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Tax Progressivity and Output: Evidence from OECD countries

João Tovar Jalles[a] Georgios Karras[b]

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Abstract

Compared to the economic effects of tax *rates*, those of tax *progressivity* have been much less studied. In this paper, we estimate the output effects of changes in tax progressivity using a data set of 33 OECD economies since 1980. Our results show that tax progressivity affects the economy in a way that is broadly consistent with the predictions of a standard neoclassical growth model. In particular, increasing tax progressivity reduces the economy's growth rate temporarily and the level of income per capita permanently. Both effects are sizable, statistically significant, and robust. Our findings also emphasize the importance of including both the tax rate and tax progressivity in the estimation: omitting either can lead to biased results.

Keywords: Tax progressivity, Tax rates, Economic Growth, Panel Data, Local Projections

JEL codes: E62, H20

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1. Introduction

The increased reliance on fiscal policy that was initiated with the onset of the Global Financial Crisis (GFC), the Great Recession, and the subsequent Zero Lower Bound constraints imposed on monetary policy, has only been intensified by the policy responses to the economic challenges posed by the Covid-19 pandemic and its aftermath. As expected, a vast and growing empirical literature has contributed significantly to our understanding of how fiscal shocks affect various types of economic activity.[1] While, predictably, a lot of this work has focused on the effects of government spending, there has also been an abundance of work that investigated the effects of changes in taxes. Limiting our review to post-GFC works, a seminal contribution was the study by Romer and Romer (2010) who used a relatively simple but powerful narrative methodology to estimate the consequences of tax increases for US macroeconomic activity. Their main finding was that higher taxes were strongly contractionary, having effects that are large, significant, and long lasting.[2]

The Romer and Romer (2010) methodology and results have been scrutinized by numerous studies that explored their validity and robustness in a number of different settings. Cloyne (2013), for example, adopts a methodology very similar to that of Romer and Romer (2010), and applying it to UK data obtains very similar results: tax changes in the UK have effects that are large and persistent.[3] Favero and Giavazzi (2012) introduce the Romer and Romer (2010) narrative shocks in a VAR framework and show that this drastically diminishes (while not eliminating) their estimated effects. Along similar lines, Perotti (2012) shows that a VAR methodology that distinguishes between discretionary and automatic components of taxation, provides estimates that are between those of Romer and Romer (2010) and Favero and Giavazzi (2012). Mertens and Ravn (2013) and Nguyen et al. (2021) also find large effects following changes in tax rates and also show that it is important to distinguish between different

[1] See Ramey (2019) for an authoritative overview of this literature's consensus and lack thereof.

[2] The empirical estimation in Romer and Romer (2010) is carried over the post-WWII period for the US. Romer and Romer (2014) conduct a similar exercise for the US Interwar period, and find again that increases in the marginal tax rate were also distortionary then, though parhaps generating smaller distortions.

[3] Cloyne et al. (forthcoming), following the example of Romer and Romer (2014), estimate tax multipliers for Interwar Britain, concluding that they are remarkably similar in size to their post-WWII UK counterparts.

types of taxes (personal vs corporate by Mertens and Ravn, or income vs consumption by Nguyen at al.).[4]

While most of this literature has focused on the effects of tax *rates*, the relationship between tax *progressivity* and economic output has also been the subject of considerable investigation. Early research, such as Barro's (1990) influential study, argued that a progressive tax system, where higher-income individuals pay a higher percentage of their income in taxes, could negatively affect economic growth. The basic premise here is that higher tax rates on the wealthy may reduce their incentives to work, save, and invest, ultimately slowing down economic growth.

Several empirical studies have supported the idea of a negative relationship between tax progressivity and economic growth. For instance, Gemmell and Hasseldine (2001) found that higher marginal tax rates on top incomes were associated with slower economic growth. The argument is that progressive taxation can discourage high-income individuals from engaging in productive economic activities. Despite the prevailing notion of a negative relationship, scholars like Slemrod and Bakija (2008) have pointed out that the link between tax progressivity and growth is more intricate. Their research suggests that while extremely high tax rates on top incomes might hinder growth, moderate levels of progressivity may not have a significant impact. This highlights the importance of considering the degree of progressivity in the tax system. The impact of tax progressivity on economic output is not solely determined by the degree of progressivity itself. Alesina and Rodrik (1994) and Besley and Persson (2013) emphasized that the quality of public institutions and the overall tax structure matter. A well-designed progressive tax system, combined with efficient public spending and governance, can mitigate the potential negative effects of high progressivity. Perhaps most ambitiously, García Peñalosa and Turnovsky (2011) and Heathcote et al. (2017) develop general equilibrium models that incorporate tax progressivity's major trade-off of ameliorating economic inequality while at the same time intensifying distortions to work and to invest that reduce output. García Peñalosa and Turnovsky (2011) investigate how the progressivity implications of lump-sum, labor, and capital income taxes influence inequality, while Heathcote et al. (2017) draw implications for the optimal degree of tax progressivity and

[4] Personal vs Corporate tax rates in Mertens and Ravn (2013) and Income vs Consumption tax rates in Nguyen et al. (2021). Barro and Redlick (2011) and Riera-Crichron et al. (2016) have also provided influential estimates of the output effects of tax chnages.

conduct calibration exercises which suggest that actual tax progressivity in the US is not far from the optimum.[5] Finally, our work is also related to the literature that looks at the relationship between tax progressivity and issues related to business cycles and stabilization. For example, Mattesini and Rossi (2012) use a standard New Keynesian model to show that progressively intensifies the tradeoff between output and inflation stabilization and steepens the Phillips curve, while at the same time softens the effects of technology and demand shocks, acting as an automatic stabilizer. Ma (2019) argues that tax progressivity can help explain why the observed consumption responses of poor and rich households move in opposite directions following government spending shocks.

While we are cognizant of the potentially powerful effects of taxation on both inequality and the business cycle, in the present paper we investigate the effects of tax progressivity on economic activity, and so we focus on the cost side of its effects. We adopt an econometric direct estimation approach and rely on a data set that covers 33 advanced economies since 1980. Our results show that tax progressivity has effects that are consistent with those predicted by a standard neoclassical growth model. In particular, an increase in progressivity lowers the growth rate of real GDP per capita temporarily and its level permanently. Both effects are sizable and statistically significant. Qualitatively, our estimates imply that raising progressivity from the level of the US to that of Portugal will slow real growth for 4-7 years, the peak effect of -0.5% to -1% occurring three years after the shock. Our results also strongly emphasize the need to include both tax progressivity and the tax rate in estimated models. Failure to include both can lead to significantly biased estimates.

The rest of the paper is organized as follows. Section 2 outlines a simple theoretical framework that introduces basic concepts and motivates our testable hypotheses. Section 3 introduces the methodology and data. Section 4 presents the empirical results. Section 5 concludes.

2. Simple Theoretical Framework

As in Feldstein (1969), Benabou (2000), Heathcote et al. (2017), and Borella et al. (2022), taxes (T) as function of income (y) can be modelled as

[5] See also Heathcote et al (2020).

$$T(y) = y - (1 - \lambda)y^{1-\tau}, \tag{1}$$

so that the average and marginal tax rates, respectively, are given by

$$ATR = T(y)/y = 1 - (1 - \lambda)y^{-\tau}, \tag{2}$$

and

$$MTR = \partial T(y)/\partial y = 1 - (1 - \lambda)(1 - \tau)y^{-\tau}. \tag{3}$$

Note first that λ equals the average tax rate when $y = 1$. In addition, the parameter τ captures the degree of progressivity of the tax system because its value determines whether the marginal tax rate exceeds the average tax rate, or vice versa. Comparing the ATR and MTR expressions above, it is clear that the tax system is *progressive* ($MTR > ATR$) if $\tau > 0$, while it is *regressive* ($ATR > MTR$) if $\tau < 0$.

