) approximates country *i*'s objectives. This approximation focuses on the structure of country objectives in a way that facilitates drawing useful inferences, but does so at the cost of restricting the validity of the findings to settings in which the approximation does not mislead. In many cases the first- and second-order terms in (1) will capture the salient features of tax rate differences, and there is little if any empirical evidence that higher-order terms significantly influence country objectives or tax rate determination.

2.2. Implications for tax rate choice.

If countries choose tax rates that advance their own objectives, and equation (1) accurately represents these objectives, then it should be the case that their tax rates maximize (1). Taking this to be the case,[2] and assuming that countries ignore their own effects on the tax rates of others and the world average tax rate, it follows that countries perceive the welfare effect of their own tax changes to be

$$(2) \qquad \frac{\partial O_i\left(\tau_i, d_i\right)}{\partial \tau_i} = 2\gamma_{1i}\left(\tau_i^* - \tau_i\right) - \gamma_{2i} + 2\gamma_{3i}\left(\overline{\tau} - \tau_i\right) + \gamma_{4i}\left(\overline{\tau} + \tau_i^* - 2\tau_i\right).$$

Setting (2) equal to zero yields the implied objective-maximizing tax rate[3]

[2] While the linearity of differentiation implies that the derivative of a function equals the derivative of its Taylor expansion, there are circumstances in which a second-order Taylor expansion closely approximates the value of a function without the derivative of the second-order expansion closely approximating the function's derivative. The derivation of (3) assumes that restricting attention to the first- and second-order expansion terms produces valid approximations not only for the value of the function but also for its derivative.
[3] The second-order condition for maximization is that the derivative of the right side of (2) is negative, which requires $\gamma_{1i} + \gamma_{3i} + \gamma_{4i} > 0$.

(3) $$\tau_i = \frac{\left(\gamma_{1i} + \frac{\gamma_{4i}}{2}\right)\tau_i^* - \frac{\gamma_{2i}}{2} + \left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right)\overline{\tau}}{\gamma_{1i} + \gamma_{3i} + \gamma_{4i}}.$$

With the second-order condition for maximization implying that the denominator of the right side of (3) is positive, the comparative statics associated with terms in the numerator of (3) are largely intuitive. The parameter γ_{2i} captures the perceived cost of differences between a country's tax rate and the world average, and as a result, higher values of γ_{2i} are associated with lower tax rates. It follows from the first term in the numerator of (3) that higher values of τ_i^*, the objective-maximizing tax rate in the absence of international tax differences, are associated with higher observed tax rates, and thus $\frac{\partial \tau_i}{\partial \tau_i^*} > 0$, as long as $\gamma_{1i} + \frac{\gamma_{4i}}{2} > 0$. The strategic element of international tax setting appears in the third term of the numerator, where a positive value of $\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right)$ implies that tax rates are strategic complements, with $\frac{\partial \tau_i}{\partial \overline{\tau}} > 0$, and a negative value would imply that they are strategic substitutes. While strategic complementarity – a country reacting to tax cuts elsewhere by reducing its own tax rate – is a common feature of tax competition models, it is far from guaranteed to be the case, and indeed there are important cases in which tax rates will be strategic substitutes. Furthermore, a system consisting of countries all with the same properties as *i* is stable only if $\frac{\partial \tau_i}{\partial \overline{\tau}} < 1$, which implies that $\gamma_{1i} + \frac{\gamma_{4i}}{2} > 0$ and therefore $\frac{\partial \tau_i}{\partial \tau_i^*} > 0$. It is a noteworthy feature of (3) that $\frac{\partial \tau_i}{\partial \tau_i^*} + \frac{\partial \tau_i}{\partial \overline{\tau}} = 1$, so $\frac{\partial \tau_i}{\partial \tau_i^*} = 1 - \frac{\partial \tau_i}{\partial \overline{\tau}}$. Finally, Equation (3) also carries the implication that

(4) $$\tau_i^* = \tau_i + \frac{\left(\tau_i - \overline{\tau}\right)\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) + \frac{\gamma_{2i}}{2}}{\gamma_{1i} + \frac{\gamma_{4i}}{2}}.$$

2.3. Aggregate objective satisfaction.

One consequence of country differences in preferred tax rates and perceived costs of deviating from the world average tax rate is that any harmonization effort is apt to further the objectives of some while thwarting the objectives of others. An overall assessment of the consistency of tax harmonization with national objectives therefore requires a method of aggregating outcome assessments from the standpoint of national governments. A natural aggregation is to take a weighted sum of national objectives, with weights w_i reflecting collective assessment of the relative importance of advancing the objectives of different governments. Denoting this weighted sum by *S*, it follows that

$$S = \sum O_i\left(\tau_i, d_i\right) w_i \,. \tag{5}$$

Together, equations (1) and (4) imply that

$$\begin{aligned} S \approx\ & \sum O_i\left(\tau_i^*, 0\right) w_i - \sum \tau_i^{*2} \gamma_{1i} w_i - \sum \tau_i^2 \gamma_{1i} w_i + 2\sum \tau_i^2 \gamma_{1i} w_i \\ & + 2\sum \frac{\tau_i \left[\left(\tau_i - \overline{\tau}\right)\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) + \frac{\gamma_{2i}}{2} \right] \gamma_{1i}}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} w_i - \sum \left(\tau_i - \overline{\tau}\right) \gamma_{2i} w_i - \sum \tau_i^2 \gamma_{3i} w_i \\ & + 2\overline{\tau} \sum \tau_i \gamma_{3i} w_i - \overline{\tau}^2 \sum \gamma_{3i} w_i + \sum \frac{\left(\tau_i - \overline{\tau}\right) \left[\left(\tau_i - \overline{\tau}\right)\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) + \frac{\gamma_{2i}}{2} \right] \gamma_{4i}}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} w_i \end{aligned} \quad . \tag{6}$$

Collecting terms and simplifying, (6) becomes

$$\begin{aligned} S \approx\ & \sum O_i\left(\tau_i^*, 0\right) w_i - \sum \tau_i^{*2} \gamma_{1i} w_i + \sum \tau_i^2 \left(\gamma_{1i} + \gamma_{3i} + \gamma_{4i}\right) w_i + \overline{\tau} \sum \frac{\gamma_{2i} \gamma_{1i}}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} w_i \\ & - \overline{\tau}^2 \sum \gamma_{3i} w_i - \overline{\tau} \sum \tau_i \gamma_{4i} w_i - \sum \frac{\overline{\tau}\left(\tau_i - \overline{\tau}\right)\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) \gamma_{4i}}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} w_i \end{aligned} \quad . \tag{7}$$

2.3. Tax harmonization.

An important alternative to independent tax setting is for all countries to harmonize their taxes at a common rate. A system of tax harmonization at tax rate τ_h yields aggregate objective satisfaction of

(8) $$H \approx \sum O_i\left(\tau_i^*, 0\right) w_i - \sum \left(\tau_i^* - \tau_h\right)^2 \gamma_{1i} w_i \ .$$

The first order condition corresponding to maximizing (8) implies that the objective-maximizing harmonized tax rate τ_h^* is

(9) $$\tau_h^* = \frac{\sum \tau_i^* \gamma_{1i} w_i}{\sum \gamma_{1i} w_i}.$$

Equation (9) offers the entirely reasonable implication that the objective-maximizing harmonized tax rate is the weighted average of the tax rates that maximize individual country objectives in the absence of competition, with weights $\gamma_{1i} w_i$.

If governments adopt (9) in harmonizing their tax rates, collective objectives are given by

(10) $$H^* \approx \sum O_i\left(\tau_i^*, 0\right) w_i - \sum \tau_i^{*2} \gamma_{1i} w_i + \frac{\left[\sum \tau_i^* \gamma_{1i} w_i\right]^2}{\sum \gamma_{1i} w_i}.$$

In evaluating the resulting expression for (10), it is useful to apply (4) to obtain that

(11) $$\begin{aligned} \left[\sum \tau_i^* \gamma_{1i} w_i\right]^2 &= \left[\sum \tau_i^* \gamma_{1i} w_i - \sum \tau_i \gamma_{1i} w_i\right]^2 + \left[\sum \tau_i \gamma_{1i} w_i\right]^2 \\ &+2\left[\sum \tau_i \gamma_{1i} w_i\right] \sum \frac{\left[\left(\tau_i - \overline{\tau}\right)\left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) + \frac{\gamma_{2i}}{2}\right] \gamma_{1i} w_i}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} \end{aligned} .$$

Equations (10) and (11) together imply that

$$H^* \approx \sum O_i\left(\tau_i^*,0\right)w_i - \sum \tau_i^{*2}\gamma_{1i}w_i + \frac{\left[\sum \tau_i^*\gamma_{1i}w_i - \sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]} + \frac{\left[\sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]}$$

(12)

$$+2\frac{\left[\sum \tau_i\gamma_{1i}w_i\right]}{\left[\sum \gamma_{1i}w_i\right]}\sum \frac{\left[\left(\tau_i-\overline{\tau}\right)\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)+\frac{\gamma_{2i}}{2}\right]\gamma_{1i}w_i}{\gamma_{1i}+\frac{\gamma_{4i}}{2}} .$$

Using the difference between (7) and (12) to identify the difference between aggregate objectives satisfaction of harmonizing taxes at rate τ_h^*,

$$S-H^* = \sum \tau_i^2\left(\gamma_{1i}+\gamma_{3i}+\gamma_{4i}\right)w_i - \frac{\left[\sum \tau_i^*\gamma_{1i}w_i - \sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]} - \frac{\left[\sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]}$$

(13)

$$+\sum \frac{\gamma_{2i}\gamma_{1i}w_i}{\gamma_{1i}+\frac{\gamma_{4i}}{2}}\left[\overline{\tau}-\frac{\sum \tau_j\gamma_{1j}w_j}{\left[\sum \gamma_{1i}w_i\right]}\right] - \overline{\tau}^2\sum \gamma_{3i}w_i - \overline{\tau}\sum \tau_i\gamma_{4i}w_i .$$

$$-2\sum\left(\tau_i-\overline{\tau}\right)\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)\left\{\frac{\gamma_{1i}\frac{\left[\sum \tau_j\gamma_{1j}w_j\right]}{\left[\sum \gamma_{1i}w_i\right]}+\overline{\tau}\frac{\gamma_{4i}}{2}}{\gamma_{1i}+\frac{\gamma_{4i}}{2}}\right\}w_i$$

Equation (13) expresses the difference between the levels of aggregate objective satisfaction produced by independent tax setting and tax harmonization as a function of observed tax rates and unobserved parameters. If $\frac{\sum \tau_i\gamma_{1i}w_i}{\sum \gamma_{1i}w_i} = \sum \tau_i v_i = \overline{\tau}$, then (13) simplifies to

(14) $$S-H^* = \sum\left(\tau_i-\overline{\tau}\right)^2\left(\gamma_{1i}+\gamma_{3i}+\gamma_{4i}\right)w_i - \Delta^2\sum \gamma_{1i}w_i ,$$

in which

(15) $$\Delta = \frac{\sum\left(\tau_i^*-\tau_i\right)\gamma_{1i}w_i}{\sum \gamma_{1i}w_i}$$

is the average extent to which tax competition reduces tax rates, with weights given by $\gamma_{1i}w_i$.

2.4. Implications.

Equation (14) indicates that tax harmonization advances collective objectives if the weighted variance of observed tax rates is less than the square of the average reduction in tax rates due to tax competition. Expressed differently, tax harmonization advances collective objectives if and only if tax competition reduces average tax rates by more than the standard deviation of observed tax rates. The right side of equation (14) can be broken into two components, as

$$S - H^* = \left[\sum\left(\tau_i - \overline{\tau}\right)^2 \gamma_{1i} w_i - \Delta^2 \sum \gamma_{1i} w_i\right] + \sum\left(\tau_i - \overline{\tau}\right)^2 \left(\gamma_{3i} + \gamma_{4i}\right) w_i . \tag{16}$$

The first component of the right side of (16) is the difference between the weighted variance of tax rates and the squared weighted average effect of competition on tax rates. The second component is an interaction between squared deviations from mean tax rates and the γ_{3i} and γ_{4i} terms that appear in strategic interactions. If these terms are positive, so that tax rates are strategic complements, then since squared deviations are also necessarily positive, it follows that Δ must exceed the weighted standard deviation of tax rates in order for (16) to be negative.

The remarkably simple standard deviation rule also carries an implication for the range of potential objective-maximizing harmonized tax rates. From (15), the objective-maximizing harmonized tax rate is the sum of the average observed tax rate and the average effect of tax competition

$$\tau_h^* = \frac{\sum \tau_i \gamma_{1i} w_i}{\sum \gamma_{1i} w_i} + \Delta . \tag{17}$$

Since (14) implies that in order for tax harmonization to advance government objectives it is necessary for Δ to exceed the standard deviation of tax rates, it follows from (17) that an objective-maximizing harmonized rate must exceed the sum of current average tax rates plus the standard deviation of tax rates.

2.5. Interpretation and extensions.

The standard deviation rule captures important aspects of the impact of tax harmonization. Tax harmonization is costly from the standpoint of achieving the objectives of governments with preferred tax rates that differ substantially from the harmonized rate, and also those governments that strongly prefer to have significantly lower tax rates than others. These costs increase with deviations from preferred tax rates, which together with the restricting attention to terms in the Taylor expansion no higher than second order, accounts for the variance terms that appear in (14). It is nonetheless striking that the criterion for tax harmonization to advance collective objectives takes so simple a form.

