Trade-Off or Win-Win? The Effects of Tax Changes on Economic Growth and Income Inequality

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September 24, 2019

Abstract

We analyze differences of tax types and rate or base changes regarding their impact on economic growth and income inequality by employing a novel narrative dataset covering more than 1200 tax changes in 23 advanced and emerging economies from 1965 to 2017. The effects on growth and inequality are estimated by local projections. Base broadening seems less harmful to economic growth than increases of the tax rate, while it may be as effective in reducing inequality. (Top) income and corporate tax rate increases are more effective in reducing inequality than indirect taxes but seem more harmful to economic growth.

Word Count: 12500
Keywords: Taxation; Inequality; Growth; Narrative Identification
JEL codes: E62, H20

1. Introduction

The recent debate about the costs and the merits of US "Tax Cuts and Jobs Act" (TCJA) mirrors an old conflict – the supposed trade-off between growth and equality when it comes to the choice of tax policy, dating back at least to Okun's (1975) "leaky bucket". Commonly, the effects of tax changes on economic growth and income inequality are regarded as a trade-off: Either a tax change promotes economic growth and widens the gap between income groups or vice versa. However, as some recent studies suggest, the relationship between equality and growth might not be as straight forward and they may even go hand in hand (Berg et al. 2012). Moreover, aggregate growth figures may not be a relevant measure of economic well-being of the median resident, when income growth is highly unequally distributed and accrues only to a small fraction of the population (Piketty et al. 2018).

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When looking at the impact of fiscal policy on growth and distribution, Guajardo et al. (2014) and Alesina et al. (2017) argue that consolidation plans based on tax increases are harmful to growth (and more harmful than spending or transfer cuts). Using a similar dataset, Ball et al. (2013) and Heimberger (2018) conclude that tax-based consolidations do not raise inequality as much as spending cuts do. From this more recent literature, based on a narrative identification in the spirit of Romer and Romer (2010), the trade-off seems to be re-established when it comes to fiscal measures. Yet, these studies lack a detailed analysis of the impact of specific policy measures on inequality and growth, in particular a distinction of more specific tax measures. Since the 1980s, OECD countries have seen a secular shift of their tax systems in favor of lower direct taxation and increased indirect taxation. At the same time there has been a U-shaped approach to tax bases, first extending tax expenditures while more recent attempts in international policy coordination are focused on base-broadening (Atkinson 2008, OECD 2011). Different tax measures likely affect economic growth and income inequality differently. Dabla-Norris and Lima (2018), detailing the above dataset of Guajardo et al. (2014) and Alesina et al. (2017) with respect to tax types, re-examined the effects on growth more precisely, but did not look at inequality effects.

In the present paper, we contribute to this literature by investigating the impact of changes of specific tax types and a distinction between rate and base changes on growth (as measured by GDP per head) and inequality (as measured by the Gini coefficient). Moreover, we differentiate between market and disposable income inequality since tax incidence may be shifted, for example from (highly concentrated) capital incomes to labor incomes.

We do so by exploiting a new and detailed international panel dataset of tax legislations, the Tax Policy Reform Database (TPRD) (Amaglobeli et al. 2018). The dataset lists more than 1200 reforms of tax policies in 23 advanced and emerging economies from 1967 to 2017, including information on tax type, timing, scale, and further details. The classification of tax types follows standards of the OECD revenue statistics by distinguishing personal income taxes (PIT), corporate income taxes (CIT), value-added and sales taxes (VAT), excise (EXE) and property taxes (PRO) and social security contributions (SSC). It further distinguishes between rate or base changes and classifies different measures within tax types which allows to specifically look at the effects of e.g. PIT top rate changes that have aroused particular interest in the literature (Piketty et al. 2014). We combine these data with macroeconomic tax revenues, GDP growth, and various inequality measures as left-hand side variables and estimate the dynamic impulse responses of the different tax measures on these variables using local projections à la Jordà (2005).

We find that classical trade-offs of lower income inequality combined with lower average income growth are more typical for tax rate hikes, in particular for CIT, PIT and PIT top rate changes. In contrast, tax base broadening is more likely to be beneficial to one aim, while neutral to the other: PIT, EXE and PRO base increases do not seem to harm growth but can reduce income inequality. An exception is widening the CIT base, which seems to be detrimental to growth and disposable income inequality at the same time.

To ensure that the findings are reliable, the baseline specifications are subject to several robustness checks. These include the control for the reliability of the TPRD by means of data on tax revenues, the estimation of the reaction of top income shares as another measure of income inequality, the control for anticipation effects on the reaction of GDP, the expansion of the estimation controlling for all contemporaneous tax changes, the use of different tax change variables and an increased number of lags of the lagged dependent variable. Despite the occurrence of anticipation effects in single cases and a higher uncertainty when measuring inequality by top-income shares, the results of the baseline specifications are demonstrated to be robust.

The paper is organized as follows: Section 2 discusses the theoretical effects of the single tax measures on growth and inequality of income. Our dataset and the econometric approach are described in Sections 3 and 4, respectively. Section 5 presents the baseline results as well as extensions. The final section concludes.

