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 does not suit all governments. A second-order 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. Minimum taxes most effectively advance collective objectives when the minimum tax rate equals the sum of the average tax rate in affected countries and the average effect of tax competition. Hence there are dominated regions: in the 2020 data, world minimum corporate tax rates between 5% and 25% are dominated by tax rates outside this range.

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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 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%.

Tax competition affects tax rates to differing degrees, reflecting the relative weights that national governments attach to having rates that differ from those imposed by other countries. One outcome of unfettered tax rate competition is that governments that feel they benefit the most from having lower tax rates than others will generally obtain this result, thereby advancing collective objectives – and this aspect disappears if all governments are required to impose a harmonized rate. This insensitivity of harmonized tax rates to differing costs of tax competition is one of the aspects of harmonization that limits its ability to advance country objectives. And it is important to bear in mind that the tax rates that countries choose reflect the objectives of national governments, which may or may not correspond to policies that actually advance the welfares of their countries. Consequently, while observed tax rates permit inferences about the ability of different tax regimes to satisfy government objectives, these do not necessarily carry direct implications for policies that maximize national welfare.

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, it is always possible to impose a minimum tax rate that advances collective objectives. Furthermore, for any given harmonized tax regime, there exists a minimum tax alternative that is more consistent with collective objectives.

The model carries the implication that 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 were 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, 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 first order condition for maximizing government objectives.

This multiplicity of local maxima arises because a minimum tax requires all countries to adhere to the same minimum rate, even though their circumstances differ. A minimum tax rate of 15% that would advance collective objectives by requiring low-rate countries to impose at least 15% taxes would not affect countries with tax rates of 20%. If it would also help advance collective objectives to have 20% tax rate countries increase their tax rates to 25%, this can be achieved with a minimum tax, but only by requiring very low tax rate countries to increase their taxes quite a bit above 15%. If both 15% tax rates and 25% tax rates satisfy the local conditions for maximizing collective objectives, then it is necessary to evaluate the effects of increasing taxes between 15% and 25% in order to evaluate which of these two minimum tax rates in fact maximizes collective objectives. If the outcome with a 25% minimum tax rate is the one that is more consistent with government objectives – which is a distinct possibility, perhaps even a likelihood – then it follows that there is a dominated range of minimum tax rates, since no minimum tax rate between 15% and 25% is consistent with maximizing collective objectives, regardless of the effect of tax competition on tax rates.

Evidence from world corporate tax rates in 2020 indicates that there is a wide range of dominated minimum tax rates: that no rate between about 5% and 25% is consistent with maximizing collective objectives. This conclusion emerges from a framework that weights country objectives and tax rates by GDP, though population weights produce a very similar outcome. If tax competition depresses (weighted) average tax rates by less than 5%, then a minimum tax rate of 5% or less advances collective objectives, whereas if tax competition has a significantly larger effect on average tax rates, then a minimum tax rate of 25% or higher maximizes collective objectives.

Applying theory to select harmonized or minimum tax rates that best advance government objectives requires knowledge of an empirical magnitude – the effect of tax competition on tax rates – that can be difficult to ascertain. The standard deviation rule for tax harmonization emerges from comparing existing uncoordinated policies and an idealized harmonization regime. Choosing the common tax rate that best advances collective objectives requires precise knowledge of the extent to which tax competition affects tax rates in the absence of coordination – and any inaccuracy in estimating this effect impedes the ability of a harmonized regime to satisfy government objectives. Explicitly incorporating imprecise estimation of the effect of tax competition yields a straightforward modification of the standard deviation rule, one that generally reduces range of circumstances in which harmonization advances government objectives and that reduces the objective-maximizing minimum tax rate.

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 real function of tax harmonization or minimum taxation lies in its impact on competition. Countries can, if they wish, adopt strong unilateral measures to protect their tax bases, including all of those contained in the OECD (2021) blueprint – but those who might otherwise be inclined are deterred from doing so on a unilateral basis out of concern over their anticompetitive effects, including reactions from other countries and the domestic politics of deviating from world norms. Consequently, it is appropriate to consider tax harmonization and minimum taxation in the context of tax competition.