To motivate our empirical investigation, we introduce this tax system in a standard version of the neoclassical growth model. As shown in Appendix A, the steady-state level of income per capita is shown to be negatively affected by both the average tax rate (λ) and tax progressivity (τ). The first of these predictions is the well-known result (for example Acemoglu, 2009, section 8.8) that an increase in the tax rate, λ, reduces the steady state value of output: $\frac{\partial y^{ss}}{\partial \lambda} < 0$. The second prediction contributes our novel theoretical result that an increase in tax progressivity, τ, will also reduce steady-state income (and capital), *even if* λ *is held constant*: $\frac{\partial y^{ss}}{\partial \tau} < 0$.[6] Figures A1 and A2 in Appendix A visualize these relationships between steady-state income and the tax rate (Figure A1) and between stead-state income and progressivity (Figure A2). As Figures A1 and A2 make clear, both the average tax rate and tax progressivity are *distortionary*: holding everything else constant, increasing either of them reduces the level of income. These theoretical results motivate the empirical part of the paper. Taking the theoretical model at face value, our testable hypothesis is that an increase in tax progressivity will permanently reduce income and temporarily reduce its growth rate.

[6] Note that neither λ nor τ affect the steady-state *growth rate* in the theoretical model, but this is a consequence of assuming this particular neoclassical production function which results in only (steady state) level effects: changes in λ or τ produce pernament effects on the level of output but only temporary effects on its growth rate. Empirically, we will be able to investigate whether changes in progressivity produce level of growth effects.

3. Methodology and Data

This section presents our basic empirical methodologies (sections 3.1 and 3.2) followed by a description of the data (section 3.3).

3.1. Methodology I: Overall Effects Using Panel Regressions

Our first empirical approach purposefully de-emphasizes elaborate dynamics with the objective of focusing on the overall effects.[7] In particular, we gauge the effect of tax progressivity on real GDP growth per capita by running the following reduced-form panel regression for our sample of 33 advanced countries over the period between 1980 and 2017:

$$Y_{i,t} - Y_{i,t-1} = \alpha_i + \delta_t + \beta d_{i,t-j} + \gamma \boldsymbol{X}'_{it-1} + \varepsilon_{it} \quad (4)$$

where $Y_{i,t}$ is the log of real GDP per capita; $d_{i,t-j}$ is the change in tax progressivity (alternative proxies are used-cf. data section); $\boldsymbol{X}$ is a vector of controls which includes common proximate causes of growth such as investment rate, human capital and population growth retrieved from the Penn World Tables; α_i and δ_t are country and time fixed effects included to control for time-invariant characteristics and global shocks; ε_{it} is an i.i.d. error term satisfying the usual assumptions of zero mean and constant variance. Countries and years are indexed by subscripts i and t, respectively. Our testable hypothesis here corresponds simply to rejecting $\beta = 0$ in favor of $\beta < 0$, so that tax progressivity is overall detrimental to economic growth.

3.2. Methodology II: Short to Medium Run using Local Projections

Recall that the simple theoretical model of section 2 predicts that tax progressivity lowers the economy's income level permanently but its growth rate temporarily. To test this, our second empirical approach relies on Jordà´s (2005) Local Projection (LP) approach. This LP

[7] We adopt this as our first empirical appoach, not because we believe that it accurately captures the dynamics of the relationship, but in order to establish a benchmark and for the purposes of comparability with some of the existing literature. Our second methodological approach (see section 3.2 below) is designed to realistically model the dynamics.

approach has been advocated by Auerbach and Gorodnichenko (2012, 2013) and Romer and Romer (2019) as a flexible alternative to Vector Autoregressions and/or distributed lag models. The LP approach is also flexible to accommodate a panel structure and does not constrain the shape of IRFs, thereby allowing to analyze different types of policy shocks (Auerbach and Gorodnichenko, 2016; Jordà and Taylor, 2016; Ramey and Zubairy, 2018; Romer and Romer, 2019; Jordà, 2023).

Given the panel data nature of our data, we prefer the LP method over commonly used VAR models for the following reasons. First, our estimation entails a large panel dataset with a constellation of fixed effects, which makes a direct application of standard VAR models more difficult. Second, the LP method obviates the need to estimate the equations for dependent variables other than the variable of interest, thereby significantly economizing on the number of estimated parameters. Moreover, lag augmentation prevents the need to correct standard errors for serial correlation in the regression residuals. Hence, local projection inference is more robust than standard VAR inference, whose validity depend sensitively on the persistence of the data and on the length of the forecast horizon (Olea and Plagborg-Møller, 2021). Third, local projection estimates are asymptotically identical to VAR estimates (Plagborg-Møller and Wolf, 2021). However, lag-augmented local projections, as in our case, are asymptotically valid over both stationary and non-stationary data over a wide range of forecast horizons. Moreover, it allows for incorporating various time-varying features of source (recipient) economies directly and allow for their endogenous response to tax progressivity/tax rate shocks. Lastly, the error term in the following panel estimations is likely to be correlated across countries. This correlation would be difficult to address in the context of VAR models, but it is easy to handle in the local projection method by either clustering standard errors or using the Driscoll-Kraay (1998) standard errors (as we do) allowing for arbitrary correlations of the errors across countries and time.

The following unconditional regression model is estimated:

$$Y_{i,t+h} - Y_{i,t} = \alpha_{i,h} + \delta_{t,h} + \sum_{j=0}^{2} \beta_{1jh} d_{i,t-j} + \sum_{l=0}^{2} \beta_{2lh} \left(Y_{i,t-l} - Y_{i,t-1-l} \right) + \sum_{c=0}^{2} \beta'_{4ch} X_{i,t-c} + u_{i,t+h} \tag{5}$$

where Y denotes the log of real GDP; h is the forecast horizon set at a maximum of 7 years, allowing the effects of progressivity shocks to evolve over time and take time to fully materialize. Time and country fixed-effects, $\alpha_{i,h}$ and $\delta_{t,h}$, respectively, are included to account for cross-country heterogeneity and global shocks. $d_{i,t}$ denotes the tax progressivity shock. We include treatment lags in our models. It is an empirical issue how long the effect of progressivity shocks persists in the data. $X_{i,t}$ is a vector of additional control variables. We use Akaike's information criterion to determine the lag length: we employ 2 lags of the shock indicator, 2 lags of the dependent variable and 2 lags of the controls included. Equation (8) is estimated using OLS.[8] In the one-stage simple LP results we calculate Spatial Correlation Consistent (SCC) standard errors as proposed by Driscoll and Kraay (1998). β_{1jh} denotes the (cumulative) response of the variable of interest h years after the progressivity shock. Impulse response functions (IRFs) are then obtained by plotting the estimated β_{1jh} for k = 0, 1, …, 7 with 90 (and 68) percent confidence bands computed using the standard deviations associated with the estimated coefficients β_{1jh}.

3.3 Data

Our main dependent variable is real GDP growth per capita (real GDP in constant USD) from the IMF World Economic Outlook database over the population retrieved from the Penn World Tables, version 10.01.

Our main regressor is a progressivity variable that comes from Gerber et al. (2020). The sample consists of 33 advanced countries over the period between 1980 and 2017. Three measures of progressive capacity of tax systems are constructed, based on the Kakwani index but calculated over a fixed range of incomes, each of which is given equal weight (i.e., income is treated as if it were uniformly distributed). To enable cross-country comparisons, the authors mostly use a range of 0–500% of per capita GDP but they also provide the measure for the 0-1000% and 0-2000% of income.