2. Theoretical Effects

2.1 Tax Changes and Growth

Most of the research dealing with the relation of tax changes and output have focused on taxation as a whole and in comparison to spending changes (e.g. Alesina et al. 2017, Gechert 2015, Hebous 2011). Nevertheless, there are also more detailed analyses of specific tax changes on GDP (e.g. Arnold 2008; Johansson et al. 2008; Lee and Gordon 2005; Widmalm 2001). Essentially, the effects of the various tax types can only be viewed with reference to a certain overall budgetary position, as their absolute impact will depend on the (intertemporal) government budget constraint, i.e. the usage of additional revenues for different spending purposes or consolidation, and symmetrically, the impact of tax cuts on spending cuts or government debt, including possible knock-on effects. The theoretical predictions will be based on the assumption of fixed spending and other taxation, i.e. we consider a tax increase for consolidation purposes, or symmetrically, a deficit-financed tax cut. In the empirical part, we

will control for government consumption as the main spending category in our baseline specification as well as other tax changes in a robustness test.

According to Johansson et al. (2008) and Arnold (2008), CIT and PIT increases are the most growth-detrimental measures. In a standard representative-agent RBC or New Keynesian model, progressive labor or capital income taxes should be harmful to growth as they retard incentives to work and produce; (flat) consumption taxes like VAT and EXE would be less harmful, in particular in an open-economy setting (Johansson et al. 2008), since they are not affecting the allocation of resources directly at the stage of production. However, allowing for inequality through heterogeneous agents with different marginal propensities to consume (Jappelli and Pistaferri 2014) may lead to a fall in aggregate demand after an increase in indirect taxes. Such demand-side effects of inequality on growth have long been discussed in Post Keynesian models (Stockhammer and Onaran 2013) and also in more recent New Keynesian models (Bayer et al. 2019).

The growth effects of SSC changes should reside somewhere in between as they are usually proportional to income but still increase labor costs. PRO taxes, especially on real estate, are generally seen as neutral with respect to growth. However, in isolation, they may imply negative aggregate demand effects, at least in the short run (Geerolf and Grjebine 2018).

Regarding rate vs. base changes, there may also be important differences. While rate changes refer to the proportion of the targeted financial flow or asset that is deducted by the tax, base changes consider the coverage of the respective tax. Base changes either refer to changes of the targeted group of taxpayers (e.g. low-income vs. high-income taxpayers), the income source (e.g. capital income vs. labor income) or the type of good that is being taxed (e.g. a reduced VAT rate for groceries). From a theoretical perspective, base broadening is assumed to reduce distortions within the tax system, making it more homogenous. This may foster economic efficiency because resources are reallocated to the most profitable investments (not the ones associated with the least tax burden). Base broadening might also have a weaker negative impact on demand since it may be less salient than rate changes. Chetty et al. (2009), for example, show that the reaction of consumers' demand on commodity taxes depends heavily on the salience of the tax. Furthermore, the effects on economic growth might be somewhat smaller, if base broadening targets high-income taxpayers. Members of this group tend to absorb negative income shocks easier than low-income taxpayers, who might be credit constrained or driven by precautionary fear. Dabla-Norris and Lima (2018) show that base broadening tends to decrease output less than increases in rates, but note that their analysis is restricted to years of fiscal consolidations.

2.2 Tax Changes and Income Inequality

Similar to the literature discussed above, a major part of the research on the link between taxation and income inequality has not distinguished between tax types (and rate or base changes) focusing on consolidation periods combining taxation and spending patterns (e.g. Ball et al. 2013, Furceri et al. 2016, Heimberger 2018). Again, some authors have looked at the effects of certain tax types in distributional regards (e.g. Piketty et al. 2014, Joumard et al. 2012, Martinez-Vazquez et al. 2012). The PIT comprises taxes on labor income as well as capital income and in most advanced countries has a progressive tax code. In the case of taxes on labor income the relative burden rises with the amount of income, thereby reducing disposable income inequality. Moreover, Piketty et al. (2014) suggest a negative impact of top marginal tax rates on pre-tax income inequality via a bargaining channel: When top tax rates decline, the incentive to bargain more aggressively to pursue rent extraction increases, at the cost of lower income groups. With respect to base changes, many tax expenditures tend to favor higher income groups, because of upward sloping marginal tax rates. Thus, tax breaks for incidences like health and child care, owner-occupied housing or retirement savings are mostly utilized by higher income groups (Joumard et al. 2012). Earned income tax credits and other measures that are designed to subsidize low incomes, may decrease disposable income inequality. On the other hand, they may lead to a decline in the wage rate, effectively subsidizing employer incomes and thus increasing market income inequality (Rothstein 2010). One would generally expect a progressive effect of capital income taxes on after-tax incomes, since capital income is concentrated at the upper end of the distribution. In this case, base broadening might be progressive as well. For example, in the USA, 90% of the savings of preferential tax treatments in capital income is benefitting the top quintile of the income distribution, and 50% the top 0.1% (Williams 2011).

Similarly, the CIT is evaluated as being progressive with respect to disposable incomes as corporate incomes are usually concentrated in the top tail of the income distribution. However, the tax incidence may be shifted to labor incomes (Fuest et al. 2018) and the extent may depend on the level of trade openness. The more open an economy is, the more likely the costs of the tax are going to be passed on to immobile labor, even if there are retarding factors (Harberger 2008). Thus, CIT rate and base increases may reinforce market income inequality in the first place.

There is no clear prior for the inequality effects of changes to SSC. Although the contributions are often shared among employers and employees, in many models, increasing costs are expected to be shifted to employees through lower wages, which may increase market

income inequality. With respect to disposable incomes, SSC are often capped at a certain threshold of income so that the overall burden shrinks at the top end of the labor income distribution (Martinez-Vazquez et al. 2012). On the other hand, in social security systems, contributions and benefits are often linked due to a balanced budget rule, pension formulae or other mechanisms. Since beneficiaries are often low income unemployed or pensioner households, increasing SSC earmarked to higher benefits could lower disposable income inequality.