This paper analyzes international business taxation, but the second order approximation that is the basis of the analysis appears to apply more generally to any competitive context. This includes not only subnational taxation, but many other government policies with competitive implications, such as environmental and other business regulations, minimum wages, school curricula, and others. The extent to which harmonizing any of these policies is consistent with 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 minima, 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

$O_i(\tau_i, d_i)$ 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.[1] For analytical convenience, $O_i(\tau_i, d_i)$ is taken to be continuous and twice continuously differentiable in its arguments, with higher values of $O_i(\tau_i, d_i)$ 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 $O_i(\tau_i, d_i)$

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[1] A country's own tax rate is a minor component of $\overline{\tau}$, a consideration that the $O_i(\tau_i, d_i)$ function can incorporate (and undo) in its weighting of d_i.

can be evaluated using a Taylor expansion around $O_i\left(\tau_i^*,0\right)$, the second-order approximation of which is

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

with $\gamma_{0i}=\dfrac{\partial O_i\left(\tau_i^*,0\right)}{\partial\tau_i}$, $\gamma_{1i}=\dfrac{-1}{2}\dfrac{\partial^2 O_i\left(\tau_i^*,0\right)}{\partial\tau_i^2}$, $\gamma_{2i}=\dfrac{-\partial O_i\left(\tau_i^*,0\right)}{\partial d_i}$, $\gamma_{3i}=\dfrac{-1}{2}\dfrac{\partial^2 O_i\left(\tau_i^*,0\right)}{\partial d_i^2}$, and $\gamma_{4i}=\dfrac{-\partial^2 O_i\left(\tau_i^*,0\right)}{\partial\tau_i\partial d_i}$.

Since τ_i^* is the objective-maximizing tax rate in the absence of tax differences, it follows that $\dfrac{\partial O_i\left(\tau_i^*,0\right)}{\partial\tau_i}=\gamma_{0i}=0$; and since τ_i^* corresponds to a maximum it must be the case that $\dfrac{-1}{2}\dfrac{\partial^2 O_i\left(\tau_i^*,0\right)}{\partial\tau_i^2}=\gamma_{1i}>0$. 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 strongly 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, it follows that countries perceive the welfare effect of their own tax changes to be

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

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

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

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}

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^*

[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 $\gamma_{1i} + \gamma_{3i} + \gamma_{4i} > 0$.

$\frac{\partial \tau_i}{\partial \tau_i^*} > 0$, 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, the system 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

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

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

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

Collecting terms and simplifying, (5) becomes

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

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

(7)
$$H \approx \sum O_i\left(\tau_i^*,0\right)w_i - \sum\left(\tau_i^*-\tau_h\right)^2\gamma_{1i}w_i .$$

The first order condition corresponding to maximizing (7) implies that the objective-maximizing harmonized tax rate τ_h^* is

(8)
$$\tau_h^* = \frac{\sum \tau_i^*\gamma_{1i}w_i}{\sum \gamma_{1i}w_i} .$$

Equation (8) 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 (8) in harmonizing their tax rates, collective objectives are given by

$$H^* \approx \sum O_i\left(\tau_i^*,0\right)w_i - \sum \tau_i^{*2}\gamma_{1i}w_i + \frac{\left[\sum \tau_i^*\gamma_{1i}w_i\right]^2}{\sum \gamma_{1i}w_i}. \tag{9}$$

In evaluating the resulting expression for (9), it is useful to apply (4) to obtain that

$$\begin{aligned}\left[\sum \tau_i^*\gamma_{1i}w_i\right]^2 &= \left[\sum \tau_i^*\gamma_{1i}w_i - \sum \tau_i\gamma_{1i}w_i\right]^2 + \left[\sum \tau_i\gamma_{1i}w_i\right]^2 \\ &+2\left[\sum \tau_i\gamma_{1i}w_i\right]\sum \frac{\left[\left(\tau_i-\overline{\tau}\right)\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)+\frac{\gamma_{2i}}{2}\right]\gamma_{1i}w_i}{\gamma_{1i}+\frac{\gamma_{4i}}{2}}.\end{aligned} \tag{10}$$