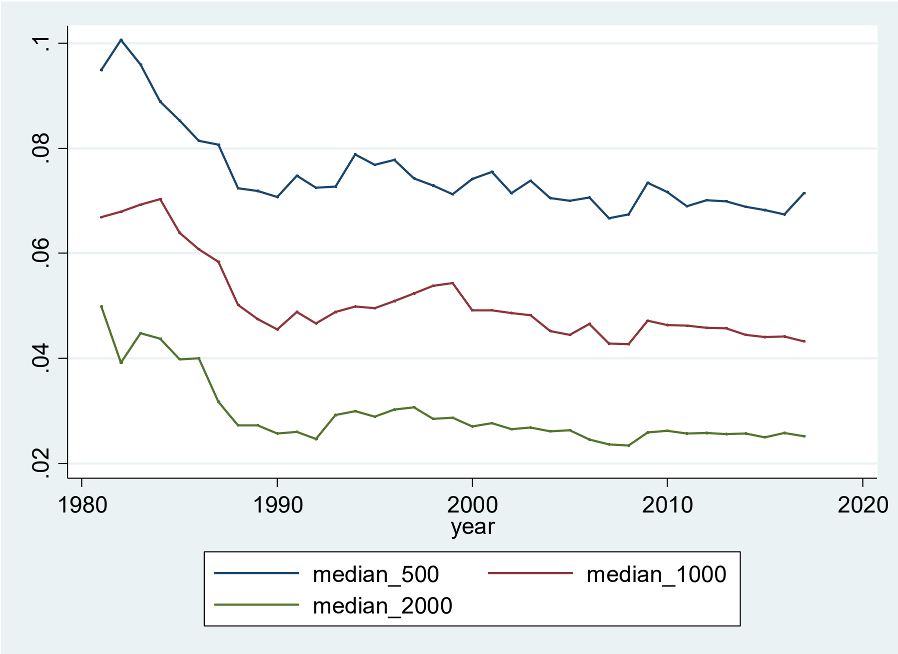
As controls we include common proximate causes of growth such as investment rate, trade openness, human capital, and population growth. Investment rate is computed as the ratio of gross fixed capital formation (expressed in current USD) over the gross value added (also expressed in current USD) retrieved from the World Bank´s World Development Indicators. Trade openness is computed as the sum of exports and imports over nominal GDP multiplied by 100. These come from the World Bank´s World Development Indicators. The human capital

[8] Another advantage of the local projection method compared to vector autoregression (or autoregressive distributed lag) specifications is that the computation of confidence bands does not require Monte Carlo simulations or asymptotic approximations. One limitation, however, is that confidence bands at longer horizons tend to be wider than those estimated by VARs.

index, based on years of schooling and returns to education comes from the Penn World Tables, version 10.01. Appendix B Table B1 shows the summary statistics.

Figure 1 plots the average time profile of the three progressivity measures for our entire sample. The individual country plots are shown in Appendix B, Figure B1.

Figure 1. Median Progressivity Measures, 1980-2017



Source: Gerber et al. (2020).

4. Results

4.1 Panel Regressions

We first discuss the results based on the panel regressions, estimated versions of model (7). Table 1 presents benchmark specifications that include each of the three main tax progressivity measures (yearly change) in the right-hand side, one at a time. Specifications (1)-(3) include contemporaneous change in progressivity measures only, while specifications (4)-(6) use the first lag. Specifications (7)-(9) augment the regression to encompass standard drivers of growth. The basic finding from Table 1 is that the estimated βs are either negative (and statistically significant) or statistically insignificant (but still negative). We interpret this as generally supportive of our hypothesis that tax progressivity is, overall, detrimental to economic growth.

Table 1. Effect on real GDP per capita growth of personal income tax progressivity changes - all countries

Specification regressors	(1)	(2)	(3)	(4)	(5)	(6)
Real GDP growth per capita (t-1)	0.410***	0.411***	0.411***	0.317***	0.318***	0.318***
	(0.068)	(0.068)	(0.068)	(0.066)	(0.066)	(0.066)
Change in Progressivity500						
Change in Progressivity1000						
Change in Progressivity2000						
Change in Progressivity500 (t-1)	-0.103**			-0.094**		
	(0.046)			(0.044)		
Change in Progressivity1000 (t-1)		-0.078			-0.085+	
		(0.058)			(0.060)	
Change in Progressivity2000 (t-1)			-0.018+			-0.019+
			(0.012)			(0.013)
Investment rate				0.113***	0.112***	0.114***
				(0.034)	(0.034)	(0.034)
Population growth				-0.813**	-0.820***	-0.825***
				(0.316)	(0.317)	(0.318)
Inflation rate				-0.056	-0.056	-0.055
				(0.049)	(0.048)	(0.049)
Trade openness				0.030***	0.030***	0.030***
				(0.011)	(0.011)	(0.011)
Observations	888	888	888	875	875	875
R-squared	0.592	0.591	0.591	0.619	0.618	0.617

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

The theoretical model of section 2 also predicts that tax *progressivity* negatively affects growth even when the effects of the tax *rate* are controlled for. Table 2 tests this by adding changes to the tax rate personal income tax rate (PIT) as an additional regressor in model (7).[9] Notice first that the estimated PIT coefficients are (mostly) negative and often statistically significant, consistent with the $\frac{\partial y^{ss}}{\partial \lambda} < 0$ prediction of the standard neoclassical growth model. More relevant for our purposes, however, note that the effect of progressivity remains negative – and, in fact, the estimated βs are more consistently negative (and now always statistically significantly so at the one-year lag) than before.

[9] Table 2 shows results only for the Progressivity500 measure to preserve space, but results are robust to the other measures and available on request.

Table 2. Effect on real GDP per capita growth of personal income tax progressivity changes, controlling for changes in PIT rates - all countries

Specification Regressors	(1)	(2)	(3)	(4)
Real GDP growth per capita (t-1)	0.317***	0.255***	0.317***	0.258***
	(0.066)	(0.095)	(0.066)	(0.097)
Investment rate	0.110***	0.204***	0.109***	0.199***
	(0.034)	(0.047)	(0.034)	(0.048)
Population growth	-0.805**	-1.448***	-0.807**	-1.463***
	(0.316)	(0.464)	(0.315)	(0.468)
Inflation rate	-0.057	-0.017	-0.056	-0.019
	(0.049)	(0.090)	(0.049)	(0.092)
Trade openness	0.029***	0.047***	0.029***	0.045**
	(0.011)	(0.018)	(0.011)	(0.018)
Change in Progressivity500 (t-1)	-0.098**	-0.201**	-0.098**	-0.204**
	(0.045)	(0.095)	(0.045)	(0.098)
Change in top comb PIT rate	-0.028*		-0.029*	
	(0.015)		(0.015)	
Change in avg PIT rate		-0.001*		-0.002**
		(0.001)		(0.001)
Change in top comb PIT rate (t-1)			-0.012	
			(0.013)	
Change in avg PIT rate (t-1)				0.001
				(0.001)
Observations	875	549	875	528
R-squared	0.620	0.664	0.620	0.668

Note: constant term omitted. Time and country fixed effects omitted included but for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

Table 3 repeats the exercise while controlling for other tax rates, such as the corporate tax rate (CIT) and VAT, obtaining qualitatively similar results. It appears that our basic theoretical results are supported by the evidence: both tax progressivity and the (average) tax rate are distortionary. The finding is robust to various measures of both variables and when both are controlled for in the regression.[10]

[10] To ensure robustness we have estimated a number of additional specifications that we are not reporting in the main text because of space considerations. Appendix B contains several of these estimated models (see Table B2).