Whether PRO taxes show regressive or progressive properties very much depends on the composition: Charging recurrent taxation on real estate, tends to be regressive in countries like the UK, Canada and the USA, where low-income groups pay a higher share of their income in property taxes than higher earners, although the latter have to pay more in absolute terms. This is the case because real estate taxes include fixed portions, such as waste collections, which do not rise with income. The same holds for motor vehicle taxes. Moreover, pensioners for example might have valuable houses, but little income to live from (Kaplan et al. 2014). However, such forms of taxation of durables are only reflected in measures of after tax income inequality, insofar as they concern property that generates rents or profits. Other property taxes on owner-occupied housing, cars and the like would only concern consumption and wealth inequality. Wealth and inheritance taxes on landlords and business capital would reduce highly concentrated after tax rents and profits, likely reducing net income inequality. Base extensions like cutting tax allowances and exemptions might thus be expected to be progressive as well. As far as market income inequality is concerned, wealth taxes may work similar to top income taxation, reducing the incentives to accumulate wealth and related capital incomes.

Measuring the impact of changes of indirect taxes such as VAT or EXE is complicated in much the same way as for PRO taxes. Distributional effects of indirect taxes are hardly captured by income-based measures of inequality, as even disposable income does not measure the differential burden of rising consumer prices on low and high income households, which will lead to adjustments in either real consumption or saving, and thus are only reflected in consumption or wealth inequality.[2] A direct effect on income inequality might materialize when VAT or EXE hikes are not passed on to consumer prices but reduce profit margins. Benedek et

[2] The effects of indirect taxes on consumption inequality have been analyzed e.g. by Martinez-Vazquez et al. (2012). Warren (2008) decomposes the disposable income of households to estimate how much different income groups spend on consumption taxes and then adds this to the measured Gini coefficient. In the case of EXE, the impact on consumption inequality depends on the commodity being taxed. Excise taxes on energy should have a distinct regressive effect, while taxes on luxury goods that are consumed by high-income groups would be progressive (Martinez-Vazquez et al. 2012; Rawdanowicz et al. 2013).

al. (2015) estimate that increases in VAT standard rates are found to be entirely shifted to consumers, while changes in reduced rates are only partly passed on (30%). Table 1 provides an overview of the theoretical discussion in this section that informs the testable hypothesis for the following empirical analysis.

Table 1: Assumed Effects of Tax Changes on Economic Growth and Income Equality

Tax Measure	Effect on Economic Growth	Effect on Disposable Income Equality	Effect on Market Income Equality
PIT_R	−	+	+
PIT_Top R	~, −	+	+
CIT_R	−	+	−
VAT_R	−	~	~
EXE_R	−	~	~
SSC_R	−	+	−
PRO_R	~, −	~	~
Total_R	−	?	?
PIT_B	~, −	+	+
CIT_B	~, −	+	−
VAT_B	~, −	~	~
EXE_B	~, −	~	~
SSC_B	~, −	~	~
PRO_B	~, −	~	~
Total_B	~, −	?	?

Notes: "R" stands for rate increases and "B" stands for base increases. Note that "+" denotes a positive effect referring to an *increase* of economic growth or equality, while "−" denotes a negative effect referring to the opposite outcomes. "~" denotes a neutral effect and "?" stands for no assumption.

3. Data

Our measure of growth in our multi-country panel is annual GDP growth rate per head at constant prices and constant purchasing power parities as obtained from OECD statistics (GDP:HVPVOB). To estimate the effects on income inequality, the Gini coefficients from *The Standardized World Income Inequality Database* (SWIID) are considered, both in levels of disposable and market income (Solt 2018), which is the most comprehensive source of multi-country Gini data.[3] Incorporating both disposable and market income allows for investigating

[3] The SWIID has been criticized for a lack of cross-country comparability due to different income definitions, data sources and methods of processing. Jenkins (2015) further criticizes the SWIID's imputation method of being non-

the channels of tax reforms on inequality in more detail. Since the Gini coefficient tends to be rather insensitive to changes at the top and bottom of the distribution, for robustness checks, we also consider top 10% income shares from the *World Inequality Database* (WID) (Alvaredo et al. 2019).[4] In order to account for changes in government spending, data on the governmental final consumption expenditure (GFCE) is obtained from the World Bank (2019). In addition, data on tax revenues is obtained from the OECD to check the reliability of the TPRD in the robustness section. An overview of the data sources is provided by Table 2.

Table 2: Overview of Data Sources

Variable	***Source***
Tax changes	TPRD
GDP	OECD
Gini coefficients	SWIID
Top income shares	WID
GFCE	World Bank
Tax revenues	OECD

In order to identify tax shocks, we exploit the novel narrative Tax Policy Reform Database (TPRD) of Amaglobeli et al. (2018). The TPRD comprises tax reforms of 23 advanced and emerging market economies[5] from 1965 to 2017.[6] It captures qualitative information, as to whether the reform is increasing or decreasing the tax burden, whether the reform is large or small and whether the tax rate or its base is targeted. Regarding the different tax types, the database distinguishes between PIT, CIT, VAT, EXE, SSC and PRO.[7] Within these tax types, the database further differentiates between categories like the top rate of the PIT which allows

transparent. He also argues that the large coverage and the comparison of more than 170 countries is questionable due to the lack of primary data quality of developing countries. Since the present paper focuses on member states of the OECD (with the exception of China and India), the basic data quality should be considerably higher.