If tax competition reduces average tax rates, then neither tax harmonization nor unfettered tax competition maximizes collective objectives. Maximizing (5) over the unrestricted choice of τ_i yields

(18) $$2\gamma_{1i}\left(\tau_i^* - \hat{\tau}_i\right) - \gamma_{2i} + 2\gamma_{3i}\left(\overline{\tau} - \hat{\tau}_i\right) + \gamma_{4i}\left(\overline{\tau} + \tau_i^* - 2\hat{\tau}_i\right) + \frac{dS}{d\overline{\tau}},$$

in which $\hat{\tau}_i$ is the value of τ_i that maximizes (5). From (1) it follows that

$$\frac{dS}{d\overline{\tau}} = \sum \gamma_{2i} w_i + 2\sum\left(\tau_i - \overline{\tau}\right)\gamma_{3i} w_i + \sum\left(\tau_i - \tau_i^*\right)\gamma_{4i} w_i ,$$

which implies that

(19) $$\frac{dS}{d\overline{\tau}} = 2\Delta\sum \gamma_{1i} w_i - \sum\left(\tau_i - \overline{\tau}\right)\gamma_{4i} w_i .$$

Together, (18) and (19) imply that

(20) $$\hat{\tau}_i = \tau_i + \frac{\left[\Delta\sum \gamma_{1i} w_i - \sum\left(\tau_i - \overline{\tau}\right)\frac{\gamma_{4i}}{2} w_i\right]}{\gamma_{1i} + \gamma_{3i} + \gamma_{4i}}.$$

Equation (20) indicates that the policy that maximizes collective objectives features significant differentiation among the tax rates of different countries. This maximization can be achieved by starting from the tax rates that countries choose and then adding selective upward adjustments to individual tax rates. It is clear from (20) that unfettered tax competition does not produce the outcome that maximizes collective objectives other than in the rare case that $\Delta\sum\gamma_{1i}w_i=\sum\left(\tau_i-\bar{\tau}\right)\frac{\gamma_{4i}}{2}w_i$, and that it is similarly unlikely that any single harmonized rate would maximize collective objectives.

The derivation of (14) relies on the assumption that $\frac{\sum\tau_i\gamma_{1i}w_i}{\sum\gamma_{1i}w_i}=\bar{\tau}$. If this is not the case, then (14) becomes

$$(21)\quad S-H^*=\sum\left(\tau_i-\bar{\tau}\right)^2\left(\gamma_{1i}+\gamma_{3i}+\gamma_{4i}\right)w_i+\left[\bar{\tau}-\frac{\sum\tau_i\gamma_{1i}w_i}{\sum\gamma_{1i}w_i}\right]\left(\Delta+\tau_h^*\right)\sum\gamma_{1i}w_i-\Delta^2\sum\gamma_{1i}w_i .$$

The difference between $\frac{\sum\tau_i\gamma_{1i}w_i}{\sum\gamma_{1i}w_i}$ and $\bar{\tau}$ arises from any differences between the weights $\gamma_{1i}w_i$ that appear in (21) and elsewhere and the weights v_i used to calculate $\bar{\tau}$. These need not be identical, since $\gamma_{1i}w_i$ is the collective assessment weight attached to squared deviations of country *i*'s tax rate from its preferred rate, whereas v_i is the weight attached to country *i*'s tax rate in producing a world average for comparison purposes. Big countries with extensive business activity can be expected to have large $\gamma_{1i}w_i$ and v_i weights, but if the v_i weights were even more heavily concentrated among the highest-tax large countries, then the $\left[\bar{\tau}-\frac{\sum\tau_i\gamma_{1i}w_i}{\sum\gamma_{1i}w_i}\right]$ term in (21) will be positive. As a result, tax harmonization would advance collective objectives only if Δ exceeds the standard deviation of tax rates plus an additional amount due to the difference in weighted tax rates. If instead the v_i weights were less concentrated among high-tax-rate countries than are the collective objective weights, then the opposite would be the case, and a smaller value of Δ would be necessary for harmonization to advance collective objectives.

The specification of a country's objective as $O_i\left(\tau_i,d_i\right)$ imposes that the relevant feature of external tax rates is their weighted average. While this is a standard formulation in tax competition models,[4] it is possible that countries instead care about pairwise comparisons of their tax rates to those of others. Given the large number of countries in the world, a second-order Taylor approximation to an objective function that incorporates pairwise comparisons would have tens of thousands of unobserved parameters, making it largely infeasible to analyze. A restricted version of this model is given by

$$(22) \qquad \begin{aligned} O_i\left(\tau_i, d_i\right) = O_i\left(\tau_i^*, 0\right) - \left(\tau_i - \tau_i^*\right)^2 \gamma_{1i} - \sum\nolimits_j \left(\tau_i - \tau_j\right) \gamma_{2i} w_j \\ - \sum\nolimits_j \left(\tau_i - \tau_j\right)^2 \gamma_{3i} w_j - \sum\nolimits_j \left(\tau_i - \tau_i^*\right)\left(\tau_i - \tau_j\right) \gamma_{4i} w_j \end{aligned},$$

which limits consideration to cases in which coefficients on all pairwise comparisons are the same for any given country. This version of a model with pairwise comparisons produces implied choices of τ_i that are the same as those in (3), but changes the comparison of collective objectives under tax competition and harmonization, so that the equivalent to (14) becomes

$$(23) \qquad S - H^* = \sum \left(\tau_i - \overline{\tau}\right)^2 \left(\gamma_{1i} + \gamma_{4i}\right) w_i - \Delta^2 \sum \gamma_{1i} w_i \, .$$

The only difference between (23) and (14) is that the γ_{3i} term does not appear on the right side of (23). Consequently, if tax rates are strategic complements because $\gamma_{3i} > 0$, then the model in which countries care about pairwise tax rate comparisons requires that the effect of tax competition exceed the standard deviation of tax rates by somewhat less in order for harmonization to advance collective objective satisfaction.

One of the important features of (14) is that it arises from imposing (8), the objective-maximizing harmonized tax rate τ_h^*. Adoption of τ_h^* as a harmonized rate requires exact knowledge of aggregate desired tax rates in the absence of competition, or equivalently Δ, the effect of tax competition on aggregate tax rates. To the extent that there is uncertainty over the value of τ_h^*, then tax harmonization is apt to produce an outcome that is less consistent with collective objectives than appears in equation (10). For example, if instead of adopting τ_h^* as the harmonized rate, governments instead were to adopt $\tau_h^* + \varepsilon_h$, then (14) becomes

[4] Keen and Konrad (2013) offer an analytical review of this literature.

(24) $$S - H^* = \sum (\tau_i - \bar{\tau})^2 (\gamma_{1i} + \gamma_{3i} + \gamma_{4i}) w_i + \varepsilon_h^2 \sum \gamma_{1i} w_i - \Delta^2 \sum \gamma_{1i} w_i \ .$$

If uncertainty over the value of Δ is the reason why a harmonized tax rate may deviate from τ_h^*, then (24) implies that the standard deviation rule should be adjusted to compare the variance of tax rates with $(\Delta^2 - \varepsilon_h^2)$, the difference between the squared tax competition effect and the variance of its estimate.

3. Harmonizing Corporate Tax Rates in 2020.

In order to apply (14) it is necessary to specify the weights $\gamma_{1i} w_i$ used to calculate the variance terms in the expression. Since there is no natural scaling, it is reasonable to normalize objective levels by specifying that $\gamma_{1i} = 1, \forall i$, though doing so imposes that countries equally prefer to avoid squared deviations from their preferred tax rates. It is then also necessary to specify the weights w_i that attach to the objectives of different countries for purposes of collective assessment, in addition to identifying $\gamma_{3i} w_i$ and $\gamma_{4i} w_i$. In the context of international corporate taxation, GDP is a natural candidate for w_i, since corporate activity and therefore the consequences of corporate tax changes closely track GDP.

Table 1 presents means and standard deviations of statutory corporate tax rates around the world, using data for 2020 reported by the Tax Foundation.[5] The results indicate that, for the 224 countries and territories for which the Tax Foundation report data, the unweighted mean tax rate in 2020 was 22.58%, with a standard deviation of 9.18%. Instead weighting these figures by population, the mean corporate tax rate was 26.72%, with a standard deviation of 4.60%. GDP data are available for a subset of 178 these countries and territories that generally omits smaller jurisdictions. In this subset, and weighting the calculations by GDP, the mean corporate tax rate was 25.85%, with a standard deviation of 4.54%.[6] It is noteworthy that the population-weighted

[5] https://taxfoundation.org/publications/corporate-tax-rates-around-the-world/

[6] The figures in Table 1 also illustrate the potential effect of countries calculating average tax rates for comparison purposes with weights that differ from those used to assess collective objectives. If collective objectives are equally weighted among jurisdictions, and equal weights are also used for tax rate comparisons, then in the absence of

and GDP-weighted calculations produce very similar standard deviations, both of which suggest that statutory tax rate harmonization has the potential to advance collective objectives only if the effect of tax competition is to reduce (weighted) average tax rates by more than 4.6%. Furthermore, the objective-maximizing harmonized tax rate exceeds 30.4% in the case of GDP weights and exceeds 31.3% in the case of population weights.

The figures in Table 1 carry implications for the effect of strategic tax setting behavior on the potential for objective-enhancing tax harmonization. If γ_1 takes a common value across all countries, and γ_3 and γ_4 do also, then (14) becomes

$$S - H^* = \gamma_1 \left[\left(1 + \frac{\gamma_3 + \gamma_4}{\gamma_1} \right) \sum \left(\tau_i - \overline{\tau} \right)^2 w_i - \Delta^2 \right]. \tag{25}$$

Equation (25) modifies the standard deviation rule to one in which tax harmonization advances collective objectives if and only if tax competition reduces average tax rates by more than the product of $\sqrt{1 + \frac{\gamma_3 + \gamma_4}{\gamma_1}}$ and the standard deviation of observed tax rates. If $\gamma_3 = 1$ and $\gamma_4 = 0.2$ for all countries, which from (3) would imply that $\frac{d\tau_i}{d\overline{\tau}} = 0.5$, then since $\sqrt{1 + \frac{\gamma_3 + \gamma_4}{\gamma_1}} = 1.48$, it follows that with GDP weights statutory tax rate harmonization has the potential to advance collective objectives only if the effect of tax competition is to reduce average tax rates by more than 6.7% – and the objective-maximizing harmonized rate is 32.6% or higher. This example illustrates that strategic tax setting is apt to make only a modest difference to the standard deviation rule, since even an exceptionally strong reaction level of $\frac{d\tau_i}{d\overline{\tau}} = 0.5$ entails a relatively minor adjustment to (14).

While the statutory corporate tax rate is a very important component in determining effective corporate tax burdens, rules concerning income inclusions, the availability of tax credits

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strategic tax setting $\left(\gamma_3 = \gamma_4 = 0\right)$ the evidence in Table 1 implies that 7.53 is the critical value of Δ in determining whether tax harmonization advances collective objectives. Alternatively, if in this exercise countries compare their and deductions, and other aspects of tax base definitions also play important roles. Consequently, an analysis of statutory corporate tax rates alone has the potential to offer misleading conclusions if the goal is to understand relative tax burdens. If instead the goal is to understand the potential consequences of tax harmonization, then an analysis of statutory rates can offer useful information. If tax harmonization would entail countries harmonizing their statutory corporate tax rates without substantially changing other aspects of their tax systems, then it is appropriate to analyze the properties of their statutory rates, since doing so corresponds to the framework of section 2. In practice, corporate tax rate changes tend to be accompanied by tax base changes (Kawano and Slemrod, 2016), which is why international agreements to harmonize taxes are likely to include restrictions to any offsetting tax base changes that countries might otherwise be inclined to adopt.

4. *Minimum Taxes.*

Minimum required tax rates are important alternatives to complete tax harmonization. Minimum taxes partition the world into two endogenous groups: countries in group A, for whom the required minimum tax rate does not impose a binding constraint, and countries in group B, for whom it does. If τ_m is the minimum tax rate, then under a minimum tax regime every country in group B imposes that tax rate. Countries in group A impose tax rates $\hat{\tau}_i$ that are not directly affected by the minimum tax requirement but nonetheless may differ from their currently observed tax rates, since minimum taxes change average tax rates, which then may influence the tax rates that countries choose. Aggregate objective satisfaction with a minimum tax rate τ_m is

$$
\begin{aligned}
M \approx & \sum O_i\left(\tau_i^*,0\right)w_i - \sum_A\left(\hat{\tau}_i-\tau_i^*\right)^2\gamma_{1i}w_i - \sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)\gamma_{2i}w_i - \sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)^2\gamma_{3i}w_i \\
& -\sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)\left(\hat{\tau}_i-\tau_i^*\right)\gamma_{4i}w_i - \sum_B\left(\tau_m-\tau_i^*\right)^2\gamma_{1i}w_i - \sum_B\left(\tau_m-\overline{\tau}_m\right)\gamma_{2i}w_i \\
& -\sum_B\left(\tau_m-\overline{\tau}_m\right)^2\gamma_{3i}w_i - \sum_B\left(\tau_m-\tau_i^*\right)\left(\tau_m-\overline{\tau}_m\right)\gamma_{4i}w_i
\end{aligned}
\quad , \qquad (26)
$$

in which

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tax rates with a GDP-weighted average of others, then the formula in (21) implies that the critical value of Δ becomes 12.40, reflecting in part that the tax correction grows as Δ increases.

(27) $$\overline{\tau}_m = \sum_A \hat{\tau}_i w_i + \tau_m \sum_B w_i$$

is the average tax rate under the minimum tax regime.