Equations (9) and (10) together imply that

$$\begin{aligned}H^* &\approx \sum O_i\left(\tau_i^*,0\right)w_i - \sum \tau_i^{*2}\gamma_{1i}w_i + \frac{\left[\sum \tau_i^*\gamma_{1i}w_i - \sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]} + \frac{\left[\sum \tau_i\gamma_{1i}w_i\right]^2}{\left[\sum \gamma_{1i}w_i\right]} \\ &+2\frac{\left[\sum \tau_i\gamma_{1i}w_i\right]}{\left[\sum \gamma_{1i}w_i\right]}\sum \frac{\left[\left(\tau_i-\overline{\tau}\right)\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)+\frac{\gamma_{2i}}{2}\right]\gamma_{1i}w_i}{\gamma_{1i}+\frac{\gamma_{4i}}{2}}.\end{aligned} \tag{11}$$

Using the difference between (6) and (11) to identify the difference between aggregate objectives satisfaction of harmonizing taxes at rate τ_h^*,

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

$$+\sum \frac{\gamma_{2i}\gamma_{1i} w_i}{\gamma_{1i} + \frac{\gamma_{4i}}{2}} \left[\overline{\tau} - \frac{\sum \tau_j \gamma_{1j} w_j}{\left[\sum \gamma_{1i} w_i\right]}\right] - \overline{\tau}^2 \sum \gamma_{3i} w_i - \overline{\tau} \sum \gamma_{4i} w_i \qquad (12)$$

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

Equation (12) 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 (12) simplifies to

$$S - H^* = \sum \left(\tau_i - \overline{\tau}\right)^2 \left(\gamma_{1i} + \gamma_{3i} + \gamma_{4i}\right) w_i - \Delta^2 \sum \gamma_{1i} w_i , \qquad (13)$$

in which

$$\Delta = \frac{\sum \left(\tau_i^* - \tau_i\right) \gamma_{1i} w_i}{\sum \gamma_{1i} w_i} \qquad (14)$$

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

2.4. Implications.

Equation (13) 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 (13) can be broken into two components, as

(13')
$$S - H^* = \left[\sum (\tau_i - \overline{\tau})^2 \gamma_{1i} w_i - \Delta^2 \sum \gamma_{1i} w_i\right] + \sum (\tau_i - \overline{\tau})^2 (\gamma_{3i} + \gamma_{4i}) w_i .$$

The first component of the right side of (13') 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 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 (13') to be negative.

The remarkably simple standard deviation rule also carries an implication for the range of potential objective-maximizing harmonized tax rates. From (14), the objective-maximizing harmonized tax rate is the sum of the average observed tax rate and the average effect of tax competition

(15)
$$\tau_h^* = \frac{\sum \tau_i \gamma_{1i} w_i}{\sum \gamma_{1i} w_i} + \Delta .$$

Since (13) 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 (15) 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 (13). It is nonetheless striking that the criterion for tax harmonization takes so simple a form.

One of the important features of (13) is that it arises from imposing (8), the objective-maximizing harmonized tax rate τ_h^*. Adoption of τ_h^* as a harmonized rate requires the central authority to know aggregate desired tax rates in the absence of competition, or equivalently, to know 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 (9). For example, if instead of adopting τ_h^* as the harmonized rate, governments instead were to adopt $\tau_h^* + \varepsilon_h$, then it is straightforward to show that (13) becomes

$$S - H^* = \sum \left(\tau_i - \overline{\tau}\right)^2 \left(\gamma_{1i} + \gamma_{3i} + \gamma_{4i}\right) w_i + \varepsilon_h^2 \sum \gamma_{1i} w_i - \Delta^2 \sum \gamma_{1i} w_i \,. \tag{13'}$$

If uncertainty over the value of Δ is the reason why a harmonized tax rate may deviate from τ_h^*, then (13') implies that the standard deviation rule should be adjusted to compare the variance of tax rates with $\left(\Delta^2 - \varepsilon_h^2\right)$, 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 the standard deviation rule it is necessary to calculate means and standard deviations of the corporate tax rates that countries choose in the absence of collective action. Table 1 presents these statistics for statutory corporate tax rates around the world, using data for 2020 reported by the Tax Foundation. 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%. It is noteworthy that the population-weighted 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.