[4] The income shares of the market income are interpolated and combined from income definitions of individual, tax unit and equal split adults on country level, including only adults (+20). With respect to disposable income shares the WID only provides data for the USA, Canada and the UK.

[5] These are Australia, Austria, Brazil, Canada, China, Czech Republic, Denmark, France, Greece, Germany, India, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Poland, Portugal, Spain, Turkey, United Kingdom and the United States.

[6] After consistency checks with OECD tax revenue time series, we have identified and added a few missing reforms to the database.

[7] PIT includes taxes on income, profits and capital gains payable by individuals; CIT includes taxes on income, profits and capital gains payable by corporations and other enterprises; VAT includes value-added and sales taxes; EXE includes any excise taxes; SSC includes social security contributions and taxes on payroll and workforce; PRO includes any taxes on property.

for detailed analyses of the effects of certain tax measures. Besides the implementation date of the reform that can be used to date the tax shock, the TPRD also indicates the announcement dates of tax changes. The latter enables the control for anticipation effects or fiscal foresight (Mertens and Ravn 2012).

There are two main limitations of the dataset: First, the TPRD does not contain consistent information on the motivation of the legislative actions. Thus, when it comes to the estimation of the effects of tax changes on economic growth, "endogenous" tax policies – in particular those that are motivated by macroeconomic circumstances and would therefore constitute a reverse causality, potentially biasing the estimates – cannot be excluded.[8] However, Gunter et al. (2017) find that, in the case of VAT changes, this bias is only relevant for the USA, where countercyclical fiscal policies create an underestimation of the effects of tax changes on economic growth and in the case of developing countries, which are often forced to procyclical fiscal policy, generating an overestimation of the effects. In the case of other industrialized economies, the authors find fiscal policy not to be related to cyclical fluctuations. Gechert et al. (2019) do not find a bias for German SSC taxes either. With respect to the estimation of the effects of tax changes on inequality, reverse causality is unlikely to be an issue, since inequality is a rather slow-moving variable such that contemporaneous changes should not systematically govern policy changes.

Second, the database does not provide quantitative estimates of the volume of the tax reforms. This makes it impossible to estimate fiscal multipliers and obtain precise values for the effects of tax changes on economic growth and income inequality. Nevertheless, the database provides a basic evaluation of the magnitude of the tax reforms by highlighting "major" tax changes. In the case of rate changes, reforms are denoted as major when the rate change exceeds one percentage point in absolute terms or, if this information is unavailable, a change is framed as major by the respective source. The latter procedure is also applied in the case of taxes that are levied per unit, like excise taxes. Changes of the tax base are defined as being major "[…] when the change in the tax base affects a large group of taxpayers or has the potential to mobilize significant resources" (Amaglobeli et al. 2018, 11).

There can be several major and minor changes with similar or opposite sign for a certain tax type within a country-year. In order to process the narrative data suitable for a panel dataset and incorporating as much information as possible, we code the tax changes as follows:

[8] Countercyclical policies would produce downward-biased coefficients, while procyclical fiscal stance, on the other hand, would lead to an upward-bias.

$$atri_{i,t}^{d,r}\begin{cases} 1\ if\ a_{i,t}^{d,r} > 0 \\ 0\ if\ a_{i,t}^{d,r} = 0 \\ -1\ if\ a_{i,t}^{d,r} < 0 \end{cases} + btri_{i,t}^{d,r}\begin{cases} 1\ if\ b_{i,t}^{d,r} > 0 \\ 0\ if\ b_{i,t}^{d,r} = 0 \\ -1\ if\ b_{i,t}^{d,r} < 0 \end{cases} = T_{i,t}^{d,r}\begin{cases} 2\ if\ btri_{i,t}^{d,r} = 1 \\ 1\ if\ atri_{i,t}^{d,r} = 1 \\ 0\ if\ atri_{i,t}^{d,r} = 0 \\ -1\ if\ atri_{i,t}^{d,r} = -1 \\ -2\ if\ btri_{i,t}^{d,r} = -1 \end{cases} \quad (1)$$

With subscripts: i being the unit (country); t=1965…2017 being the year; d containing the tax type (PIT, CIT, SSC, VAT, EXE, PRO, Total), where Total includes all tax types; and r denotes whether it is a rate or base change. First, all tax changes are summed up by country, year and tax type. a cumulates all tax changes (including major and minor changes), while b cumulates only the major (big) changes among them. Tax increases are counted as 1, while tax decreases are counted as -1. To give an extreme example, if there are two major and two minor decreases in the PIT rate code and one major increase in Australia in 1972, we would have $a_{AUS,1972}^{PIT,R} = -3$ and $b_{AUS,1972}^{PIT,R} = -1$. Since it is doubtful to assume that the impact of the tax changes rises in proportion with the implemented number of tax reforms, the metric scale of a and b is transformed into $atri$ and $btri$, which are ordinal variables with only three states. They would be $atri_{AUS,1972}^{PIT,R} = -1$ and $btri_{AUS,1972}^{PIT,R} = -1$ in the given example. Adding both ordinal variables gives a five-state ordinal variable $T_{i,t}^{d,r}$ that processes positive as well as negative tax changes and incorporates the available qualitative information on the scale of the tax change. In our example it would be $T_{AUS,1972}^{PIT,R} = -2$. Luckily, there are only a few examples where there is substantial cumulation and cancelation of reforms in (a, b) for a certain tax type. For the Total tax type the computation of the two-step variable is exactly the same, but obviously cumulation and cancelation of single reforms happen more frequently.