It is useful to clarify some of the properties of the average tax rate with minimum taxes. It follows from (3) and (27) that

(28) $$\overline{\tau}_m = \sum_A \tau_i w_i + \left(\overline{\tau}_m - \overline{\tau}\right) \sum_A \frac{\gamma_{3i} + \frac{\gamma_{4i}}{2}}{\gamma_{1i} + \gamma_{3i} + \gamma_{4i}} w_i + \tau_m \sum_B w_i \ ,$$

as the second term on the right side of (28) captures the spillover effect of minimum taxes on the tax rates of countries for which the minimum is not a binding constraint. Equation (28) can be simplified to yield

(29) $$\overline{\tau}_m = \overline{\tau} + \frac{\left(\gamma_{1i} + \gamma_{3i} + \gamma_{4i}\right)\left\{\tau_m \sum_B w_i - \sum_B \tau_i w_i - \left[\overline{\tau} - \sum \tau_i w_i\right]\right\}}{\left(\gamma_{1i} + \frac{\gamma_{4i}}{2}\right) + \left(\gamma_{3i} + \frac{\gamma_{4i}}{2}\right) \sum_B w_i}.$$

One of the challenges of analyzing the implications of (26) is strategic interactions make it impossible to know which countries would fall into groups A and B, since even a low tax rate country might respond to $\overline{\tau}_m > \overline{\tau}$ by so increasing its tax rate that it would land in group A. And with unrestricted strategic reactions, the converse is also possible: a high tax country might respond to $\overline{\tau}_m > \overline{\tau}$ by so reducing its tax rate that it winds up in group B. Consequently, it is necessary to restrict the range of possible strategic interactions in order to apply the theory to tax rate data. This section proceeds by assuming that all countries have the same value of $\frac{d\tau_i}{d\overline{\tau}}$, and specifically that $\gamma_{ji} = \gamma_j, \forall i, j = 1,3,4$.

Applying this assumption, and following extensive algebraic manipulation, (26) implies

$$M \approx \sum O_i\left(\tau_i, d_i\right) w_i - \gamma_1 \sum \tau_i^{*2} w_i - \gamma_4 \bar{\tau} \sum \tau_i w_i + \left[\bar{\tau} - \sum \tau_i w_i\right] \frac{\gamma_4\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\gamma_1 + \frac{\gamma_4}{2}}$$

(30) $$+\left(\gamma_1 + \gamma_3 + \gamma_4\right)\left[\sum_A \tau_i^2 w_i + \tau_m\left(2 - \tau_m\right) \sum_B w_i\right] + \left(\gamma_3 + \frac{\gamma_4}{2}\right)\left(\bar{\tau}_m - \bar{\tau}\right)\left[\bar{\tau} - \sum \tau_i w_i\right].$$

$$+\frac{\gamma_4}{2}\left(\bar{\tau}_m - \bar{\tau}\right)^2 + \frac{\gamma_1 \bar{\tau}_m}{\gamma_1 + \frac{\gamma_4}{2}} \sum \gamma_{2i} w_i + \left(\bar{\tau}_m - \bar{\tau}\right)\left(\gamma_3 + \frac{\gamma_4}{2}\right)\left[\tau_m \sum_B w_i - \sum_B \tau_i w_i\right]$$

Differentiating (30) with respect to τ_m, applying (29), and imposing that $\bar{\tau} = \sum \tau_i w_i$ yields

(31) $$\frac{dM/d\tau_m}{2\left(d\bar{\tau}_m/d\tau_m\right)} = \left[\frac{\sum_B \tau_i w_i}{\sum_B w_i} - \tau_m\right]\left[1 + \frac{\gamma_4}{2\gamma_1} \frac{\left(1 - \sum_B w_i\right)}{\left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \frac{\gamma_4}{2}\right)} \sum_B w_i\right]}\right] + \Delta.$$

Denoting by τ_m^* the tax rate at which $dM/d\tau_m = 0$, it follows from (31) that

(32) $$\tau_m^* = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \frac{\Delta}{\left[1 + \frac{\gamma_4}{2\gamma_1} \frac{\left(1 - \sum_B w_i\right)}{\left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \frac{\gamma_4}{2}\right)} \sum_B w_i\right]}\right]}.$$

Equation (32) is most readily interpreted in the case in which $\gamma_3 = \gamma_4 = 0$, when

(33) $$\tau_m^* = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \Delta,$$

so the objective-maximizing minimum tax rate is the sum of the average tax rate of affected countries and the amount by which competition reduces average tax rates. Of course, the set of group B countries whose tax rates are constrained by the minimum tax rule is itself a function of the minimum tax rate; but to find τ_m^*, it is simply necessary to use tax rate data to search for values of τ_m for which $\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i} = \Delta$.

It is noteworthy that the relevant value of Δ in (33) is that for all countries, not just the affected group B whose tax rates would be constrained by the minimum rate. This makes the rule easy to apply, and captures two distinct effects of a minimum tax rate. One thing that a minimum tax rate does is to harmonize the tax rates of countries in group B, and restricting attention simply to the collective objectives of that group would, applying (9), entail setting τ_m^* equal to the average tax rate of group B countries plus the amount by which competition reduces their tax rates. But since the second thing that a minimum tax rate does is to affect outcomes of countries in group A, the values that group A countries attach to having competitive tax rates also matter for the objective-maximizing tax rate. The parameters that capture the effect of tax competition on national objectives determine the effect of tax competition on tax rates. As a result, the effect of tax competition on the tax rates of group A countries is an exact proxy for the impact of higher group B tax rates on country A objectives, which is why the effect of tax competition on all tax rates, including those of group A countries, appears in (33).

In the $\gamma_3 = \gamma_4 = 0$ case in which strategic tax rate considerations are absent, $\Delta = \sum \frac{\gamma_{2i}}{2} w_i$, so

(34)
$$\Delta = \frac{\sum_B \frac{\gamma_{2i}}{2} w_i}{\sum_B w_i} + \sum_A w_i \left[\frac{\sum_A \frac{\gamma_{2i}}{2} w_i}{\sum_A w_i} - \frac{\sum_B \frac{\gamma_{2i}}{2} w_i}{\sum_B w_i} \right].$$

The first term on the right side of (34) is the average amount by which perceived competition with other countries reduces the tax rates of group B countries. The second term on the right side of (34) is the product of the collective objective weight on group A countries and the difference between the average effects of tax rate comparisons on the objectives of group A and group B countries. If group A and group B countries do not differ in how they perceive the effects of tax rate comparisons, then this difference is zero, $\Delta = \frac{\sum_B \frac{\gamma_{2i}}{2} w_i}{\sum_B w_i}$, and the objective-maximizing minimum tax rate is the same rate that countries in group B would choose as a harmonized rate to maximize their collective objectives. If countries in group A attach greater weight to tax comparisons than do countries in group B, then $\Delta > \frac{\sum_B \frac{\gamma_{2i}}{2} w_i}{\sum_B w_i}$, and a somewhat higher minimum tax rate will advance collective objectives. The striking aspect of (33) is that the two effects of a minimum tax – harmonizing group B tax rates and elevating average tax rates for all countries – are succinctly summarized in the single value Δ.

Equation (31) carries the implication that if $\gamma_4 = 0$ and tax competition reduces average tax rates, so $\Delta > 0$, then at a low rate of minimum taxation increases collective objective attainment compared to a regime with no minimum taxes. At a very low minimum tax rate, $\left[\frac{\sum_B \tau_i w_i}{\sum_B w_i} - \tau_m \right]$ is close to zero, but Δ will not be, so the right side of (31) is positive, and therefore $dM/d\tau_m > 0$. Consequently, in a broad range of cases minimum taxes advance collective objectives, though there remains the question of which minimum tax rate does so most effectively.

One of the important implications of (33) is that multiple solutions are possible, depending on the distribution of average tax rates in the data. These multiple solutions arise because while average tax rates of group B countries must rise monotonically with τ_m, the rate of increase is indeterminate, and in particular may be quite high over certain tax rate ranges. If average tax rates increase very rapidly with τ_m at some points, as will be the case if taxes are strongly concentrated at certain rates, then $\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i}$ will be increasing in τ_m over some ranges and decreasing over others, as a result of which more than one value of τ_m may satisfy

(33). As noted earlier, this reflects that minimum tax rules bear only on countries whose rates are otherwise below the required minimum. As a result, there can be one local maximum of (30) at a low minimum tax rate, and others at a higher minimum tax rates that impact many additional countries.

Equation (32) suggests that even explicit incorporation of strategic tax interactions produces a rule that is closely approximated by an objective-maximizing minimum tax rate equal to the sum of the average tax rate of affected countries and the amount by which competition reduces average tax rates. The γ_4 term that appears in (32) is the coefficient in equation (1) on the interaction between the deviation of actual and desired tax rates and deviation of a country's tax rate from the world average. By contrast, γ_1 is the coefficient on the squared deviation of a country's tax rate from its desired rate. It is reasonable to expect the perceived marginal cost of deviating from a preferred tax rate to increase much more with deviations from preferred rates than with deviations from world averages, in which case the magnitude of γ_1 will significantly exceed that of γ_4, and equation (32) closely approximate $\tau_m^* = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \Delta$.

In the presence of significant strategic interactions it is not possible to apply (32) directly to tax rate data, since strategic interactions will affect which countries fall in groups A and B at any given value of τ_m. If tax rates are strategic complements, then group B consists of countries with tax rates substantially below τ_m. The assumption that countries have common values of γ_1, γ_2, and γ_4 ensures that they maintain the same tax rate rank ordering in the presence of strategic interactions, but that alone does not identify the impact of τ_m. For a given minimum tax rate, the group of countries in group B whose tax rates are constrained by the minimum requirement will be those for which

(35) $$\tau_i + \frac{\left(\overline{\tau}_m - \overline{\tau}\right)\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \gamma_3 + \gamma_4\right)} \leq \tau_m$$

Denoting by $\tilde{\tau}$ the tax rate τ_i at which the left side of (35) equals the right, it follows that

(36) $$\tau_m = \tilde{\tau} + \sum\nolimits_B w_i \left(\tilde{\tau} - \frac{\sum_B \tau_i w_i}{\sum_B w_i} \right) \frac{\left(\gamma_3 + \frac{\gamma_4}{2} \right)}{\left(\gamma_1 + \frac{\gamma_4}{2} \right)} .$$

Imposing (36), and replacing τ_m^* with τ_m, (32) becomes

(37) $$\tilde{\tau} = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \frac{\Delta}{1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2} \right)}{\left(\gamma_1 + \frac{\gamma_4}{2} \right)} \sum_B w_i + \frac{\gamma_4}{2\gamma_1} \left(1 - \sum_B w_i \right)} .$$

Equation (37) can be applied to tax rate data, with group B consisting of all countries with tax rates equal to or less than $\tilde{\tau}$. This application entails searching for points at which the modified term $\left[\tilde{\tau} - \frac{\sum_B \tau_i w_i}{\sum_B w_i} \right] \left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2} \right)}{\left(\gamma_1 + \frac{\gamma_4}{2} \right)} \sum_B w_i + \frac{\gamma_4}{2\gamma_1} \left(1 - \sum_B w_i \right) \right]$ equals Δ. The ratio $\frac{\left(\gamma_3 + \frac{\gamma_4}{2} \right)}{\left(\gamma_1 + \frac{\gamma_4}{2} \right)}$ that appears in the denominator of the second term on the right side of (37) equals $\frac{d\tau_i / d\overline{\tau}}{\left(1 - d\tau_i / d\overline{\tau} \right)}$, which can be estimated, albeit with some difficulty, from tax rate data. Values of $\tilde{\tau}$ that satisfy (37) can then be applied to (36) to produce implied values of τ_m, which if necessary can be compared using (30) to determine those that represent choices that maximize collective objectives for any given value of Δ.

The derivation of (32) relies on the assumption that $\frac{\sum \tau_i \gamma_{1i} w_i}{\sum \gamma_{1i} w_i} = \overline{\tau}$. If this is not the case, then (32) becomes

$$\tau_m^* = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \frac{\Delta - \left[\bar{\tau} - \sum \tau_i w_i\right] \frac{\gamma_4}{2\gamma_1} \left[\frac{(\gamma_1 + \gamma_3 + \gamma_4)}{\gamma_1 + \frac{\gamma_4}{2} + \left(\gamma_3 + \frac{\gamma_4}{2}\right) \sum_B w_i} \right]}{\left[1 + \frac{\gamma_4}{2\gamma_1} \frac{\left(1 - \sum_B w_i\right)}{\left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \frac{\gamma_4}{2}\right)} \sum_B w_i \right]} \right]} \quad (38)$$

Equation (38) indicates that any differences between $\bar{\tau}$ and $\sum \tau_i w_i$ entail modifying the numerator of the second term on the right side of (32). If the v_i weights used to calculate $\bar{\tau}$ are more heavily concentrated among higher-tax countries than are the w_i weights, then the $\left[\bar{\tau} - \sum \tau_i w_i\right]$ term in (38) will be positive, which increases the size of Δ associated with any given objective-maximizing minimum tax rate. The opposite is the case if the v_i weights are more heavily concentrated among lower-tax countries. Given that these adjustments are multiplied by $\gamma_4 / 2\gamma_1$, they are unlikely to be large in magnitude.

5. Analysis of Minimum Taxes with 2020 Data.

It is evident from (32) that minimum tax rates that maximize collective objectives are functions both of Δ and of the distribution of observed tax rates. Consequently, it is possible to use the 2020 world corporate statutory tax rate data to identify the extent to which different possible minimum tax rates may be consistent with maximizing collective objectives.

It is useful to start by considering cases of $\gamma_3 = \gamma_4 = 0$, in which there are no strategic interactions among tax rates. As (33) indicates, if $\gamma_3 = \gamma_4 = 0$ then the condition that characterizes a local objective-maximizing point is that $\Delta = \tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i}$. Figure 1 plots values of $\frac{\sum_B \tau_i w_i}{\sum_B w_i}$, using GDP weights, for 177 of the countries for which tax rate and GDP data are available.[7] As expected, the locus in Figure 1 exhibits sharp upward jumps at popular tax rates such as 20% and 25%. Figure 2 is the corresponding plot of $\left[\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]$, again with GDP weights. It is clear from the multiplicity of values of τ_m that share the same value of $\left[\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]$ in Figure 2 that there will be multiple local objective-maximizing points for many values of Δ between 2% and 8%. Applying (30) to identify which of these points maximizes collective objective satisfaction, and omitting those that do not, yields Figure 3.