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 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 would 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 influence the tax rates that countries choose. Aggregate objective satisfaction with a minimum tax rate τ_m is

$$M \approx \sum O_i\left(\tau_i^*,0\right)w_i - \sum_A\left(\hat{\tau}_i-\tau_i^*\right)^2\gamma_{1i}w_i - \sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)\gamma_{2i}w_i - \sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)^2\gamma_{3i}w_i$$

(16) $$-\sum_A\left(\hat{\tau}_i-\overline{\tau}_m\right)\left(\hat{\tau}_i-\tau_i^*\right)\gamma_{4i}w_i - \sum_B\left(\tau_m-\tau_i^*\right)^2\gamma_{1i}w_i - \sum_B\left(\tau_m-\overline{\tau}_m\right)\gamma_{2i}w_i \quad ,$$

$$-\sum_B\left(\tau_m-\overline{\tau}_m\right)^2\gamma_{3i}w_i - \sum_B\left(\tau_m-\tau_i^*\right)\left(\tau_m-\overline{\tau}_m\right)\gamma_{4i}w_i$$

in which

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

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 (17) that

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

Which can be simplified to yield

(19) $$\overline{\tau}_m = \overline{\tau} + \frac{\sum_B \tau_i w_i + \tau_m \sum_B w_i}{\sum_B w_i + \sum_A \frac{\gamma_{1i}+\frac{\gamma_{4i}}{2}}{\gamma_{1i}+\gamma_{2i}+\gamma_{3i}}}.$$

Differentiating (19) produces

(20) $$\frac{d\overline{\tau}_m}{d\tau_m} = \frac{\sum_B w_i}{\sum_B w_i + \sum_A \frac{\gamma_{1i}+\frac{\gamma_{4i}}{2}}{\gamma_{1i}+\gamma_{2i}+\gamma_{3i}}}.$$

Slightly increasing the minimum tax rate will increase the number of countries for which the minimum tax is a binding constraint, thereby increasing the world average tax rate and possibly inducing additional tax changes through strategic reactions. From the envelope condition, the induced individual country tax changes have no consequences for objective

τ_m and applying the envelope condition for each country produces

$$
(21)\qquad
\begin{aligned}
\frac{dM}{d\tau_m} = & -2\sum_B\left(\tau_m-\tau_i^*\right)\left(\gamma_{1i}+\frac{\gamma_{4i}}{2}\right)w_i-\sum_B\gamma_{2i}w_i-2\left(\tau_m-\overline{\tau}_m\right)\sum_B\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)w_i \\
& +\frac{d\overline{\tau}_m}{d\tau_m}\left[\begin{aligned}&\sum\gamma_{2i}w_i+2\sum_A\hat{\tau}_i\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)w_i-2\overline{\tau}_m\sum\gamma_{3i}w_i\\ &-\sum\tau_i^*\gamma_{4i}w_i+2\tau_m\sum_B\left(\gamma_{3i}+\frac{\gamma_{4i}}{2}\right)w_i\end{aligned}\right].
\end{aligned}
$$

Setting the right side of (21) equal to zero and applying (20) implicitly characterizes the minimum tax rate that best advances collective objectives. One of the challenges of applying the resulting conditions is that 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 strategic reactions are the same, and specifically that $\gamma_{ji} = \gamma_j, \forall i, j = 1,3,4$.

This assumption greatly simplifies the resulting calculations, as a result of which (21) becomes

$$
(22)\qquad
\begin{aligned}
\frac{dM}{d\tau_m} = & \left(\gamma_1+\gamma_2+\gamma_3\right)\left[\sum_B\tau_i w_i-\tau_m\sum_B w_i\right]+\left(\gamma_3+\frac{\gamma_4}{2}\right)\left(\overline{\tau}_m-\overline{\tau}\right)\sum_B w_i \\
& +\frac{d\overline{\tau}_m}{d\tau_m}\left\{\begin{aligned}&\frac{\gamma_1}{\gamma_1+\gamma_4}\sum\frac{\gamma_2}{2}+\tau_m\left(\gamma_3+\frac{\gamma_4}{2}\right)\sum_B w_i+\left(\gamma_3+\frac{\gamma_4}{2}\right)\sum_A\tau_i w_i-\overline{\tau}\left(\gamma_3+\frac{\gamma_4}{2}\right)\\ &+\left[\sum_A w_i\frac{\left(\gamma_3+\frac{\gamma_4}{2}\right)^2}{\left(\gamma_1+\gamma_2+\gamma_3\right)}-\gamma_3\right]\left[\frac{\sum\tau_i w_i+\tau_m\sum_B w_i-\overline{\tau}}{\sum_B w_i+\frac{\left(\gamma_1+\frac{\gamma_4}{2}\right)}{\left(\gamma_1+\gamma_2+\gamma_3\right)}}\right]\end{aligned}\right\}.
\end{aligned}
$$