Table 3. Effect on real GDP per capita growth of personal income tax progressivity changes, controlling for changes in other tax rates - all countries

Specification Regressors	(1)	(2)	(3)	(4)
Real GDP growth per capita (t-1)	0.316***	0.333***	0.332***	0.269***
	(0.067)	(0.060)	(0.060)	(0.075)
Investment rate	0.113***	0.126***	0.123***	0.217***
	(0.034)	(0.034)	(0.034)	(0.047)
Population growth	-0.813**	-0.796***	-0.790***	-1.378***
	(0.316)	(0.288)	(0.287)	(0.341)
Inflation rate	-0.056	-0.029	-0.029	-0.005
	(0.049)	(0.059)	(0.059)	(0.091)
Trade openness	0.030***	0.034***	0.033***	0.048***
	(0.011)	(0.010)	(0.010)	(0.012)
Change in Progressivity500 (t-1)	-0.094**	-0.121***	-0.125***	-0.238***
	(0.044)	(0.042)	(0.043)	(0.086)
Change in CIT top comb rate	-0.000		-0.000	-0.000
	(0.000)		(0.000)	(0.000)
Change in VAT comb rate		-0.003*	-0.003*	-0.005**
		(0.002)	(0.002)	(0.002)
Change in top comb PIT rate			-0.024+	
			(0.016)	
Change in avg PIT rate				-0.001*
				(0.001)
Observations	875	779	779	524
R-squared	0.619	0.660	0.661	0.712

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

For completeness we also estimate versions of model (7) where the left-hand side equals the growth rate of private consumption and investment, usually the largest and most volatile components of GDP, respectively. The consumption results are in Table 4, while Table 5 reports the investment regressions.[11] We note that the estimated progressivity coefficients are negative for both variables, so tax progressivity, as expected,[12] has a negative overall effect on both consumption and investment. Interestingly enough, however, changes in tax progressivity appear to affect consumption contemporaneously (within the year) whereas the investment effects are more strongly negative with a one-year lag. We will return to this issue in the next section that employes a more fully specified model of dynamics.

[11] Tables 4 and 5 report specifications that include PIT as a regressor. We have also estimated all models without controlling for other taxes, but we confine these results to Appendix B, Tables B3 and B4).

[12] We consider these the expected results because from the theoretical model, $c^{ss} = f(k^{ss}) - T^{ss} - (n+\delta)k^{ss}$ and $k^{ss} = \left(\frac{\beta(1-\tau)(1-\lambda)}{n+\rho+\delta}\right)^{\frac{1}{1-\beta(1-\tau)}}$, so that $\frac{\partial c^{ss}}{\partial \tau} < 0$ and $\frac{\partial k^{ss}}{\partial \tau} < 0$.

Table 4. Effect on real private consumption per capita growth of personal income tax progressivity changes, controlling for changes in PIT rates - all countries

Specification Regressors	(1)	(3)	(3)	(4)
Real consumption growth per capita (t-1)	0.426***	0.434***	0.384***	0.370***
	(0.057)	(0.081)	(0.058)	(0.088)
Investment rate			0.071**	0.141**
			(0.036)	(0.055)
Population growth			-0.244	-0.727*
			(0.296)	(0.376)
Inflation rate			-0.111**	-0.159
			(0.049)	(0.149)
Trade openness			0.009	0.024**
			(0.007)	(0.011)
Change in Progressivity500 (t-1)	-0.099*	-0.020	-0.094*	-0.000
	(0.051)	(0.092)	(0.054)	(0.092)
Change in top comb PIT rate	-0.036**		-0.038**	
	(0.017)		(0.018)	
Change in top comb PIT rate (t-1)		-0.001+		-0.001*
		(0.001)		(0.001)
Change in avg PIT rate			-0.015	
			(0.016)	
Change in avg PIT rate (t-1)				0.000
				(0.001)
Observations	922	582	910	560
R-squared	0.504	0.547	0.525	0.574

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

Table 5. Effect on real private investment per capita growth of personal income tax progressivity changes, controlling for changes in PIT rates - all countries

Specification Regressors	(1)	(2)	(3)	(4)
Real investment growth per capita (t-1)	0.319***	0.328***	0.201***	0.082
	(0.058)	(0.074)	(0.057)	(0.069)
Investment rate			0.706***	1.363***
			(0.159)	(0.254)
Population growth			-3.289***	-6.959***
			(1.203)	(1.621)
Inflation rate			-0.478*	-1.157**
			(0.263)	(0.523)
Trade openness			0.118***	0.226***
			(0.036)	(0.055)
Change in Progressivity500 (t-1)	-0.275	-0.932**	-0.229	-0.802*
	(0.232)	(0.461)	(0.214)	(0.408)
Change in top comb PIT rate	-0.084		-0.055	
	(0.080)		(0.080)	
Change in avg PIT rate		0.000		-0.001
		(0.003)		(0.003)
Change in top comb PIT rate (t-1)			0.012	
			(0.060)	
Change in avg PIT rate (t-1)				-0.001
				(0.003)
Observations	857	540	845	519
R-squared	0.439	0.475	0.489	0.571

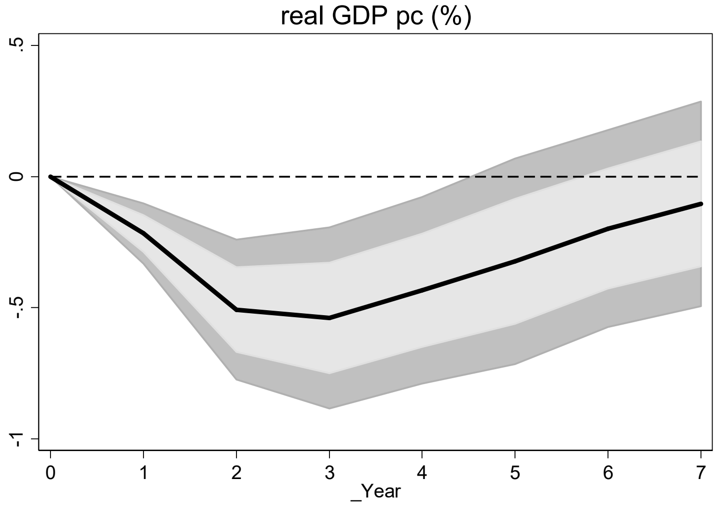
Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

4.2 Local Projections

Having established the overall negative relationship between tax progressivity and economic activity, we now proceed with the LP empirical approach of model (5) in order to pay closer attention to the dynamic nature of the effects and thus gain the ability to distinguish between temporary and permanent effects.

Our baseline result is reported in Figure 2 which plots the IRF of the growth rate of real GDP per capita (the estimated β_{1jh}s from equation (5)) to a tax progressivity shock – without controlling for changes in any tax rate. The thought experiment here is a change that makes the tax code more progressive (increases τ) but without altering the average tax rate (λ). Figure 2 shows that the increase in tax progressivity gradually reduces real GDP growth, achieving its maximum (negative) effect three years after the shock. After that the effect gradually dies out, its point estimate converging back to zero seven years after the shock (while becoming statistically insignificant five years after the shock). The negative effect is statistically significant for years 1-4 after the shock. We note this inverse hump-shaped response is entirely consistent with the predictions of the theoretical model: increasing tax progressivity reduces the economy's growth rate temporarily and the level of income per capita permanently.[13]

Figure 2. Baseline: effect of progressivity shock on real GDP growth per capita



Notes: The solid black line in the figure plots the impulse responses of tax progressivity shocks on real GDP growth. Year=1 is the first year after a tax progressivity shock took place at year=0. So, the position of the line at e.g., year=7 shows the change in the real GDP growth 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.