Figure 3 indicates that the objective-maximizing choice of τ_m increases one-for-one with Δ over the range 0-3.8%. At $\Delta = 3.8$ there is a discontinuous jump in the objective-maximizing τ_m: at $\Delta = 3.8$, collective objectives are maximized by $\tau_m = 3.8$, whereas at $\Delta = 3.81$, collective objectives are maximized by $\tau_m = 27.33$. There is no value of Δ for which minimum tax rates between 3.8% and 27.33% maximize collective objectives. And as Figure 3 also indicates, there is a subsequent noticeable, though smaller, discontinuous jump in the objective-maximizing τ_m in the neighborhood of 30%.

Incorporating strategic interactions appears to affect these results rather little. The four panels in Figure 4 plot values of $\left[\tilde{\tau} - \frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]\left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \frac{\gamma_4}{2}\right)}\sum_B w_i + \frac{\gamma_4}{2\gamma_1}\left(1 - \sum_B w_i\right)\right]$ for four different scenarios: (i) in the upper left, $\gamma_3 = \gamma_4 = 0$, which is the same as in Figure 2; (ii) in the upper right, $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$, which implies that $d\tau_i/d\overline{\tau} = 0.5$; (iii) in the lower left,

[7] There are data for 178 countries, but the single country with the highest tax rate is outside the range of the figures.

$\gamma_3/\gamma_1 = 0.4$ and $\gamma_4/\gamma_1 = 0.1$, which implies that $d\tau_i/d\overline{\tau} = 0.3$; and (iv) in the lower right, $\gamma_3/\gamma_1 = 0.25$ and $\gamma_4 = 0$, which implies that $d\tau_i/d\overline{\tau} = 0.2$. As the figure indicates, all four of these scenarios feature multiple local optima at intermediate ranges of Δ, and do so with roughly the same patterns. Figure 5 presents four panels that plot the corresponding objective-maximizing choices of τ_m. As is evident from all four panels, these choices again feature discontinuous jumps over similar ranges of minimum tax rates.

The evidence presented in figures 1-5 uses statutory corporate tax rates weighted by GDP. Figures 6-10 present corresponding figures produced using statutory corporate tax rates weighted by population, applying data for a larger sample of 222 countries. The data in Figure 7 clearly indicate that there are multiple local optima at values of Δ between 2% and 7.5%. The objective-maximizing choices of τ_m in Figure 8 again feature large discontinuous jumps, which appear in approximately the same places, and at roughly the same rates, as those for GDP-weighted calculations presented in Figure 3. Incorporating strategic tax rate interactions, as in the calculations depicted in Figures 9 and 10, produces only small changes in the values of implied minimum tax rates and does not change their patterns.

Figures 11-15 present the same calculations using unweighted corporate tax rate data for the same 178 countries for which GDP data are available. The data in Figure 12 imply that there are again multiple local optima, though over a 4%-9% range of Δ that somewhat differs from the corresponding ranges in the GDP- and population-weighted calculations. Figure 13 indicates that there are multiple discrete jumps in the objective-maximizing choices of τ_m over much of the range of Δ. The figure indicates that, at low values of Δ, the implied minimum tax rate increases roughly one-for-one with Δ. At $\Delta = 5\%$ the implied minimum tax rate is roughly 7%, which increases to 27% as Δ rises to 7%. This sharp increase in τ_m is the product of several large discontinuous jumps, though there exist values of Δ between 5% and 7% for which minimum tax rates between 7-27% would represent objective-maximizing choices in a framework that assigns equal weights to every country and territory. Figures 14 and 15 display the product of calculations confirming that these patterns persist in the presence of strategic tax interactions, though it is noteworthy that in the scenario with $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$ there are much less dramatic jumps in τ_m for values of Δ between 7% and 9.5.

6. Tax Rates.

Tax harmonization and minimum taxation are alternative methods of addressing tax competition, which itself is the inevitable product of deliberate tax policy adoption. Since national tax policies are typically formed independently, competitive tax rate-setting can become a race to the bottom, producing tax rates that are very low or even zero. There is considerable controversy over the likelihood and course of such a race to the bottom in business tax rates,[8] and a lively possibility that incentives to engage in tax exporting by imposing higher taxes, the burden of which is partially borne by foreigners, could offset or even reverse the race to the bottom.[9] Many workhorse models of tax competition carry the implication that tax rates are strategic complements,[10] though some have the feature that tax rates can be strategic substitutes,[11] with countries reacting to foreign rate reductions by increasing their own tax rates.[12]

Empirical investigation of the role of competition in corporate tax policy determination confronts a limited availability of exogenous changes with which to estimate the magnitudes of any competitive effects. Despite this challenge it is possible to draw important lessons from

[8] See, for example, Zodrow and Mieszkowski (1986), Wilson (1986), Wildasin (1988), Black and Hoyt (1989), Bucovetsky and Wilson (1991), Bucovetsky (1991), and Baldwin and Krugman (2004). Davies and Eckel (2010), Haufler and Stahler (2013) and Niu (2017) note that if governments have limited tax instruments then with sufficient taxpayer heterogeneity there may not be a Nash equilibrium of any kind in the tax-setting game.

[9] See for example Haufler and Wooton (1999), Keen and Kotsogiannis (2002, 2004), Noiset (2003), Madies (2008), and Keen and Konrad (2013).

[10] Many of these studies are surveyed in Wilson (1999) and Keen and Konrad (2013). Rota-Graziosi (2019) identifies sufficient conditions for the Nash game in tax rates to be supermodular, in which case the Nash equilibrium exists and has the property that tax rates are strategic complements. The Rota-Graziosi paper notes that it is much more straightforward to identify sufficient conditions for supermodularity when the government is assumed to choose tax rates to maximize tax revenue than when the government chooses tax rates to maximize welfare.

[11] See Mintz and Tulkens (1986), Zodrow and Mieszkowski (1986), Wildasin (1988), Mendoza and Tesar (2005), and Vrijburg and de Mooij (2016).

[12] Kiss (2012) raises the intriguing possibility that minimum tax agreements might actually reduce equilibrium tax rates by limiting the ability of countries to punish others for deviating from collusive agreements to maintain high tax rates.

patterns in the data, the first and most obvious of which is that corporate tax rates are not all zero, thereby firmly rejecting the simplest version of a race to the bottom model. A second clear feature of recent experience is that statutory corporate tax rates have fallen significantly since 1980,[13] which is consistent with countries adjusting their corporate tax systems to competitive pressures in an increasingly globalized world. Smaller countries tend to have lower tax rates,[14] which is likewise consistent with competition exerting significant pressures on tax rates.[15] Estimated reaction functions often suggest that tax rates are strategic complements,[16] though these findings may be sensitive to specifications that, if modified, can yield the opposite conclusion that tax rates are strategic substitutes.[17]

The tax rates that countries choose provide valuable information on the objectives of their governments. Using this information to evaluate harmonized taxes and minimum tax requirements takes government objectives to be the basis of analysis. Government objectives include not only the criteria that countries use to determine the tax rates that they would choose in the absence of international competition, but also how they evaluate the effects of differences between a country's tax rate and the world average. Since government objectives can be inconsistent with national welfare, it follows that the implications of tax rate choices for tax harmonization and minimum taxation, while informative about how governments would evaluate these policies, need not directly bear on economic welfare.

7. Conclusion.

Countries choose tax policies based on many considerations, including revenue needs, economic conditions, distributional preferences, and prevailing notions of sound fiscal policy. Some governments tailor business taxes to make their countries attractive investment locations; and even countries without explicit tax-based economic development strategies generally try to

[13] This is documented by Slemrod (2004), Hines (2007), Ali Abbas and Klemm (2013), Keen and Konrad (2013), and numerous others.
[14] See Hines and Rice (1994), Bretschger and Hettich (2002), Hines (2007), and Dharamapala and Hines (2009).
[15] See Bucovetsky (1991) and Haufler and Wooten (1999).
[16] See Hayashi and Boadway (2001), Devereux, Lockwood and Redoano (2008), Overesch and Rincke (2011), Altshuler and Goodspeed (2015); Devereux and Loretz (2013) survey this literature.
[17] Chirinko and Wilson (2017).

avoid adopting tax systems that would excessively discourage business activity. Tax competition appears to reduce business tax rates to levels below those that countries would otherwise choose. Coordinated action can address the effects of tax competition, but common coordination methods such as tax harmonization or minimum taxation require strict adherence to uniform rules that limit their appeal. As a result, tax harmonization can advance collective objectives only if the standard deviation of tax rates is less than the average effect of tax competition. Minimum tax rules afford greater flexibility, though here too the average effect of tax competition is of central concern, since it plus the average tax rate of affected countries equals the minimum tax rate that most effectively advances collective objectives. It is evident that a sound understanding of the impact of tax competition is an indispensable element in evaluating tax harmonization alternatives.

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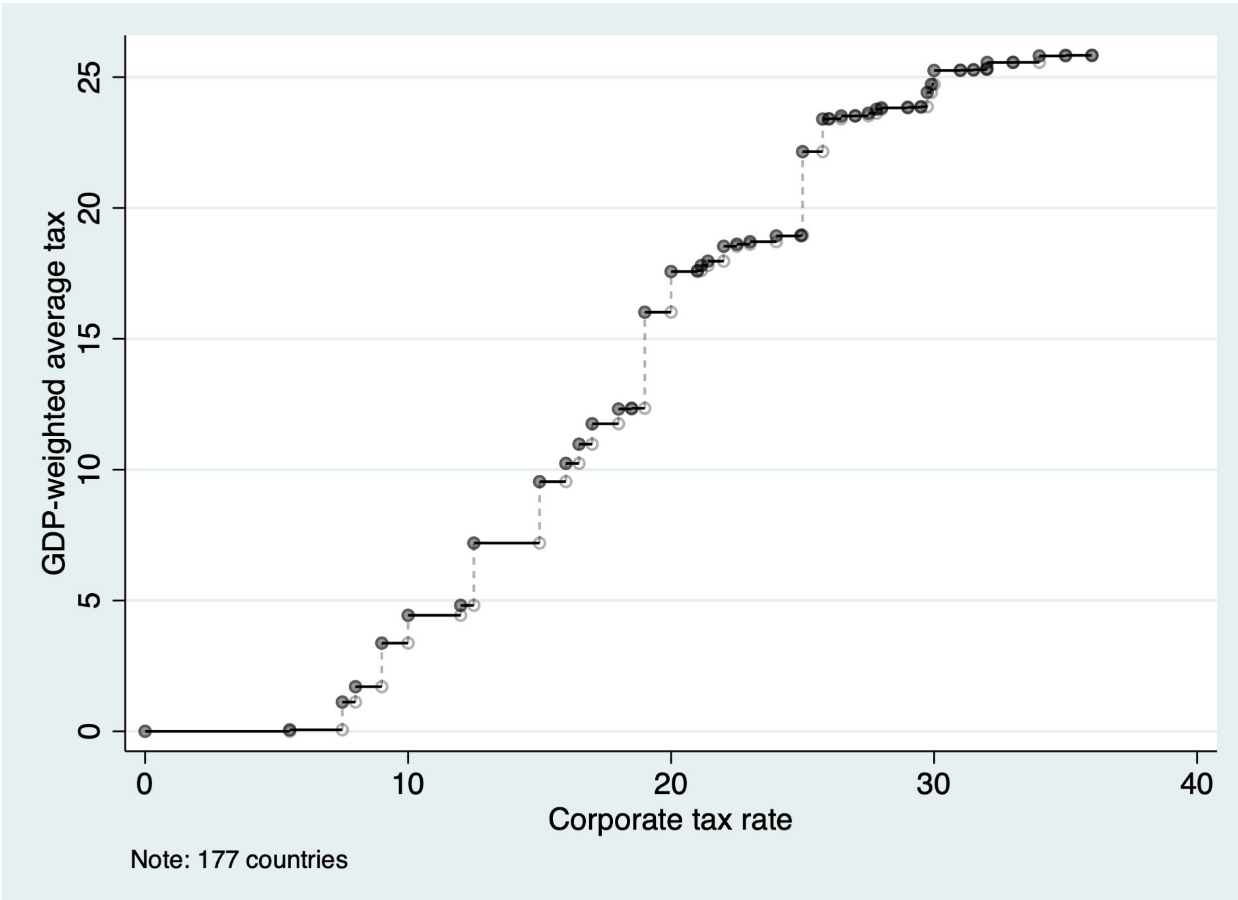
Table 1