Considerable algebraic manipulation plus applying (20) yields

$$\text{(23)} \qquad \frac{dM/d\tau_m}{2\left(d\overline{\tau}_m/d\tau_m\right)} = \left[\frac{\sum_B \tau_i w_i}{\sum_B w_i} - \tau_m\right]\left[1 + \frac{\gamma_4\left(1-\sum_B w_i\right)}{2\gamma_1\left[1+\frac{\left(\gamma_3+\frac{\gamma_4}{2}\right)}{\left(\gamma_1+\frac{\gamma_4}{2}\right)}\sum_B w_i\right]}\right] + \Delta .$$

Denoting by τ_m^* the tax rate at which $dM/d\tau_m = 0$, it follows from (23) and (3) that

$$\text{(24)} \qquad \tau_m^* = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \frac{\Delta}{\left[1 + \frac{\gamma_4\left(1-\sum_B w_i\right)}{2\gamma_1\left[1+\frac{\left(d\tau/d\overline{\tau}\right)}{\left(1-d\tau/d\overline{\tau}\right)}\sum_B w_i\right]}\right]} .$$

Equation (24) is most readily interpreted in the case in which $\gamma_4 = 0$, when 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. It is noteworthy that, in that case, the relevant value of Δ 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 the two different 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 that group would, applying (8), 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 the achievement of objectives of countries in group A, the amount that tax competition reduces their tax rates also matters to the calculation of (24), with relative weights that produce a rule based on the simple aggregate effect of tax competition on all countries.

Equation (24) suggests that even explicit incorporation of strategic tax interactions produces a rule that is closely approximated by an objective-maximizing minimum tax rate equal

γ_4 term that appears in (24) 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 (24) 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 (24) 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. 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

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

Denoting by $\tilde{\tau}$ the tax rate τ_i for which the left side of (25) equals the right, it follows that

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

Imposing (26), and replacing τ_m^* with $\tilde{\tau}$, (24) becomes

(27) $$\tilde{\tau} = \frac{\sum_B \tau_i w_i}{\sum_B w_i} + \frac{\Delta}{1 + \frac{(d\tau/d\overline{\tau})}{(1 - d\tau/d\overline{\tau})} \sum_B w_i + \frac{\gamma_4 \left(1 - \sum_B w_i\right)}{2\gamma_1}}.$$

Equation (27) can be applied to data, using the value of $\tilde{\tau}$ drawn from the top of the distribution of tax rates of group B. Directly applying (27) requires knowledge of $d\tau/d\overline{\tau}$ as well as γ_1 and γ_4, though directional results are obtainable even without these parameter values. One of the important implications of (27) 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 must rise monotonically with τ_m, the rate of increase is indeterminate, and in particular may be quite high over certain tax rate ranges. As a result, more than one value of $\tilde{\tau}$ may satisfy (27), and therefore more than one value of τ_m satisfy (24).

5. Analysis of Minimum Taxes with 2020 Data

This section uses the 2020 corporate tax rate data to analyze the extent to which different possible minimum tax rates are consistent with maximizing collective objectives.

6. Interpretation

To be provided.

7. Conclusion

To be provided.