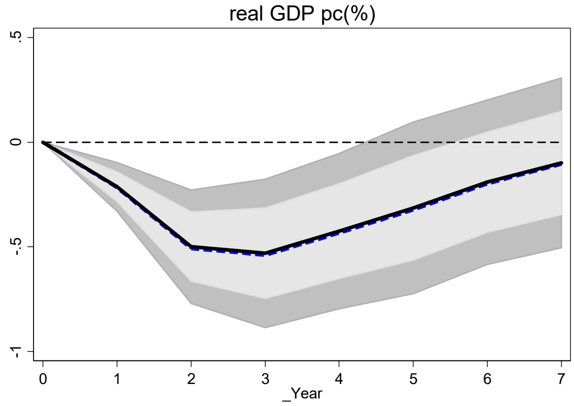
Figure 3 re-estimates model (5) controlling for various measures of the PIT rate. As can be seen from the IRFs, the inverse hump-shape survives in all specifications, confirming that the effects of tax progressivity on growth are as predicted by the theory: higher progressivity results in a permanently lower level of GDP and a temporarily lower growth rate. As the panel equations of section 4.1 had first indicated, controlling for the tax rate often increases (in absolute value) the estimated effect of progressivity on real growth.[14] Put differently, failing to control for changes in the tax rate results in underestimating the (detrimental) growth effects of progressivity.

[13] To get a sense of the magnitudes involved, note that the size of the shock is normalized to .14, which equals one standard deviation of the difference of the log of the progressivity500 series. A 14% increase corresponds roughly to tax progressivity increasing from the average US level (0.0804) to the average Portuguese level (0.0910), or from the average Japanese level (0.1024) to a bit less than the average Swedish level (0.1203).

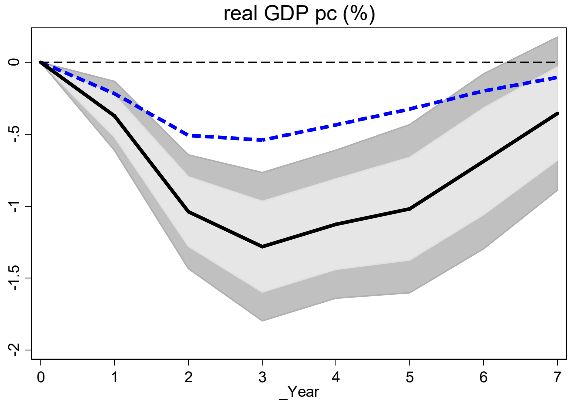
[14] And the differnce can be substantial, raising the (absolute value of the) peak growth effect from 0.5% to more than 1%.

Figure 3. Robustness: effect of progressivity shock on real GDP growth per capita controlling for tax rate changes

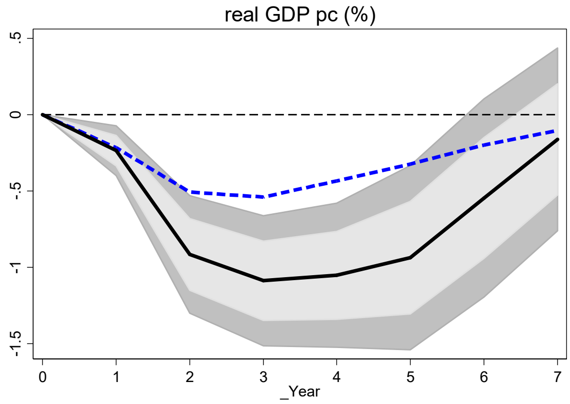
a. Controlling for change in PIT top comb rate



b. Controlling for change in avg PIT rate



c. Controlling for change in avg PIT rate, change in CIT top comb rate and VAT comb rate

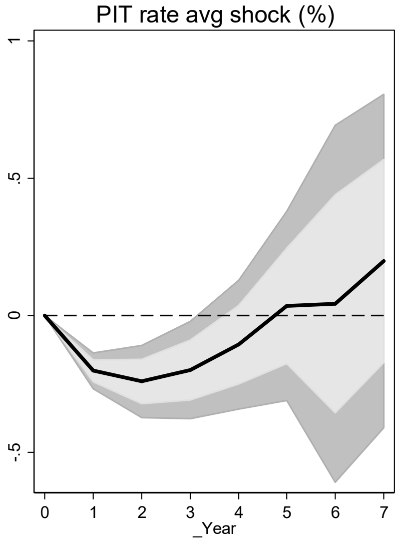


Notes: The solid black line in the figure plots the impulse responses of tax progressivity shocks on real GDP growth. The blue dotted line denotes the baseline result from Figure 1. Year=1 is the first year after a reform took place at year=0. So, the position of the line at e.g., year=7 shows the change in the real GDP growth 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.

For completeness, we also report the IRF of the growth rate of real GDP per capita to a tax rate shock in Figure 4. As expected, this also follows an inverse hump-shaped pattern, so that an increase in the tax rate also reduces the economy's growth rate temporarily and the level of income per capita permanently.[15]

[15] To get a sense of the time series properites of our tax progressivity and tax rate shocks themselves, refer to Figure B1 in Appendix B. As the two panels of the figure show, both shocks have very long lasting effects on their corresponfing variables. Indeed in the case of progressivity the effect is virtually permanent. Figure B2 also shows that progressivity responds to tax rate shocks, and vice versa, which underscores the neccessaity of including both variables in the estimated models.

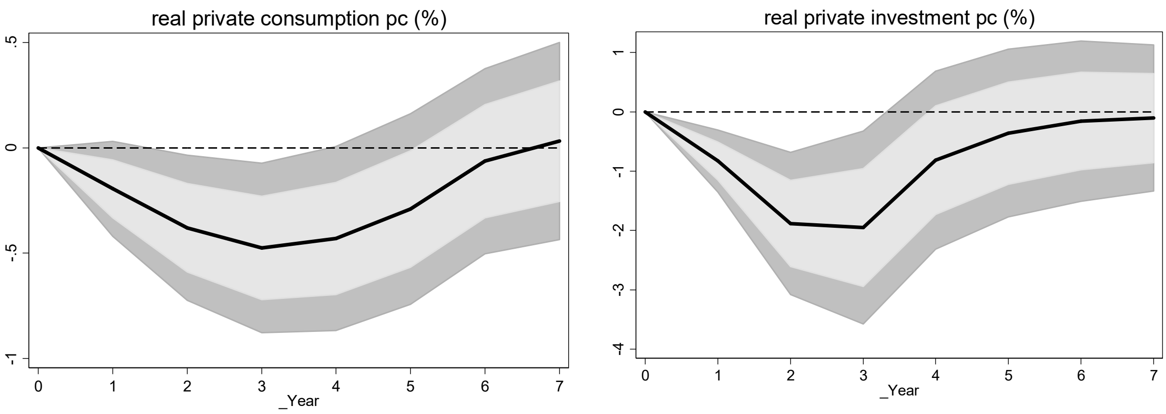
Figure 4. Effect of PIT average rate shock on real GDP growth per capita



Notes: The solid black line in the figure plots the impulse responses of PIT average rate shocks on real GDP growth. Year=1 is the first year after a reform took place at year=0. So, the position of the line at e.g., year=7 shows the change in the real GDP growth 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.

Finally, Figure 5 estimates IRFs for consumption and investment growth, revealing the same inverse hump-shaped pattern for these two variables as well.