World Corporate Tax Rate Means and Standard Deviations, 2020

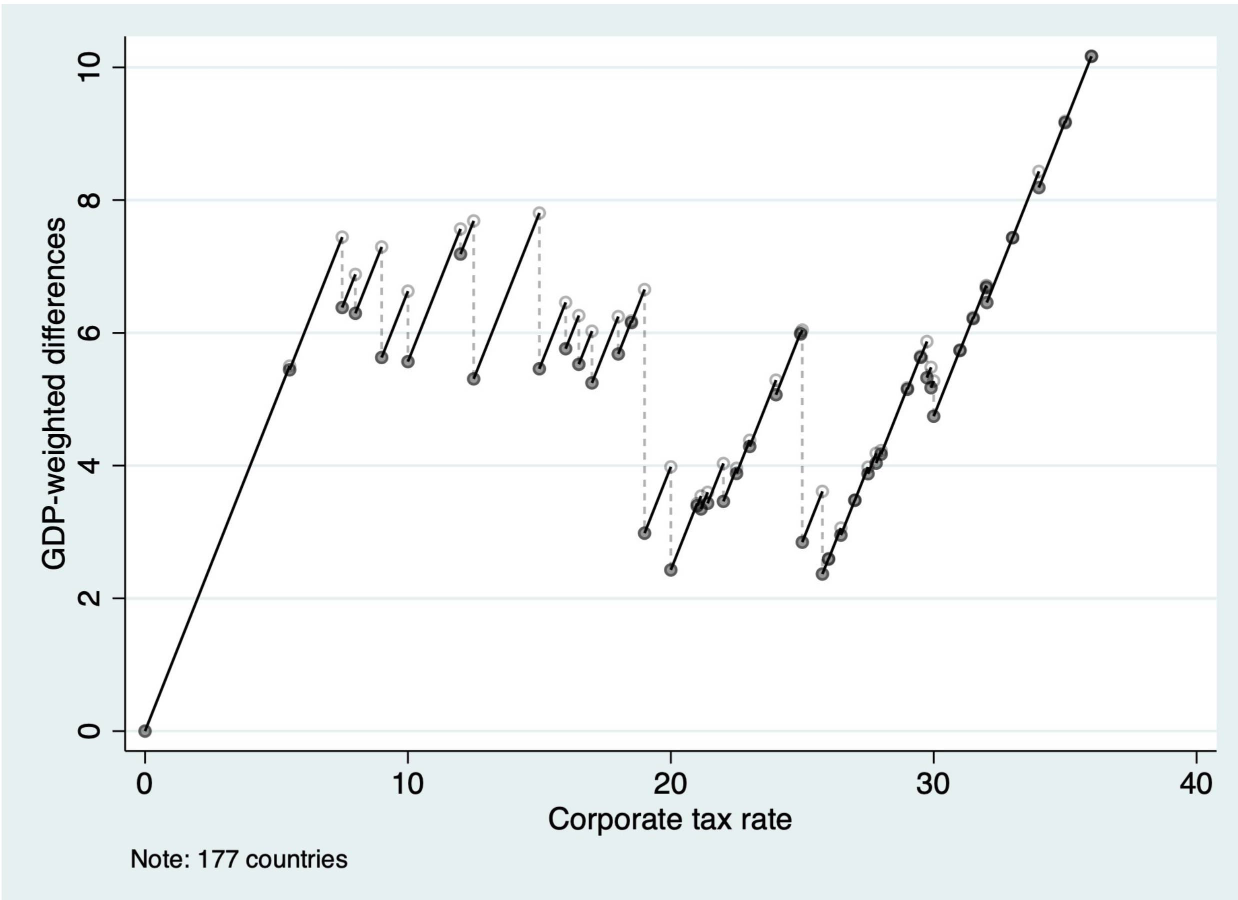
Sample	*Weights*	$\overline{\tau}$	σ	$(\overline{\tau}+\sigma)$
224 countries	Unweighted	22.58	9.18	31.76
224 countries	Population	26.72	4.60	31.32
178 countries with GDP data	Unweighted	23.86	7.53	31.39
178 countries with GDP data	GDP	25.85	4.54	30.39

Figure 1
GDP-Weighted Average Statutory Tax Rates, 2020



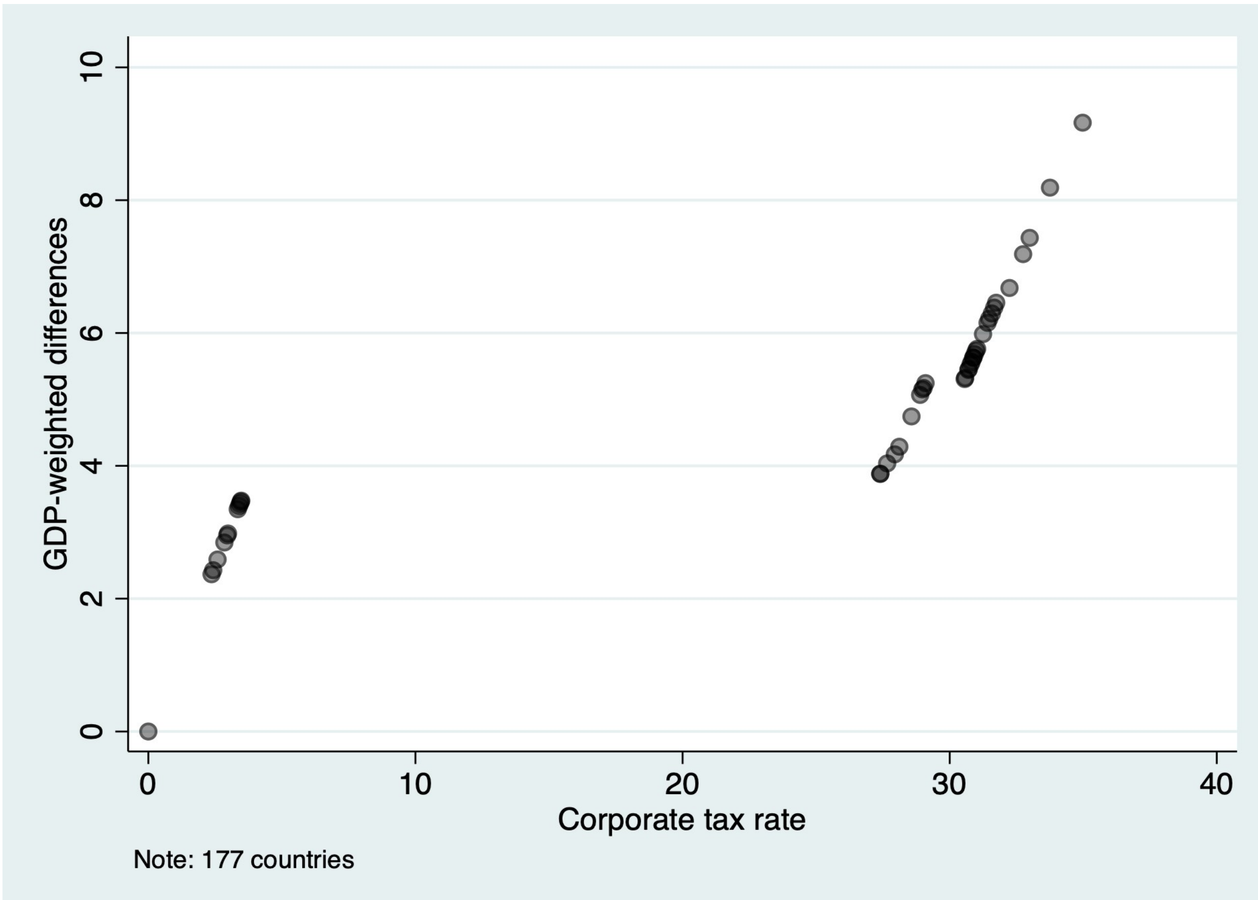
Note: the figure plots average statutory corporate tax rates $\frac{\sum_B \tau_i w_i}{\sum_B w_i}$ of countries with tax rates equal to or less than τ_m, with tax rates weighted by GDP.

Figure 2
GDP-Weighted Tax Rate Differences, 2020



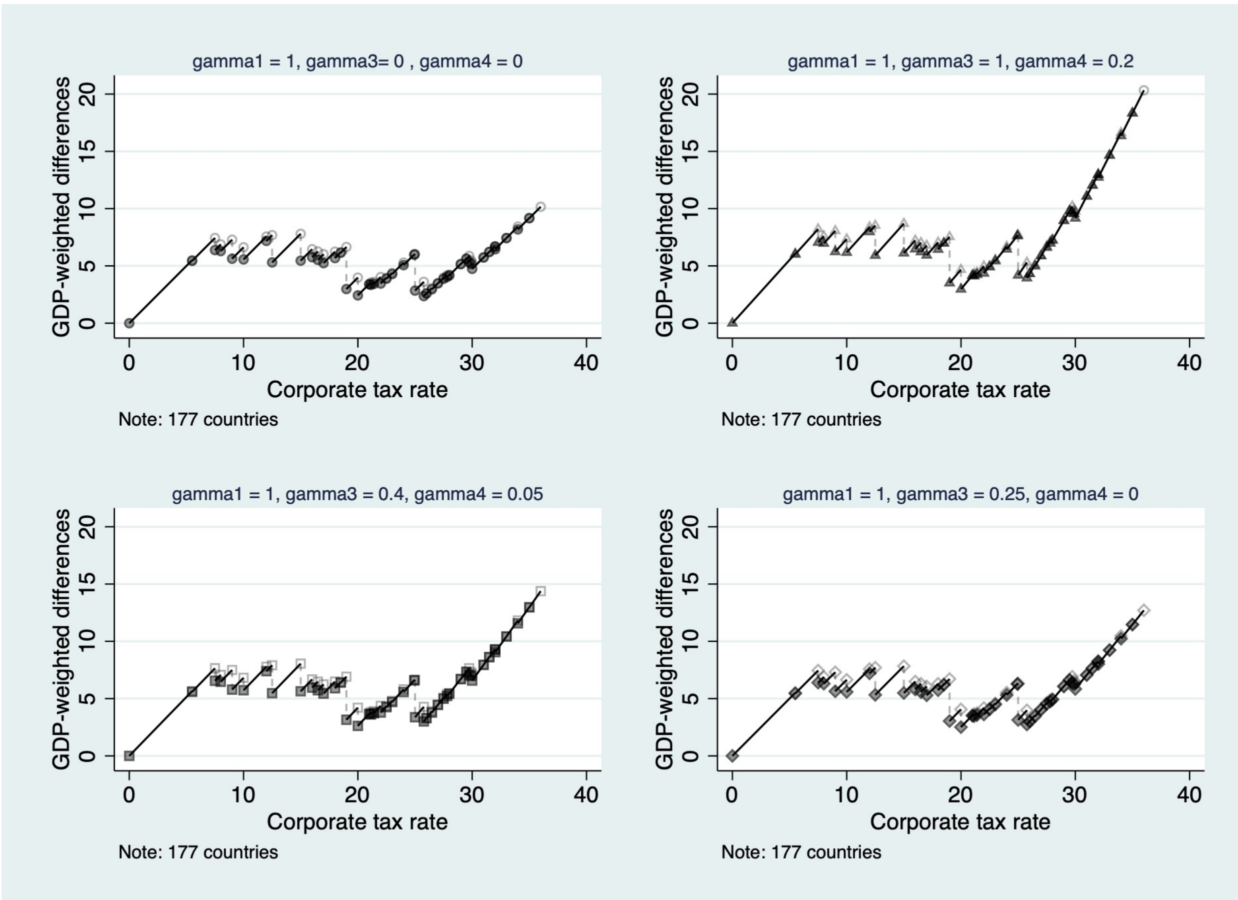
Note: the figure plots $\left[\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i} \right]$ for different possible values of τ_m using GDP weights.

Figure 3
Implied Objective-Maximizing Minimum Taxes with GDP Weights, 2020



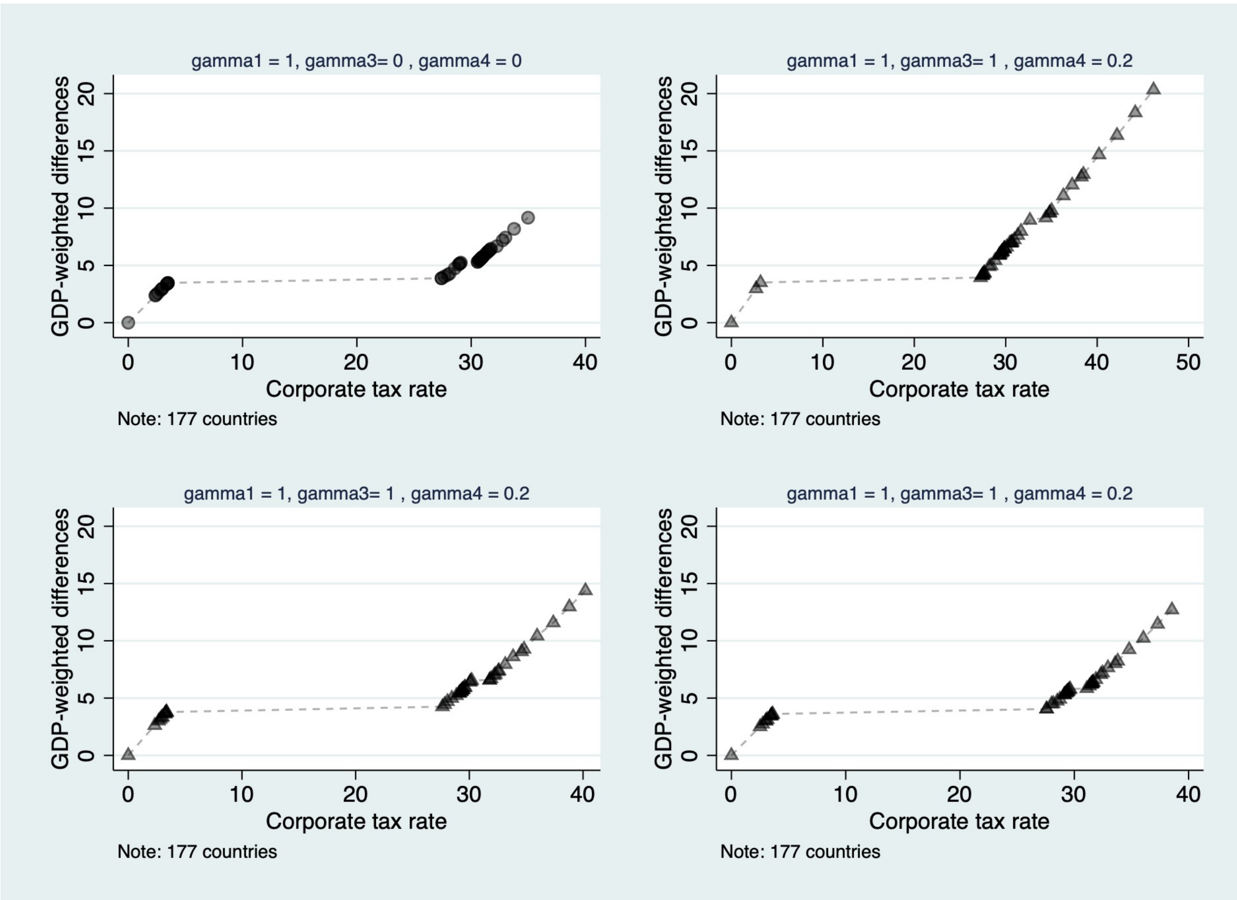
Note: The figure presents objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis).