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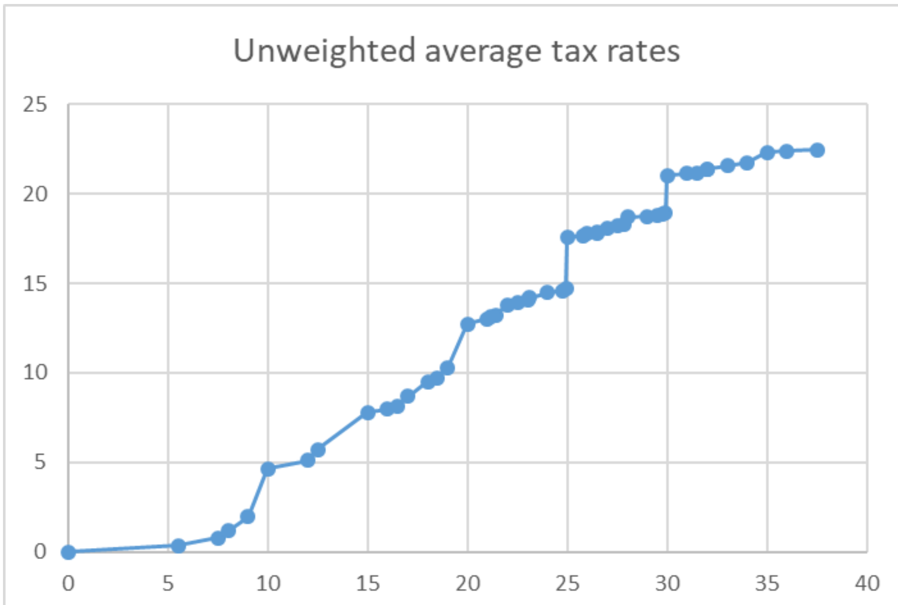
Table 1

World Corporate Tax Rate Means and Standard Deviations, 2020

Sample	*Weights*	$\bar{\tau}$	σ	$(\bar{\tau}+\sigma)$
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

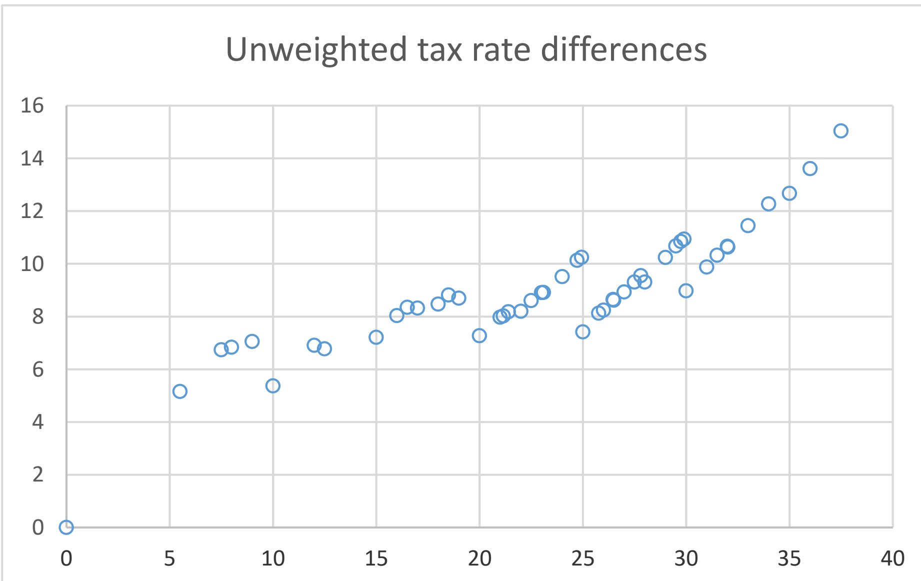
Figure 1

Average
tax rate of
affected
countries



Minimum tax rate

Figure 1b


Unweighted tax rate differences
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14
12
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30
35
40