Figure 5. Effect of progressivity shock on real private consumption and investment growth per capita



Notes: The solid black line in the figure plots the impulse responses of tax progressivity shocks on real private consumption and investment per capita. Year=1 is the first year after a tax progressivity shock took place at year=0. So, the position of the line at e.g., year=7 shows the change in the real GDP growth 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.

5. Conclusions

While not yet as extensively studied as the effects of tax *rates*, the importance of tax *progressivity* is increasingly more scrutinized. In both theoretical and empirical contributions, the literature has considered the effects of progressivity on economic activity, economic inequality and business-cycle and stabilization issues.

The present paper contributes to the estimation of the output effects of tax progressivity using a recently constructed data set (Gerber at al., 2020) that covers 33 advanced economies since 1980. Our results are easily summarized as follows.

First, we show that tax progressivity is negatively related to growth of output per capita in the full panel data set. The result remains valid when the tax rate is controlled for – and in fact the effect of progressivity is often strengthened by adding the tax rate in the regressions.

Next, when we turn to the dynamics using a Local Projections methodology, we find that an increase in tax progressivity lowers the growth rate of real GDP per capita temporarily, and its level permanently. Both effects are consistent with the theoretical predictions of the standard neoclassical growth model, sizable, statistically significant, and robust. Quantitatively, our estimates suggest that raising tax progressivity from US to Portuguese (or from Japanese to Swedish) levels retards the real GDP growth rate for 4-7 years, the negative effect peaking at 0.5% to 1% slowdown in the growth rate three years after the shock. In terms of policy implications, it is important to note here that our study sheds light only on the (negative) growth effects, which in practice would have to be considered jointly with the (positive) effects of progressivity on the income distribution. Estimation of the latter, as well as realistic comparisons between the two is a highly promising area of future research.

Finally, our results strongly suggest that consistent estimation requires including both tax progressivity and the tax rate in the estimated models. Failure to include both can lead to significantly biased estimates.

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Appendix A

The objective is to maximize $U = \int_0^{\infty} e^{-\rho t}\, u(c_t) dt$, subject to the budget constraint $\dot{k}_t = f(k_t) - T_t - c_t - (n+\delta)k_t$, where ρ is the subjective rate of time preference, u is the instantaneous utility function, c_t is consumption, k_t is the capital stock, $y_t = f(k_t)$ is a neoclassical production function, n is the population growth rate, and δ is the depreciation rate.[16] In order to obtain closed-form expressions for the steady state values of k and y, we will assume that utility takes the CRAA form, $u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \sigma > 0$, and that the production function is Cobb-Douglas $f(k_t) = k_t^{\beta}, 0 < \beta < 1$.

The problem's present value Hamiltonian is:

$$H = \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \theta_t \left[(1-\lambda)(k_t^{\beta})^{(1-\tau)} - c_t - (n+\delta)k_t \right] \right\} e^{-\rho t}$$

where θ_t denotes the multiplier. The first-order conditions are

$$\frac{\partial H}{\partial c_t} = 0$$

$$\frac{d(\theta_t e^{-\rho t})}{dt} = -\frac{\partial H}{\partial k_t}$$

and

$$\lim_{t \to \infty} k_t \theta_t e^{-\rho} = 0$$

These imply $c_t^{-\sigma} = \theta_t$ and $\frac{\dot{\theta}_t}{\theta_t} = n + \rho + \delta - \beta(1-\tau)(1-\lambda)k_t^{\beta(1-\tau)-1}$. At the steady state, where $\frac{\dot{\theta}_t}{\theta_t} = 0$, we have $\beta(1-\tau)(1-\lambda)(k^{ss})^{\beta(1-\tau)-1} = n + \rho + \delta$, which can be solved for the steady-state capital stock, $k^{ss} = \left(\frac{\beta(1-\tau)(1-\lambda)}{n+\rho+\delta} \right)^{\frac{1}{1-\beta(1-\tau)}}$. Substituting into the production function, we get the steady-state level of output,

[16] In the literature this version of the neoclassical model is often referred to as the "Ramsey" or "Cass-Koopmans" model. See Blanchard and Fischer (1989), Barro and Sala-i-Martin (2004), Acemoglu (2009), and Romer (2019).

$$y^{ss} = \left(\frac{\beta(1-\tau)(1-\lambda)}{n+\rho+\delta}\right)^{\frac{\beta}{1-\beta(1-\tau)}}$$

which can be used to illustrate the relationship between output and both the average tax rate (λ) and tax progressivity (τ).

Looking at the effect of the average tax rate first, the y^{ss} equation is consistent with the well-known result (for example Acemoglu, 2009, section 8.8) that an increase in λ reduces the steady state value of output: $\frac{\partial y^{ss}}{\partial \lambda} < 0$.

Moving next to the effects of tax progressivity, the y^{ss} equation contributes our novel theoretical result that an increase in τ will also reduce steady-state income (and capital), *even if λ is held constant*: $\frac{\partial y^{ss}}{\partial \tau} < 0$.[17]

To quantify the magnitudes of these effects, we use the y^{ss} equation to plot steady-state income (y^{ss}) as a function of the average tax rate parameter (λ) in Figure A1, and as a function of the tax progressivity parameter (τ) in Figure A2. The rest of the parameters are set at the values suggested by Mankiw (2022), $\beta = 1/3, n = 0.01, \delta = 0.05$; and $\rho = 0.03$.

Figure A1 looks at how steady state income is related to the average tax rate for three different values of progressivity. Figure A2 examines how steady-state income varies with progressivity for three different values of the average tax rate parameter. As Figures A1 and A2 make clear both the average tax rate and tax progressivity are *distortionary*: holding everything else constant, increasing either of them reduces the level of income.

These theoretical results motivate the empirical part of the paper. Taking the theoretical model at face value, our testable hypothesis is that an increase in tax progressivity will permanently reduce income and temporarily reduce its growth rate.

[17] Note that neither λ nor τ affect the steady-state *growth rate* in the theoretical model, but this is a consequence of assuming this particular neoclassical production function which results in only (steady state) level effects: changes in λ or τ produce pernament effects on the level of output but only temporary effects on its growth rate. Empirically, we will be able to investigate whether changes in progressivity produce level of growth effects.

Figure A1: Theoretical relationship between the average tax rate and steady-state output per capita

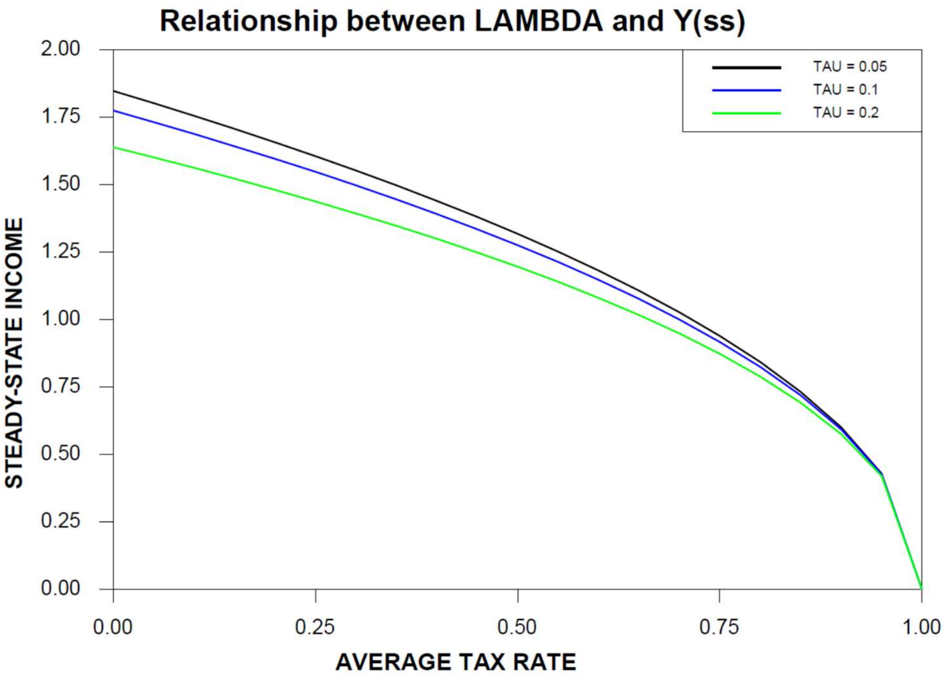


Figure A1 shows steady-state income per capita (y^{ss}) as a function of the average tax rate (λ), as implied by equation (6) and setting $\beta = 1/3$, $n = 0.01$, $\delta = 0.05$, and $\rho = 0.03$ (see Mankiw, 2022). The function is graphed for three different values of tax progressivity ($\tau = .05$, $\tau = .10$, and $\tau = .20$).