Figure 4
GDP-Weighted Tax Rate Differences with Strategic Interactions, 2020



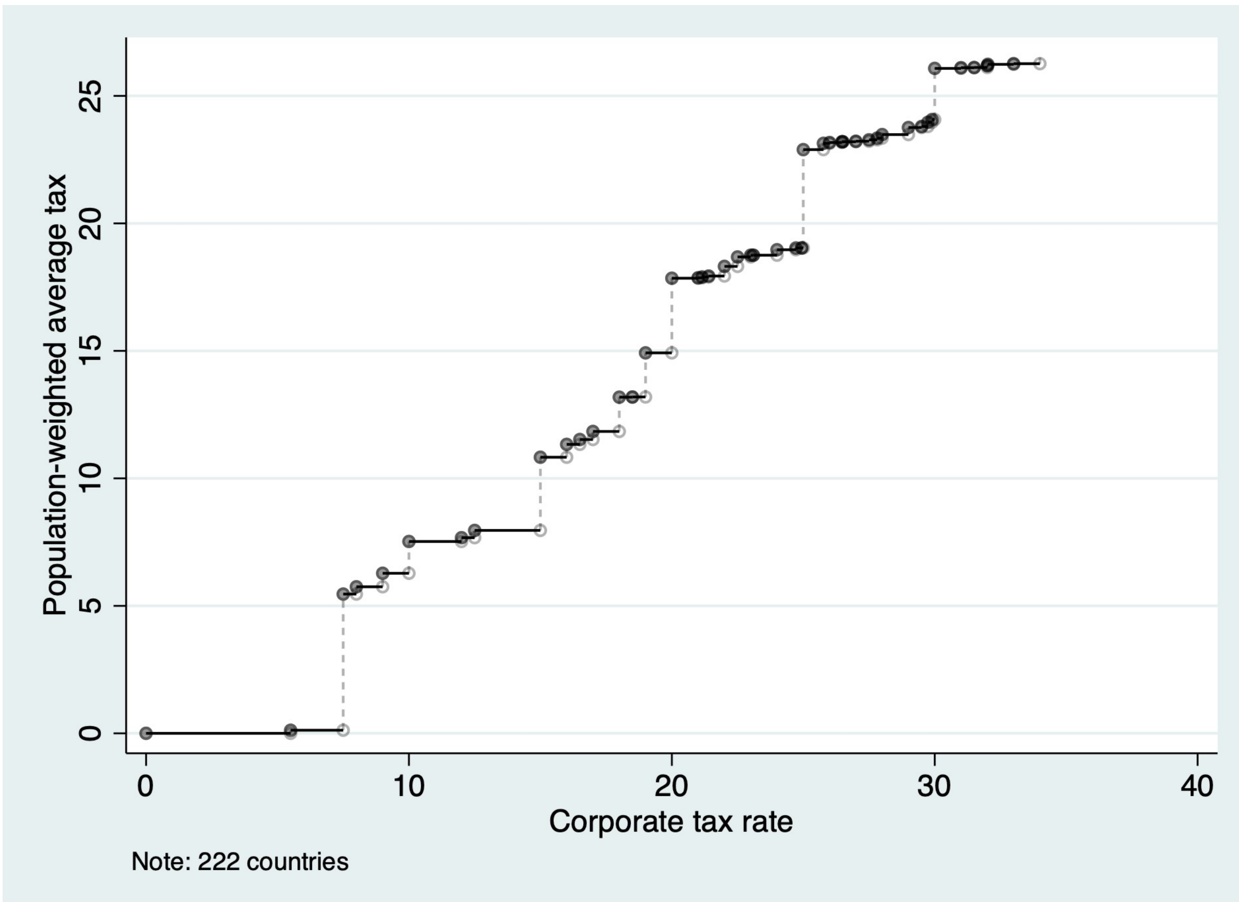
Note: The four panels of Figure 4 use 2020 corporate statutory tax rate data, weighted by GDP, to plot values of $\left[\tilde{\tau}-\frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]\left[1+\frac{\left(\gamma_3+\frac{\gamma_4}{2}\right)}{\left(\gamma_1+\frac{\gamma_4}{2}\right)}\sum_B w_i+\frac{\gamma_4}{2\gamma_1}\left(1-\sum_B w_i\right)\right]$ for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3=\gamma_4=0$; (ii) in the upper right, $\gamma_3/\gamma_1=1$ and $\gamma_4/\gamma_1=0.2$; (iii) in the lower left, $\gamma_3/\gamma_1=0.4$ and $\gamma_4/\gamma_1=0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1=0.25$ and $\gamma_4=0$.

Figure 5
Implied Objective-Maximizing Minimum Taxes with Strategic Tax Setting and GDP Weights, 2020



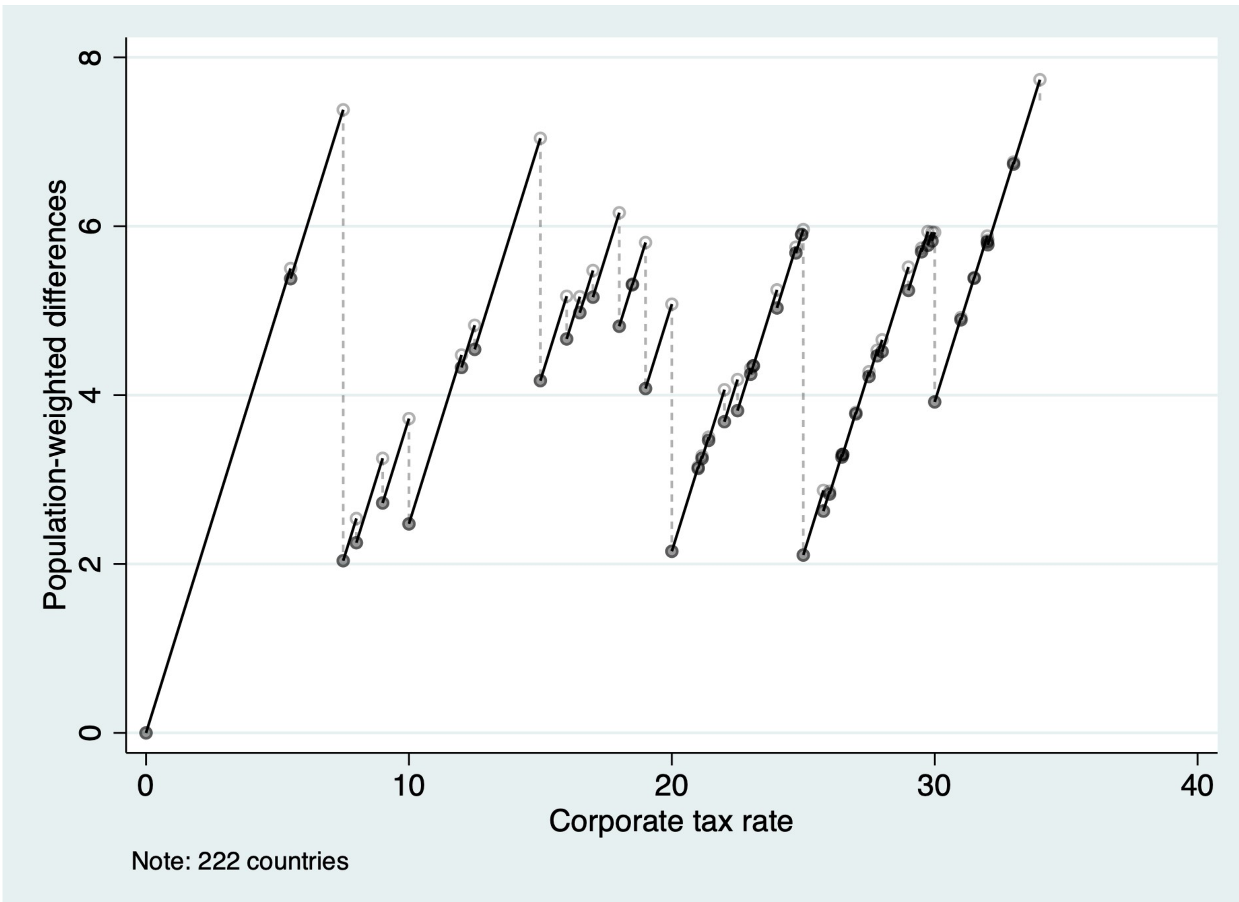
Note: The four panels of Figure 5 use 2020 corporate statutory tax rate data, weighted by GDP, to plot objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis) for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3 = \gamma_4 = 0$; (ii) in the upper right, $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$; (iii) in the lower left, $\gamma_3/\gamma_1 = 0.4$ and $\gamma_4/\gamma_1 = 0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1 = 0.25$ and $\gamma_4 = 0$.

Figure 6
Population-Weighted Average Statutory Tax Rates, 2020



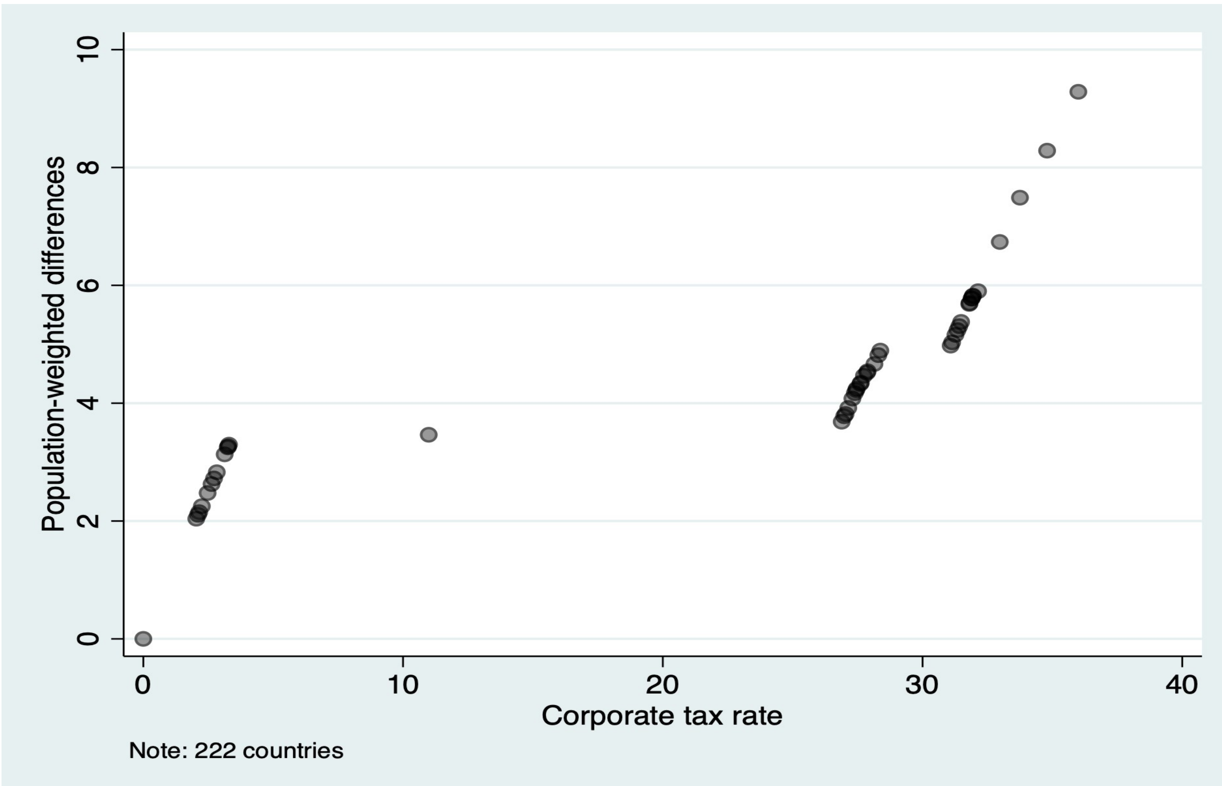
Note: the figure plots average statutory corporate tax rates $\frac{\sum_B \tau_i w_i}{\sum_B w_i}$ of countries with tax rates equal to or less than τ_m, with tax rates weighted by population.