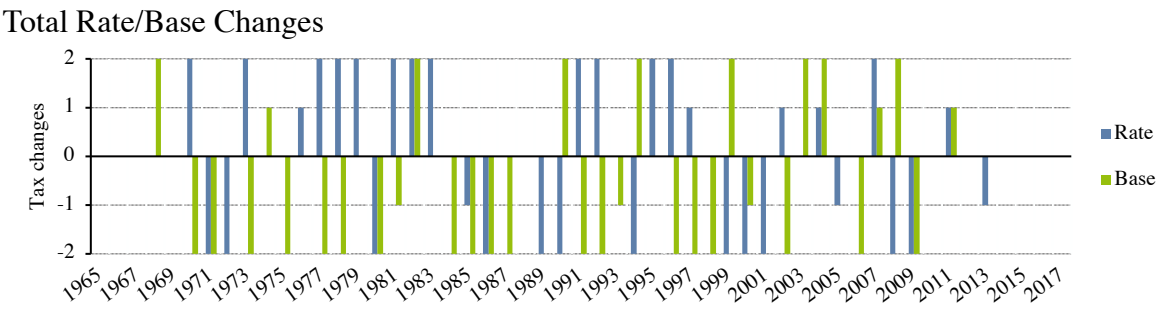
Certainly, this procedure might create unfavorable characteristics of the exogenous variable. Considering the computation of the metric variables (a, b) in equation (1), increases and decreases are subtracted such that tax changes, for example for different tax brackets in the PIT, may cancel each other, such that $T_{i,t}^{d,r} = 0$ signals no change, even though the single reforms could have substantial distributional or growth effects. Of course, this problem is not unique to the TPRD but can occur with pure time series analyses and quantitative narrative approaches as well, when net changes appear small but hide substantial opposing gross changes.

The computation of the ordinal state variables constitutes a loss of information, basically ignoring the number of tax increases or decreases that occur within the tax type. These issues are aggravated in the case of the catch-all Total tax variable since it incorporates all tax types evenly, despite their possible different impact in terms of revenues. We test for the robustness

of our choices by estimating our baseline results when simply using the b and $btri$ variants of the explanatory variable in Section 5.5.

An example of the tax shock series that are obtained from these computations is given in Figure 1, which depicts the tax changes of Germany from 1965 to 2017. It contains the series of total rate and base changes according to equation (1). The 1970s saw by far more rate increases, while the 1980s and 1990s were characterized by rate cuts. On the other hand, base decreases have been more prominent from the 1980s to the 1990s, while base increases have occurred more frequently since the 2000s.

Figure 1: Tax Shock Series for Germany according to $T_{GER,t}^{Total,R}$

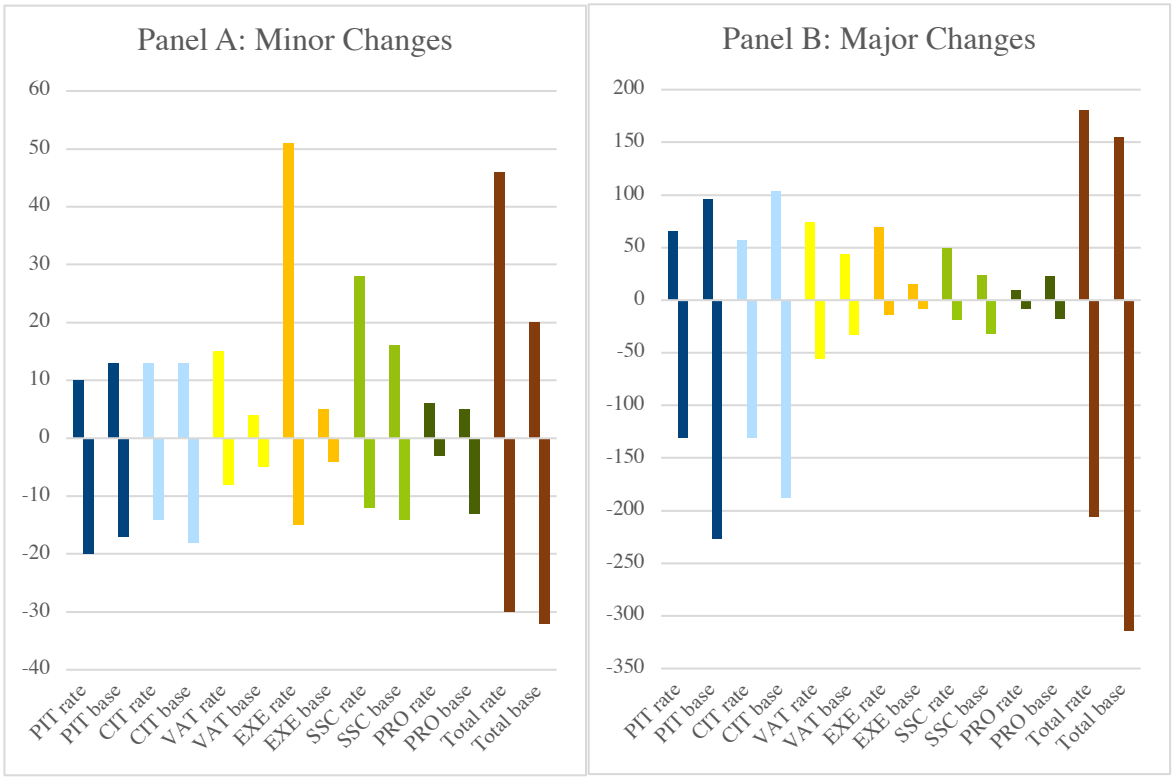


The graph shows the occurrence of tax shocks over time, including their sign, qualitative size (major {-2;2} vs. minor {-1;1}) and whether it was a rate or base change.