Figure A2: Theoretical relationship between tax progressivity and steady-state output per capita

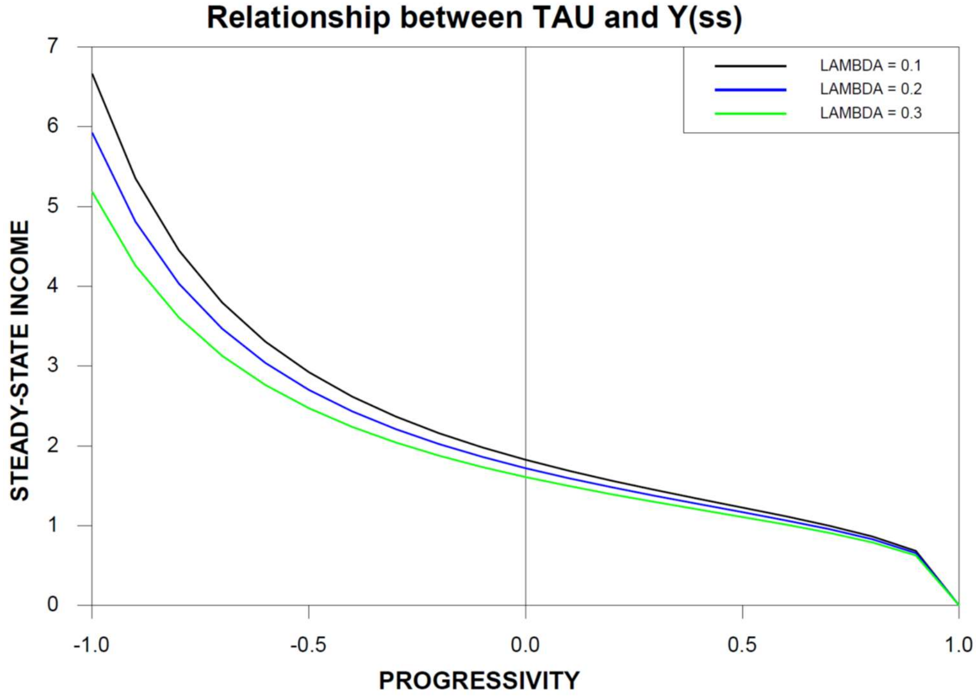
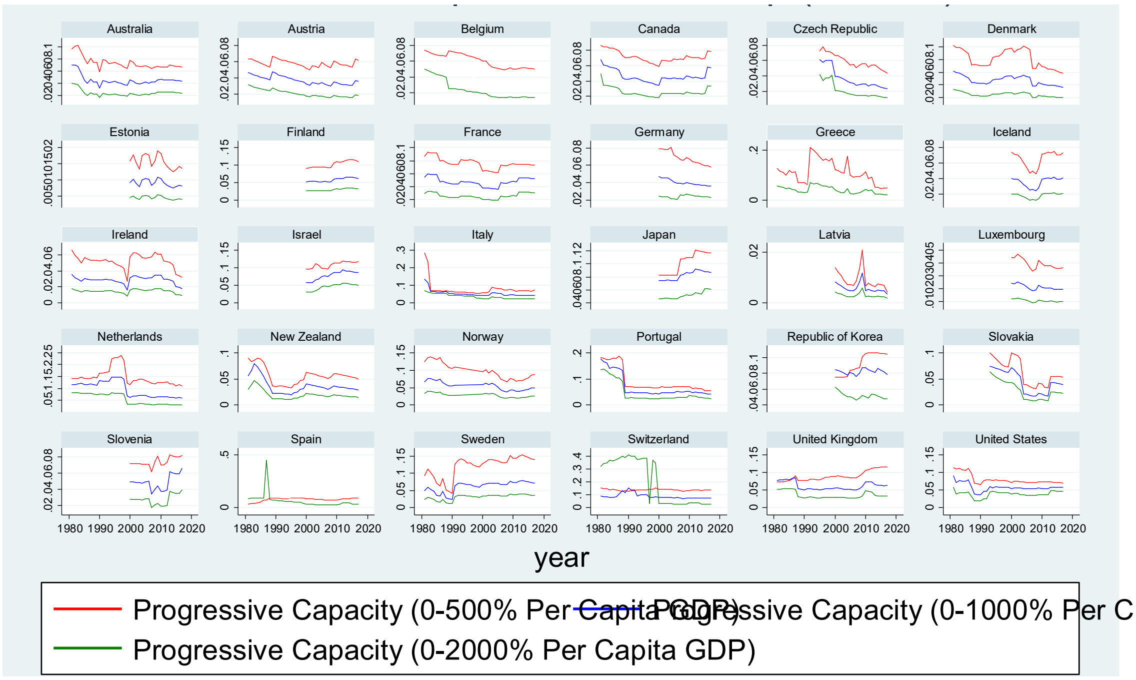


Figure A2 shows steady-state income per capita (y^{ss}) as a function of tax progressivity (τ), as implied by equation (6) and setting $\beta = 1/3$, $n = 0.01$, $\delta = 0.05$, and $\rho = 0.03$ (see Mankiw, 2022). The function is graphed for three different values of the average tax rate ($\lambda = .1$, $\lambda = .2$, and $\lambda = .3$).

Appendix B

Figure B1. Time profile of progressivity measures by country, 1980-2017



Source: Gerber et al. (2020).

Table B1. Summary Statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Real GDP growth per capita	956	0.0179	0.0284	-0.152	0.218
Investment rate	978	0.253	0.041	0.121	0.421
Population growth	1000	0.0056	0.0062	-0.0122	0.025
Inflation rate	1000	0.042	0.057	-0.044	0.549
Trade openness	995	0.821	0.476	0.166	3.537
avg PIT rate	630	26.709	5.465	14.96	42.75
Progressivity500	1000	0.081	0.0399	-0.0026	0.283
Progressivity1000	1000	0.055	0.032	-1.19e-07	0.239
Progressivity2000	1000	0.0387	0.0531	-5.96e-08	0.452

Table B2. Effect on real GDP per capita growth of personal income tax progressivity changes, controlling for changes in other tax rates - all countries