Figure 7
Population-Weighted Tax Rate Differences, 2020



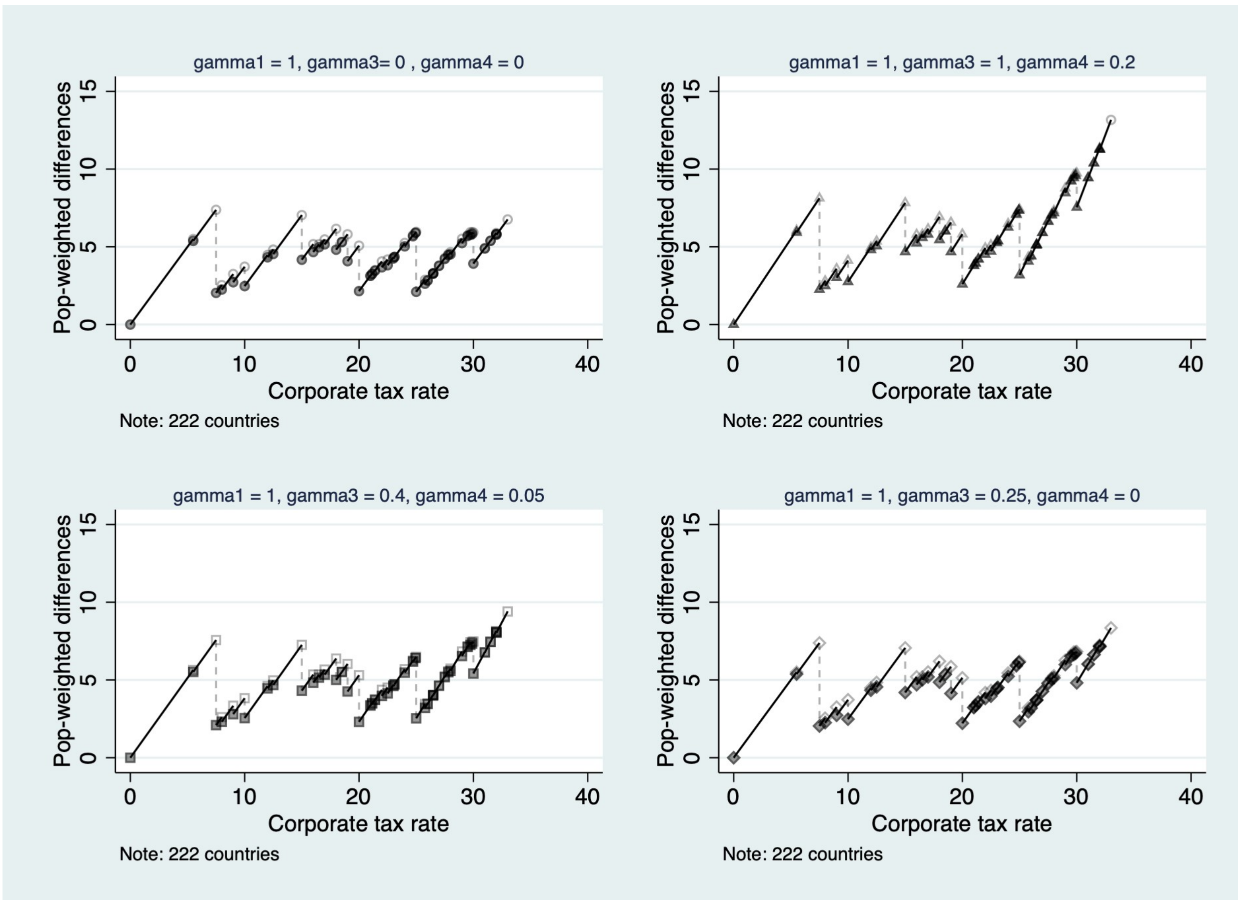
Note: the figure plots $\left[\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i} \right]$ for different possible values of τ_m using population weights.

Figure 8
Implied Objective-Maximizing Minimum Taxes with Population Weights, 2020



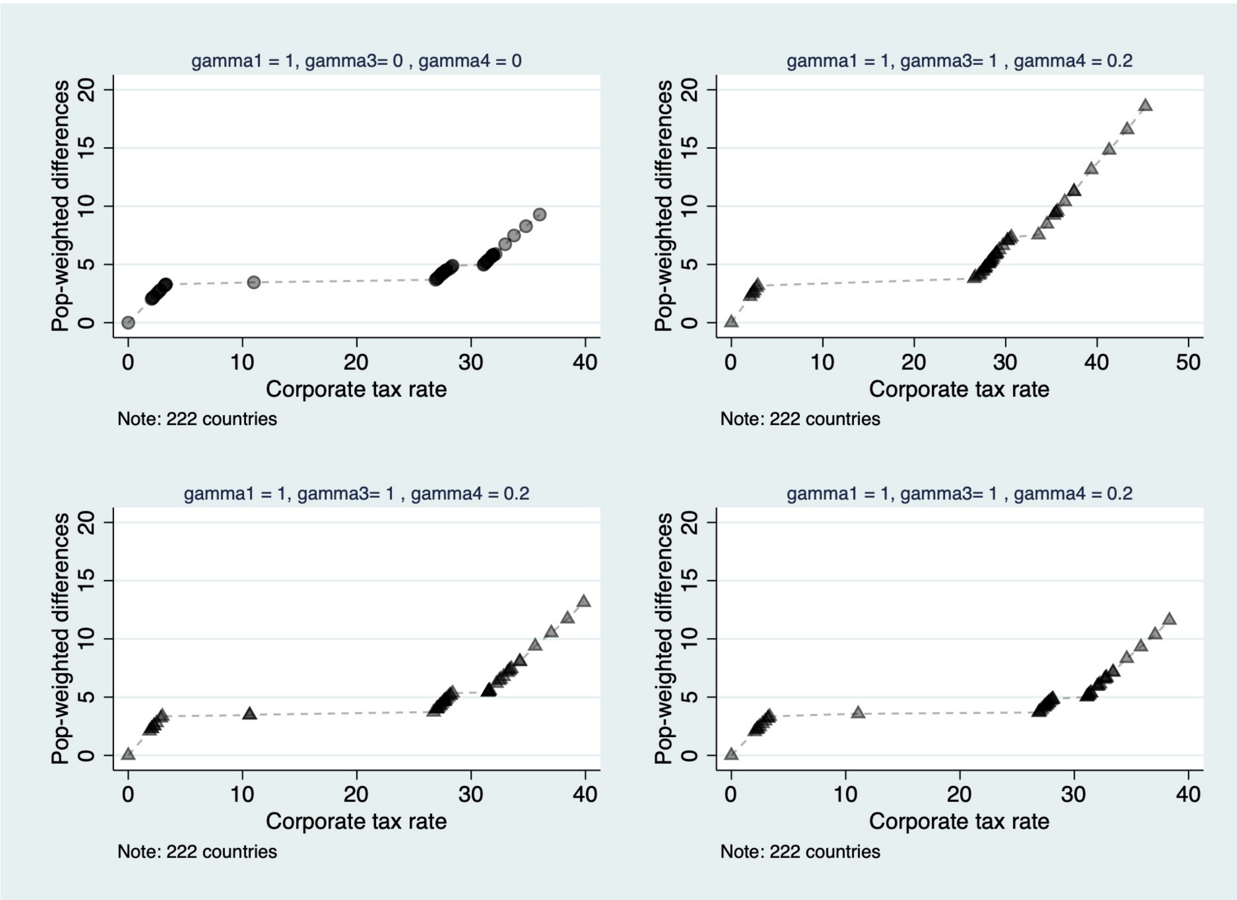
Note: The figure presents objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis).

Figure 9
Population-Weighted Tax Rate Differences with Strategic Interactions, 2020



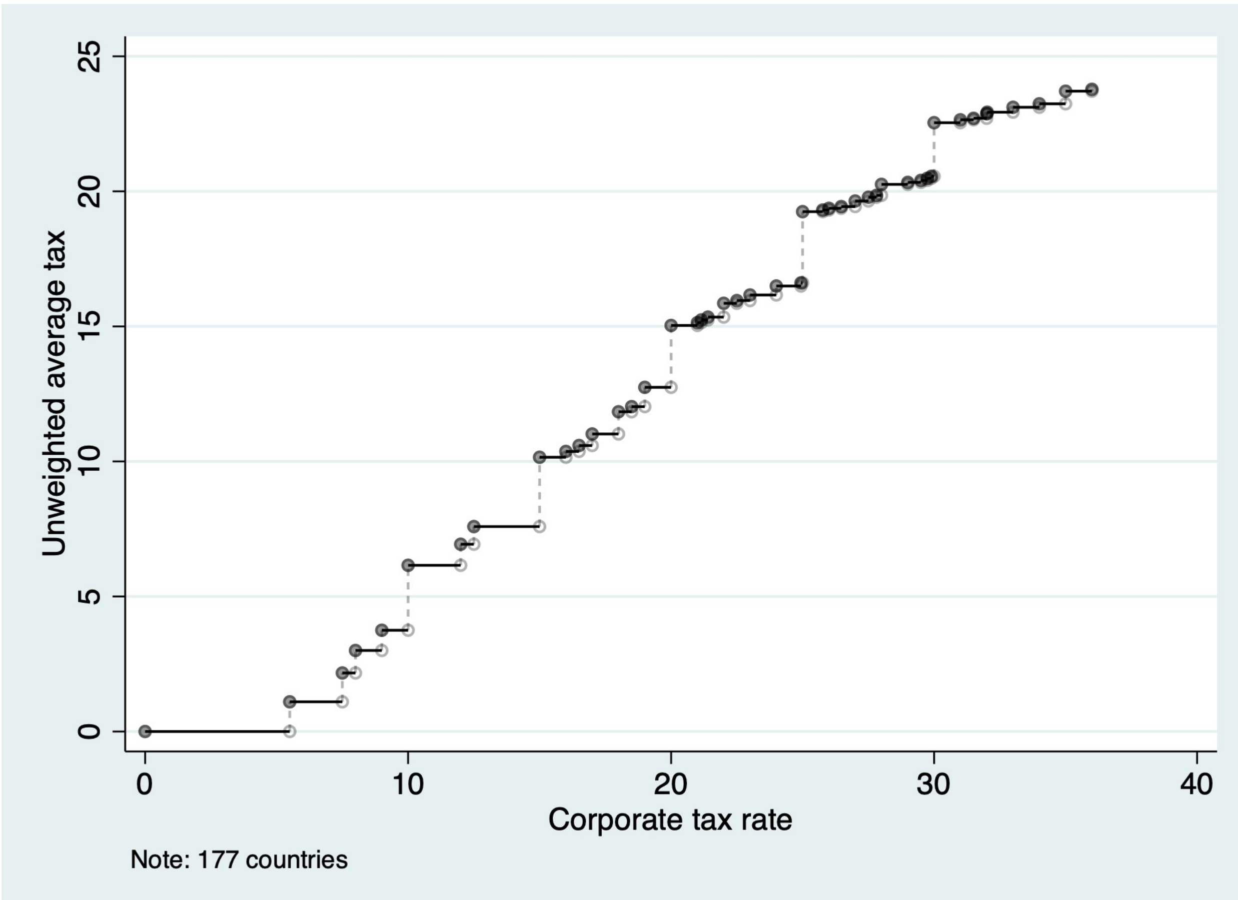
Note: The four panels of Figure 9 use 2020 corporate statutory tax rate data, weighted by population, to plot values of $\left[\tilde{\tau} - \frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]\left[1 + \frac{\left(\gamma_3 + \frac{\gamma_4}{2}\right)}{\left(\gamma_1 + \frac{\gamma_4}{2}\right)}\sum_B w_i + \frac{\gamma_4}{2\gamma_1}\left(1 - \sum_B w_i\right)\right]$ for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3 = \gamma_4 = 0$; (ii) in the upper right, $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$; (iii) in the lower left, $\gamma_3/\gamma_1 = 0.4$ and $\gamma_4/\gamma_1 = 0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1 = 0.25$ and $\gamma_4 = 0$.

Figure 10
Implied Objective-Maximizing Minimum Taxes with Strategic Tax Setting and Population Weights, 2020



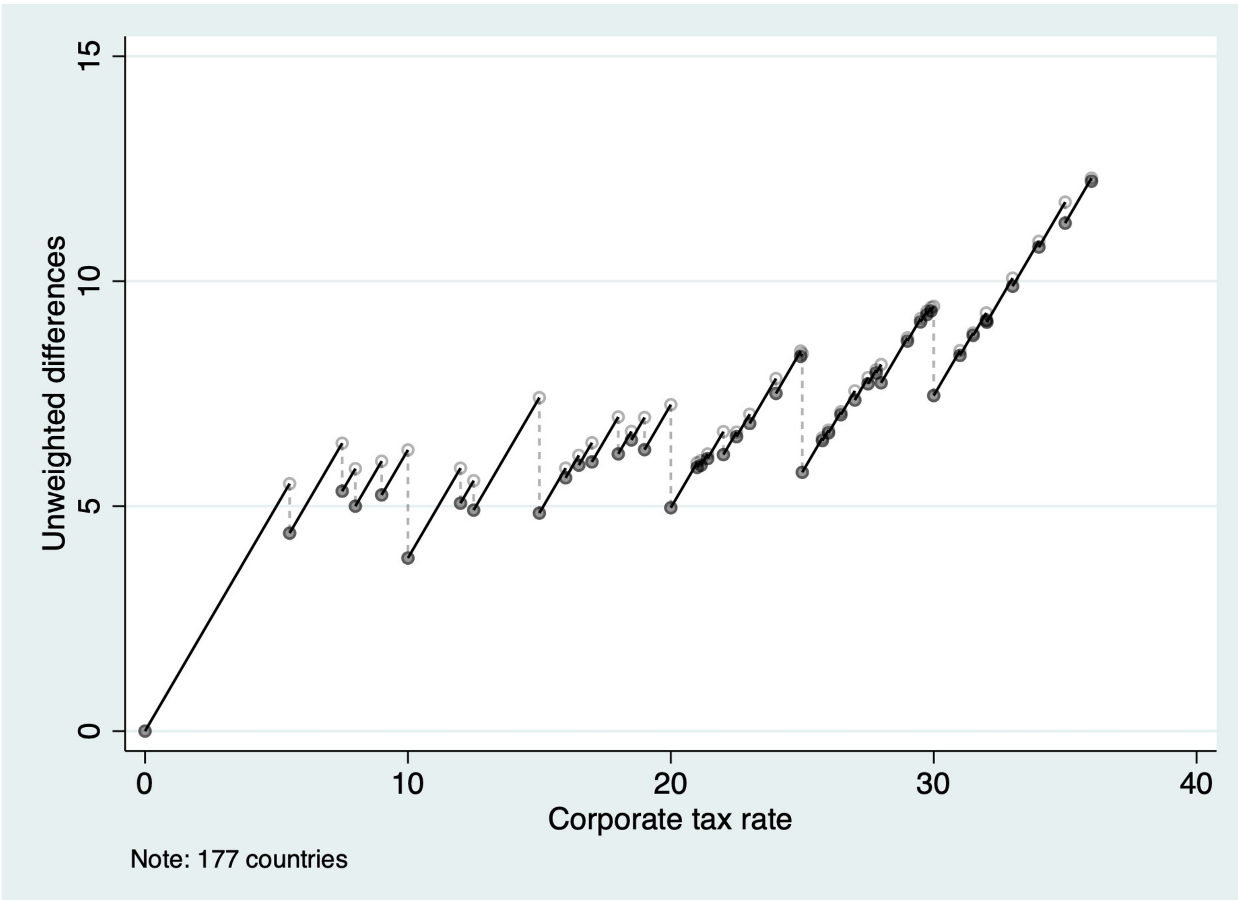
Note: The four panels of Figure 10 use 2020 corporate statutory tax rate data, weighted by population, to plot objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis) for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3 = \gamma_4 = 0$; (ii) in the upper right, $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$; (iii) in the lower left, $\gamma_3/\gamma_1 = 0.4$ and $\gamma_4/\gamma_1 = 0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1 = 0.25$ and $\gamma_4 = 0$.