To get an impression of the overall number of tax changes for all countries in the sample that are covered by the five states variables ($T_{i,t}^{d,r}$), Figure 2 displays the number of tax changes of each tax type and total tax changes split by rate and base that have been classified either as minor (Panel A) or major tax changes (Panel B). The positive values refer to increases, while the negative ones represent the amount of decreases. Since $T_{i,t}^{d,r}$ is computed in a way that major changes override contemporaneous minor changes, there is a dominance of major changes concerning the absolute number of tax changes. Among the minor changes, EXE and SSC rate increases occur strikingly often. Also considering total taxation, rate increases are the dominant characteristic for minor changes. Concerning major changes, there is a remarkable dominance of rate and base decreases of PIT and CIT. Major changes among other tax types occur comparatively rarely with PRO changes being the least frequent measure. Panel B shows that, in the case of indirect taxes, major rate and base increases tend to happen more frequently than

decreases which generally reflects the secular shift from direct to indirect taxation (despite SSC increases).

Figure 2: Number of Minor and Major Tax Changes in $T_{i,t}^{d,r}$



Panel A shows the number of observations where $T_{i,t}^{d,r} = \{1; -1\}$. Panel B shows the number of observations where $T_{i,t}^{d,r} = \{2; -2\}$.

4. Estimation Strategy

We estimate impulse response functions of GDP per head and inequality measures after tax increases directly from local projections over increasing time horizons. This approach has been put forward by Jordà (2005) emphasizing that it can be applied in the same fashion as vector autoregressions (VAR), while making use of simple regressions being less inclined to misspecification, enabling joint or point-wise analysis and being able to incorporate complex specifications. For each time horizon of $h = 1, \ldots, 5$ years, the following equations are estimated based on annual data:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + Time_t^h + \beta_h T_{i,t}^{d,r} + \gamma_h C_{i,t} + \sum_{j=1}^{l} \delta_j^h \Delta y_{i,t-j} + \epsilon_{i,t}^h \qquad (2)$$

Equation (2) estimates the effect on y, which is either the growth rate of the GDP or the percentage change of the Gini coefficient over an increasing time horizon. It incorporates $\sum_{j=1}^{l} \delta_j^h \Delta y_{i,t+1-j}$, the sum of lagged first relative changes of the dependent variable up to three lags (we check robustness of the results with more lags). $T_{i,t}^{d,r}$ represents the tax shock variable as defined in equation (1), i.e. a five-state variable that equals 0, if there is no tax change, 1 (-1) if there is a minor tax increase (decrease) and 2 (-2), if there is a major increase (decrease); α_i^h represents country-fixed effects; $Time_t^h$ is a time trend; $C_{i,t}$ is a vector containing control variables such as GFCE, and base (rate) changes of the same tax type when estimating rate (base) changes.

Moreover, Dabla-Norris and Lima (2018) recommend controlling for tax base changes when estimating the effects of tax rate changes and vice versa since they assume a correlation of both. A pairwise correlation matrix of the tax measures used in the present paper does not support this assumption as can be seen in Table 4 in the Appendix. Most tax measures show only minor correlation coefficients ($|\rho| < 0.1$), regardless of tax rate or base changes. Only PIT and CIT changes display sizeable correlation (rate changes: 0.36, base changes: 0.33). This finding is plausible, since following an increase in personal income taxes wealthy individuals may shift profits to their companies thereby urging governments to adjust corporate income taxes as well to avoid loopholes (Zucman 2014). Despite the weak evidence of tax rate and base correlations within the same tax type, the reciprocal control for each counterpart is included in the baseline model.

As proposed by Beck and Katz (1995), the regressions are computed using Ordinary Least Squares (OLS) and the Panel Corrected Standard Error (PCSE) estimator which takes panel heteroskedasticity and contemporaneous correlation between the countries into account. Since the scale of the GDP growth rates and the increase of income inequality differ among the countries and the integration of international trade and tax policies creates cross-country correlations, this is important to avert biased standard errors. According to Beck and Katz (1995), in the case of time-series cross-sectional data, this estimation technique is superior to the application of Feasible General Least Squares (FGLS) estimations, which tends to understate the standard error of the estimated coefficients. The OLS-PCSE approach has been applied in similar empirical settings (e.g. Ball et al. 2013; Dabla-Norris and Lima 2018; Furceri et al. 2016; Heimberger 2018; Woo et al. 2016).

5. Results

Subsequently, the findings of the empirical analysis are illustrated and discussed. At first, the results of the baseline specifications are presented regarding the effect on economic growth in Section 5.1 and regarding the effect on income inequality in Section 5.2. Section 5.3 is dedicated to the effects of PIT top rate changes and Section 5.4 examines the results in a joint manner to identify trade-offs regarding the two goals, or other constellations. After that, several checks and modifications of the baseline specifications are conducted to verify the results of the analysis in Section 5.5.