Specification regressors	(1)	(2)	(3)	(4)	(5)
Real GDP growth per capita (t-1)	0.413***	0.432***	0.405***	0.427***	0.399***
	(0.069)	(0.063)	(0.081)	(0.063)	(0.081)
Change in Progressivity500	-0.067+	-0.044	-0.099	-0.045	-0.102
	(0.047)	(0.042)	(0.112)	(0.044)	(0.107)
Change in Progressivity500 (t-1)	-0.103**	-0.134***	-0.259*	-0.127**	-0.289**
	(0.049)	(0.046)	(0.133)	(0.051)	(0.112)
Change in Min PIT rate			-0.072		
			(0.067)		
Change in CIT top comb rate	-0.000		-0.000	-0.000	-0.000
	(0.000)		(0.001)	(0.000)	(0.001)
Change in VAT comb rate		-0.003	-0.004*	-0.003	-0.004**
		(0.002)	(0.002)	(0.002)	(0.002)
Change in Min PIT rate (t-1)			0.061		
			(0.049)		
Change in CIT top comb rate (t-1)	0.000		0.000	0.000	-0.000
	(0.000)		(0.000)	(0.000)	(0.000)
Change in VAT comb rate (t-1)		0.001	0.001	0.001	-0.000
		(0.001)	(0.002)	(0.001)	(0.002)
Change in top comb PIT rate				-0.030*	
				(0.016)	
Change in top comb PIT rate (t-1)				-0.009	
				(0.013)	
Change in avg PIT rate					-0.002**
					(0.001)
Change in avg PIT rate (t-1)					0.001
					(0.001)
Observations	885	770	504	770	504
R-squared	0.594	0.643	0.689	0.645	0.692

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

Table B3. Effect on real private consumption per capita growth of personal income tax progressivity changes - all countries

Specification regressors	(1)	(2)	(3)	(4)	(5)	(6)
Real GDP growth per capita (t-1)				0.430***	0.429***	0.431***
				(0.056)	(0.057)	(0.057)
Change in Progressivity500	-0.022			-0.028		
	(0.049)			(0.049)		
Change in Progressivity1000		-0.034			-0.031	
		(0.077)			(0.083)	
Change in Progressivity2000			0.003			-0.002
			(0.024)			(0.026)
Change in Progressivity500 (t-1)				-0.095*		
				(0.052)		
Change in Progressivity1000 (t-1)					-0.092+	
					(0.065)	
Change in Progressivity2000 (t-1)						-0.024+
						(0.017)
Observations	957	957	957	919	919	919
R-squared	0.360	0.361	0.360	0.502	0.501	0.501

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

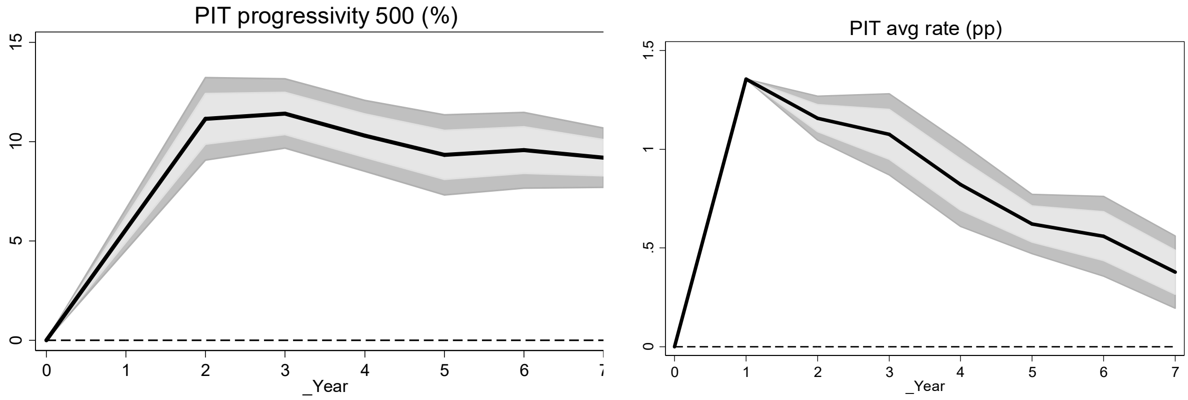
Table B4. Effect on real private investment per capita growth of personal income tax progressivity changes - all countries

Specification regressors	(1)	(2)	(3)	(4)	(5)	(6)
Real GDP growth per capita (t-1)				0.323***	0.322***	0.322***
				(0.059)	(0.059)	(0.059)
Change in Progressivity500	-0.070			-0.174		
	(0.219)			(0.204)		
Change in Progressivity1000		0.005			-0.116	
		(0.259)			(0.260)	
Change in Progressivity2000			0.037			0.016
			(0.072)			(0.062)
Change in Progressivity500 (t-1)				-0.286		
				(0.233)		
Change in Progressivity1000 (t-1)					-0.164	
					(0.221)	
Change in Progressivity2000 (t-1)						-0.015
						(0.040)
Observations	891	891	891	854	854	854
R-squared	0.361	0.361	0.361	0.439	0.438	0.437

Note: constant term omitted. Time and country fixed effects included but omitted for reasons of parsimony. Robust standard errors in parenthesis. +, *, **, *** denote statistical significance at the 15, 10, 5, and 1 percent levels, respectively.

Appendix Figure B1. Effect of effect of progressivity shock on PIT progressivity and PIT avg rate on PIT avg rate

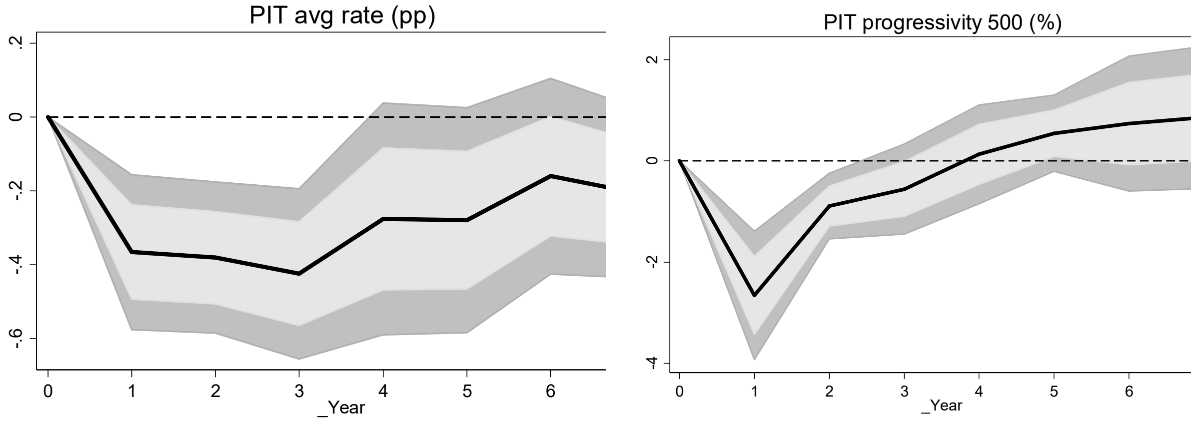
Progressivity on progressivity | *PIT avg rate on PIT avg rate*



Notes: The solid black line in the figure plots the variables´ impulse responses to own shocks. Year=1 is the first year after a given shock took place at year=0. So, the position of the line at e.g., year=7 shows the change in respective dependent variable 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.

Appendix Figure B2. Effect of effect of progressivity shock on PIT progressivity and PIT shock on Progressivity

Progressivity on PIT | *PIT on Progressivity*



Notes: The solid black line in the figure plots the progressivity´s and PIT tax rate´s impulse responses to PIT tax rate and progressivity shocks, respectively. Year=1 is the first year after a given shock took place at year=0. So, the position of the line at e.g., year=7 shows the change in respective dependent variable 7 years after the shock. The dark grey shaded areas display the 90% Driscoll-Kraay robust error bands; the light grey shaded areas display the 68% Driscoll-Kraay robust error bands.