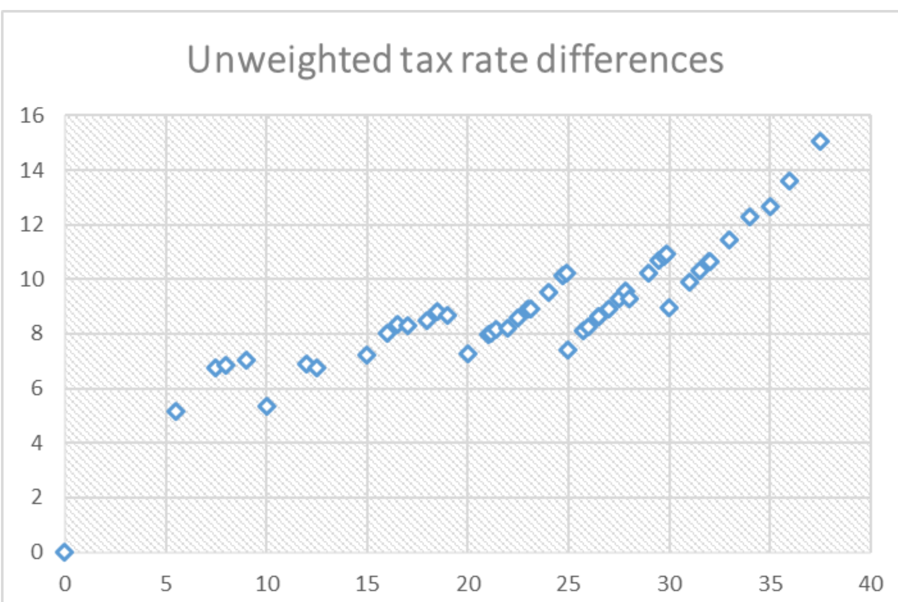
Unweighted tax rate differences
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Figure 2a

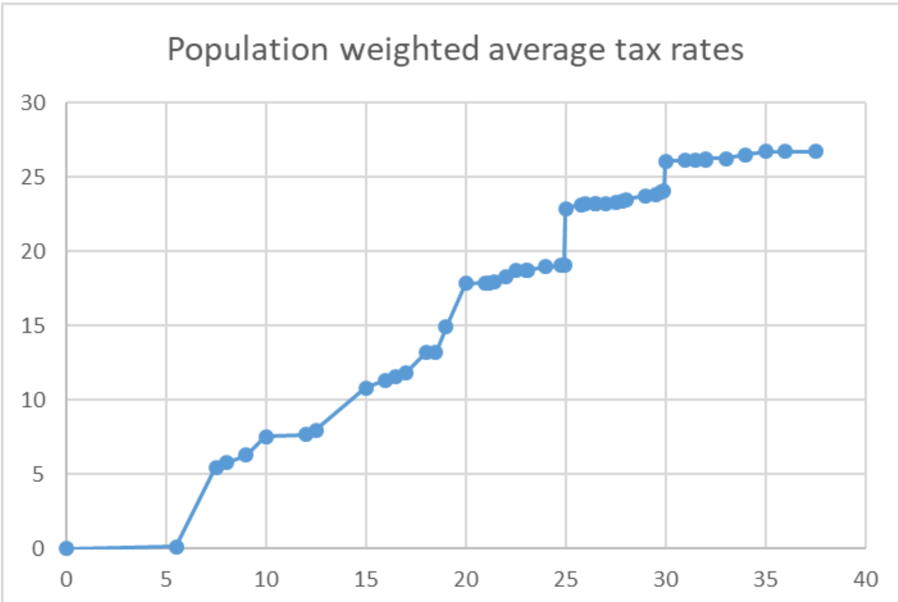
Population weighted average tax rates
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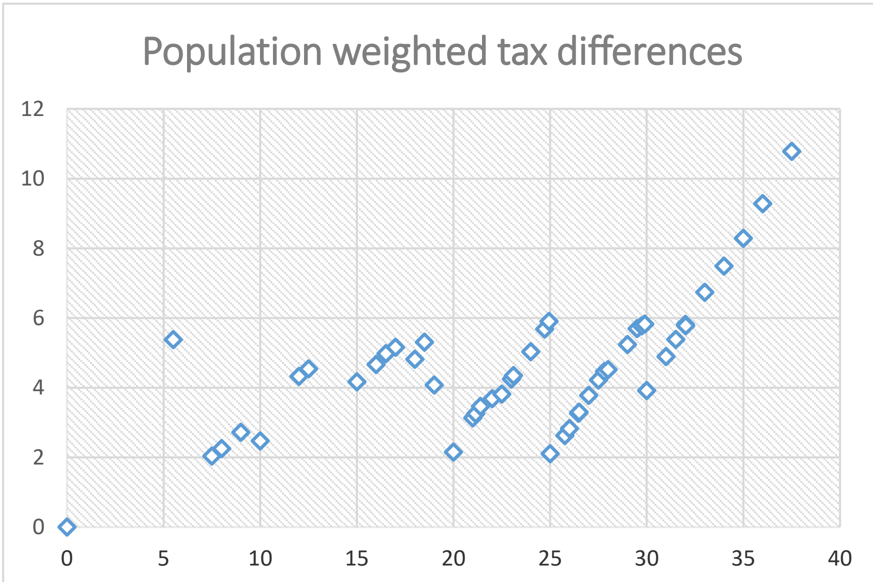
Figure 2b