The impulse response functions from local projections represent the β_h-coefficients of equations (2) and (3), plotted at every year of the time horizon h as continuous line. Furthermore, centered error bands are obtained by multiplying the standard errors of the β_h coefficient with the z-values corresponding to the 68% confidence level (one standard error bands, dark grey) and the 95% confidence level (two standard error bands, light grey). In each assembly of graphs, the first row refers to rate changes, while the second refers to base changes. At the end of each row, the Total tax variable capturing the tax rate or base changes of all tax types is depicted.

Usually, the impact on the dependent variable is measured as a response to a tax change corresponding to the volume of 1% of the GDP. However, as mentioned above, a quantitative evaluation of the effects of tax changes is not feasible due to the lack of information on the exact volume of the tax reforms. The impulse responses of the dependent variable thus refer to the percentage change after a *one-step increase* of the considered tax measure $T_{i,t}^{d,r}$. "One step" either relates to the difference between no change and a minor change or between a minor change and a major one. For example, the top-left diagram of Figure 3 could be interpreted such that a minor tax rate increase of the PIT dampens GDP by 0.5%. Thus, taking two steps on the $T_{i,t}^{d,r}$-variable, an average major tax rate increase reduces GDP by 1% after three years.

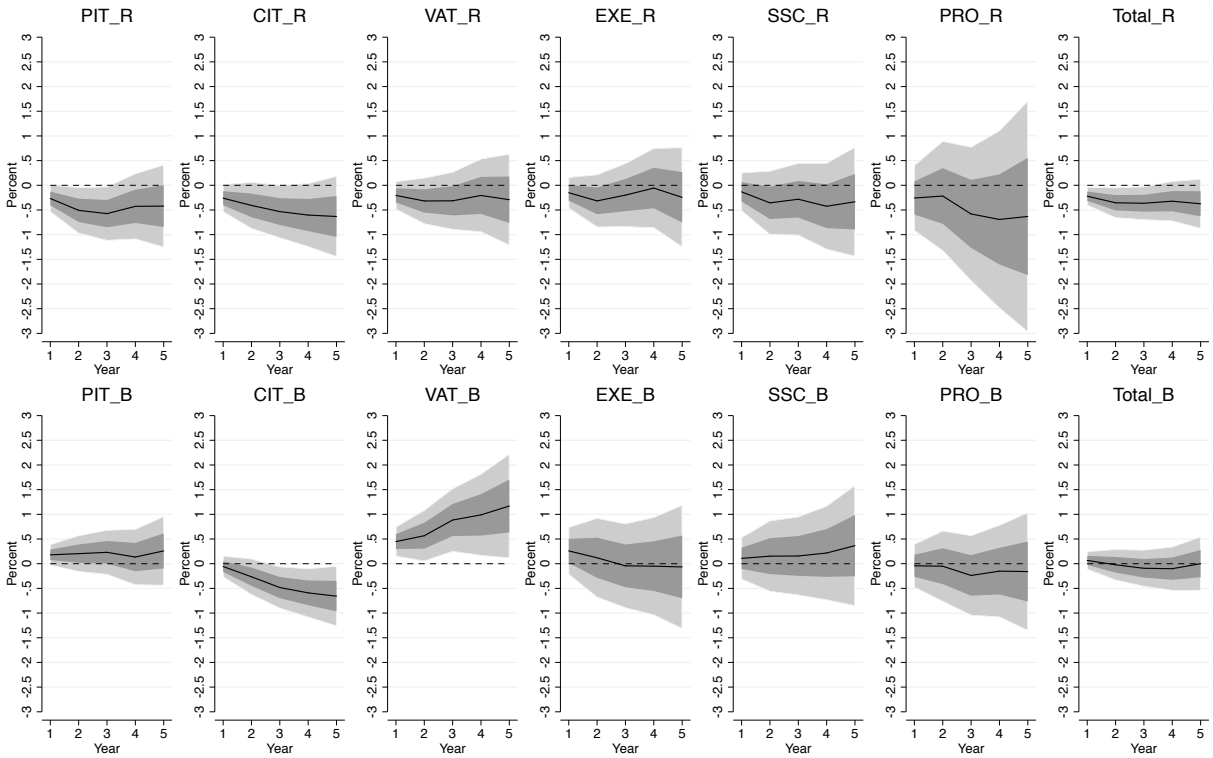
5.1 Effects of Tax Changes on GDP

As can been seen from Figure 3, the assumptions of the effects of tax changes on economic growth that have been derived from former examinations are only partly confirmed by the present analysis. There is indeed a distinct difference regarding the influence that rate and base changes exert in total on GDP. While rate changes in total have a significantly negative effect on economic growth during the first three years, a mix of all base changes does essentially not affect GDP. Therefore, the assumption that rate increases are generally more detrimental to

economic growth than base increases can be supported based on the findings. As argued in Section 2, the assumed reason for this tendency is that broadening the tax base reduces distortions concerning the allocation of resources by equalizing the tax burden among the targeted groups of taxpayers, types of income or goods. Conversely, rate increases are deemed to exacerbate growth-dampening distortions.

When shifting the focus to the rate changes of the individual tax types, it can be seen that PIT and CIT increases, which are regarded as being most detrimental to economic growth, both reduce the GDP statistically significantly on a 95% confidence level – in the case of the PIT during the first three years, in the case of the CIT only in the third year and very close to being insignificant at that level. In comparison, VAT and EXE rate changes show a less pronounced effect on GDP, in compliance with the assumptions from the respective literature. Both results are only temporarily significant on a 68% confidence level within the first three years. The increase of SSC rates also seems to have a sustained negative but essentially insignificant effect on GDP. In line with theoretical considerations, the effect is lower than for progressive direct taxes and higher than for indirect taxes. In the case of the PRO rate increases, the point estimate is comparably larger at a more distant horizon but remains completely insignificant. The relatively high uncertainty of the estimate might be due to the small number of incidences of PRO rate changes as presented in Figure 2.