Figure 11
Unweighted Average Statutory Tax Rates, 2020



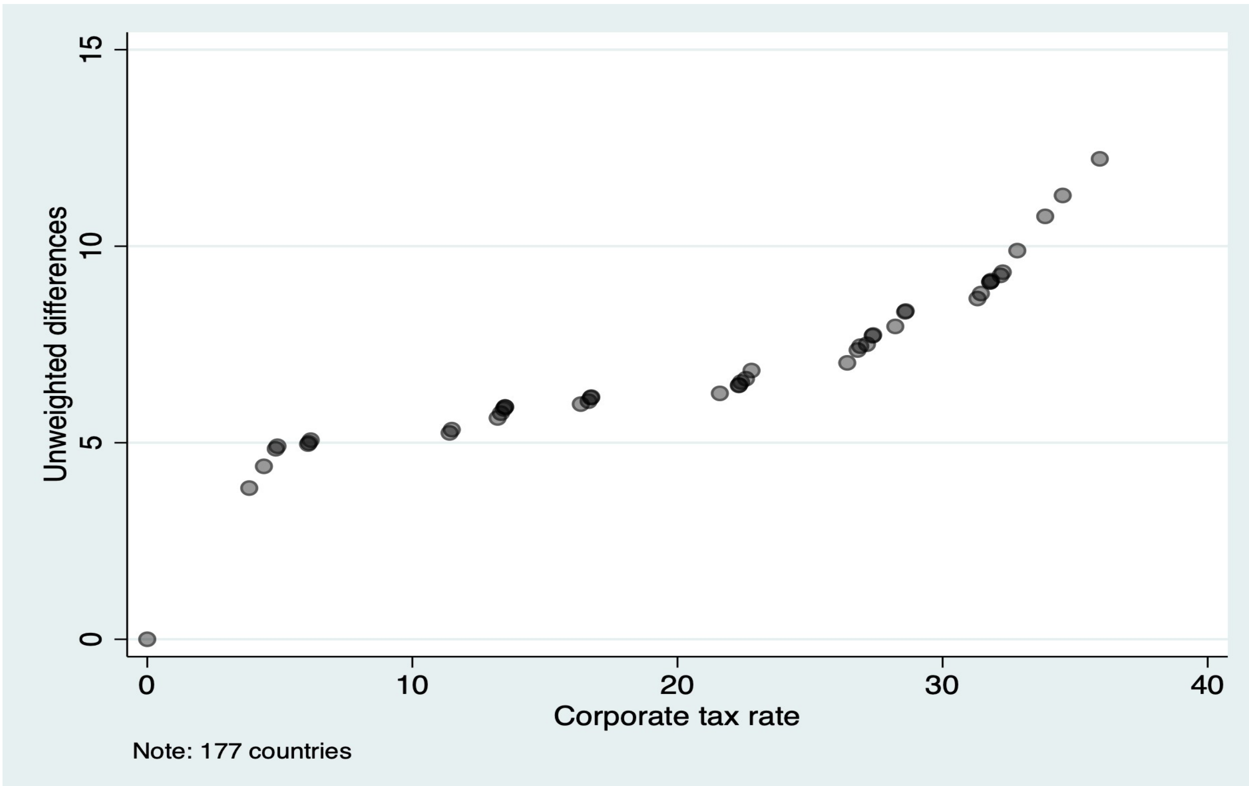
Note: the figure plots average unweighted statutory corporate tax rates $\frac{\sum_B \tau_i w_i}{\sum_B w_i}$ of countries with tax rates equal to or less than τ_m.

Figure 12
Unweighted Tax Rate Differences, 2020



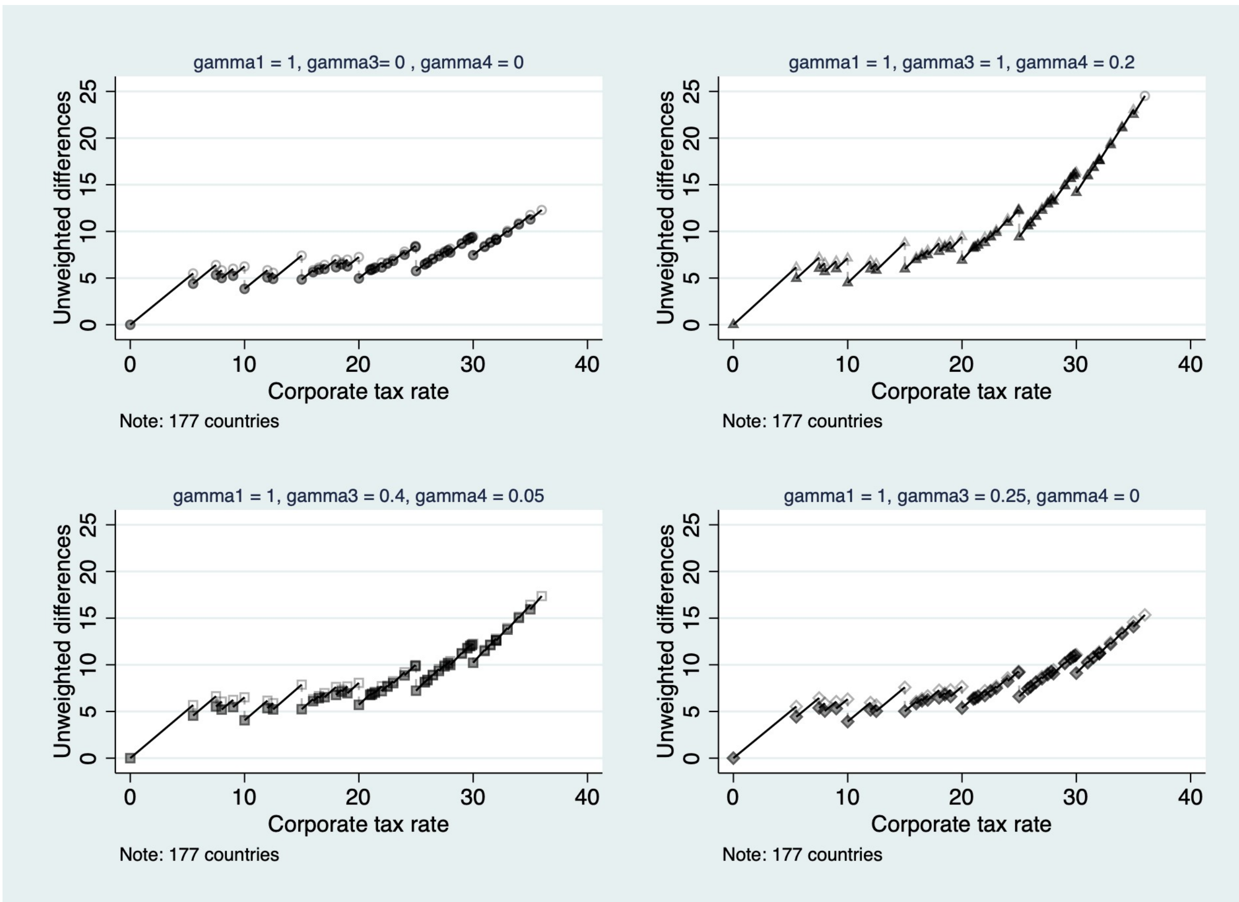
Note: the figure plots $\left[\tau_m - \frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]$ for different possible values of τ_m using unweighted statutory tax rates.

Figure 13
Implied Objective-Maximizing Minimum Taxes with Unweighted Data, 2020



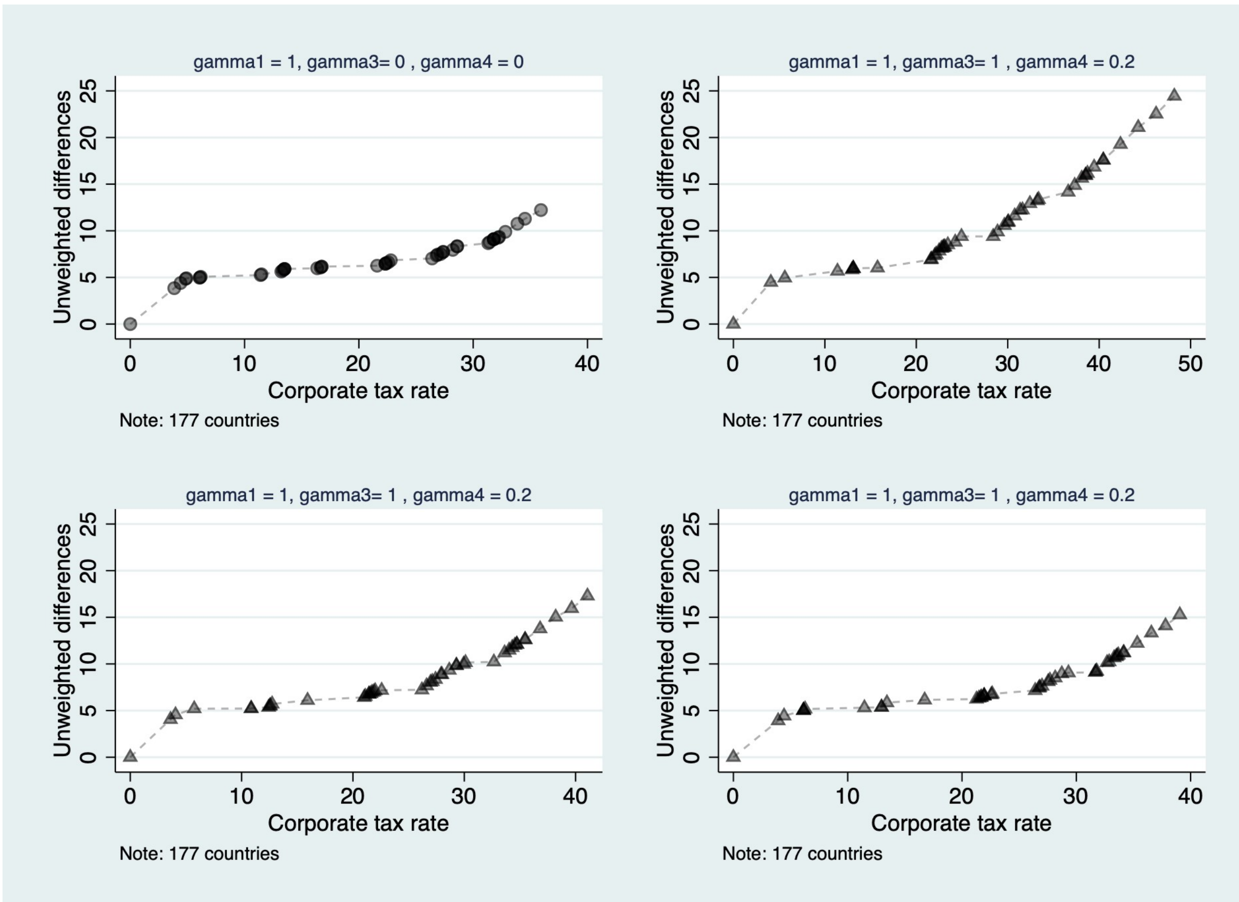
Note: The figure presents objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis).

Figure 14
Unweighted Tax Rate Differences with Strategic Interactions, 2020



Note: The four panels of Figure 14 use unweighted 2020 corporate statutory tax rate data to plot values of $\left[\tilde{\tau}-\frac{\sum_B \tau_i w_i}{\sum_B w_i}\right]\left[1+\frac{\left(\gamma_3+\frac{\gamma_4}{2}\right)}{\left(\gamma_1+\frac{\gamma_4}{2}\right)}\sum_B w_i+\frac{\gamma_4}{2\gamma_1}\left(1-\sum_B w_i\right)\right]$ for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3=\gamma_4=0$; (ii) in the upper right, $\gamma_3/\gamma_1=1$ and $\gamma_4/\gamma_1=0.2$; (iii) in the lower left, $\gamma_3/\gamma_1=0.4$ and $\gamma_4/\gamma_1=0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1=0.25$ and $\gamma_4=0$.

Figure 15
Implied Objective-Maximizing Minimum Taxes with Strategic Tax Setting and Unweighted Statutory Corporate Tax Rate Data, 2020



Note: The four panels of Figure 15 use unweighted 2020 corporate statutory tax rate data to plot objective-maximizing choices of τ_m (horizontal axis) corresponding to different values of Δ (vertical axis) for four different strategic tax setting scenarios: (i) in the upper left, $\gamma_3 = \gamma_4 = 0$; (ii) in the upper right, $\gamma_3/\gamma_1 = 1$ and $\gamma_4/\gamma_1 = 0.2$; (iii) in the lower left, $\gamma_3/\gamma_1 = 0.4$ and $\gamma_4/\gamma_1 = 0.1$; and (iv) in the lower right, $\gamma_3/\gamma_1 = 0.25$ and $\gamma_4 = 0$.