Population weighted tax differences
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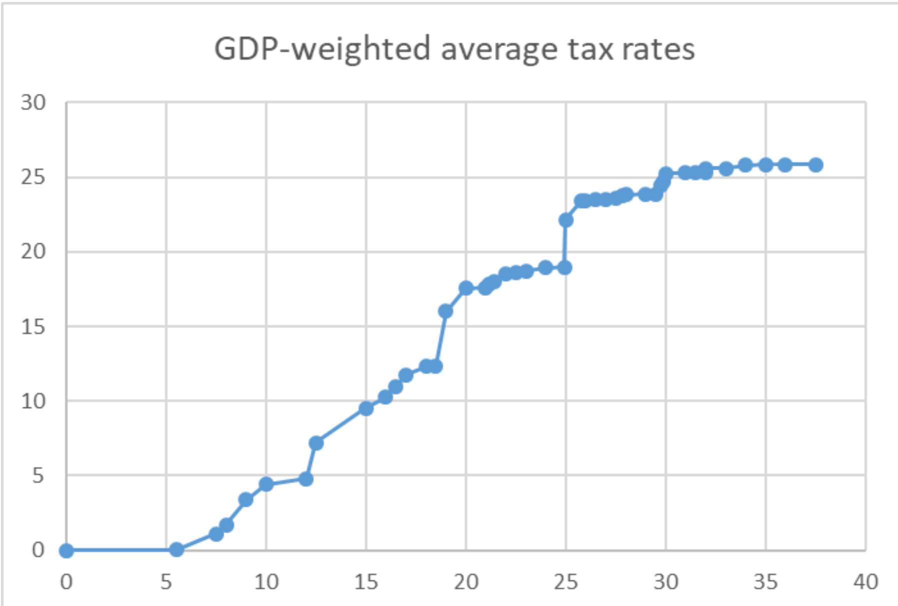

GDP-weighted average tax rates
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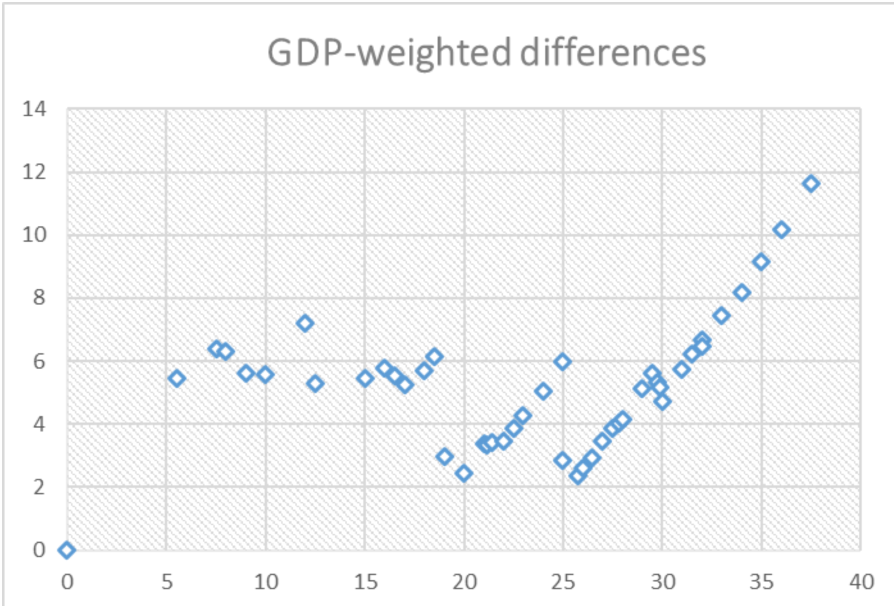
GDP-weighted differences
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