Figure 3: Effects of Tax Changes on GDP



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. “R” stands for rate changes and “B” stands for base changes.

In contrast to rate increases of the several tax types, only broadening the base of CIT leads to a statistically significant reduction of economic growth: There, the negative effect increases continuously from year one to five and is significant at the 95% confidence level from year three onwards. A tentative explanation for this reaction would be that corporations, which are affected by the base increase, lose a part of their competitiveness when the tax burden rises and that this cannot be compensated by the assumed efficiency increases of the harmonization of the tax system. Another explanation could be that the targeted corporations shift their production or at least their capital to other countries levying lower CITs (as examined in Zucman (2014)). The logic of a growth-enhancing reduction of distortions by base broadening does not seem applicable in this case. However, considering a base increase of the PIT, there is even a small and persistent positive effect to be observed, although it is only significant at the 68% confidence level within the first three years. Therefore, economic growth does not seem to be suffering from eliminating tax exemptions within the PIT.

Probably the most puzzling result is the large and increasing positive response of GDP following an increase of the VAT base. The coefficient starts at 0.5% in the first year and rises to over 1% in the fifth, while being statistically significant at the 95% confidence level during the entire period. A rather speculative explanation could be that the widening of the VAT base might come along with coverage of goods and services that previously belonged to the informal sector, thereby extending the range of incorporated markets as a whole and technically increasing measured GDP per head. Alternatively, there could be a simple omitted variable bias at work, for example correlation with other tax changes. However, even controlling for all other contemporaneous tax changes in the robustness section (Figure 10) does not alter the result. In contrast, the reaction of the GDP to base changes of EXE, SSC and PRO can be described as neutral since the IRFs are consistently insignificant.

5.2 Effects of Tax Changes on Gini Coefficients

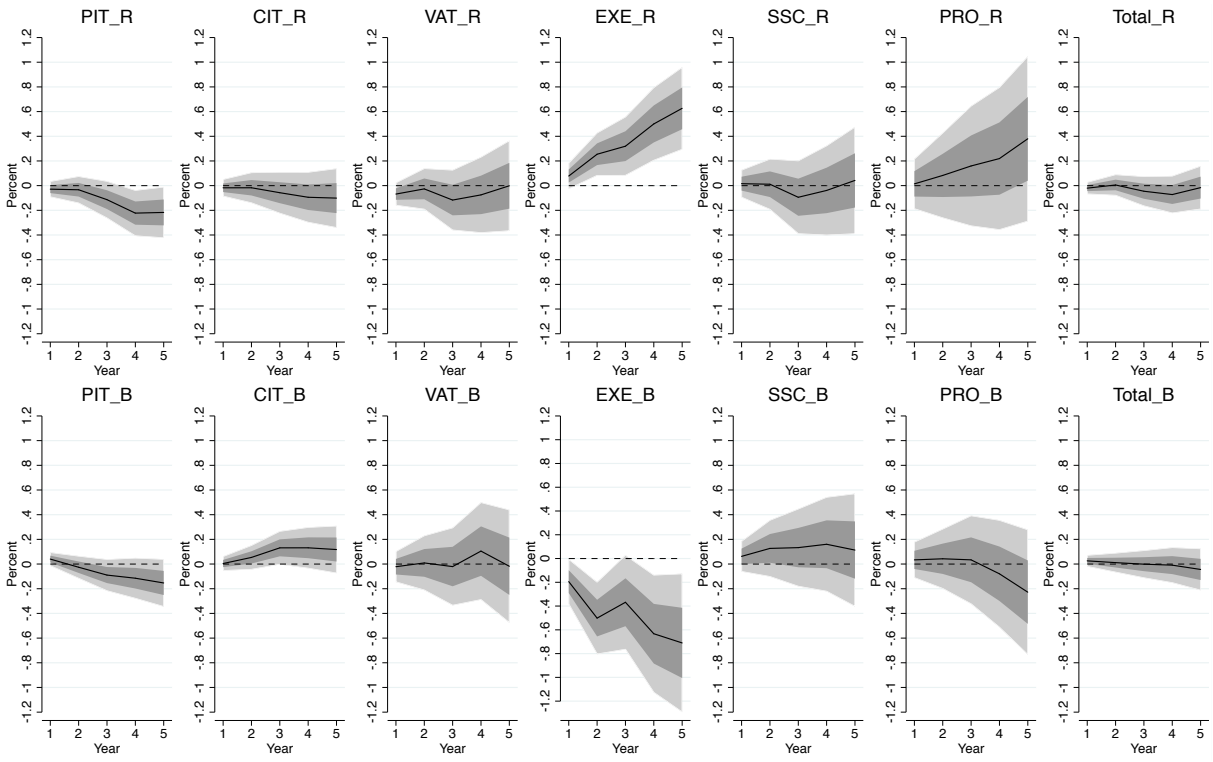
Figure 4 depicts the effects of tax changes on the Gini coefficient. Panel A refers to disposable income and Panel B refers to market income inequality. Considering the effects of total tax rate changes, there is hardly a difference noticeable between the reaction of the Gini coefficient of disposable income and market income. Both decline slightly but the change is essentially insignificant. On the other hand, base broadening in total significantly lowers market

income inequality, but it does not lower disposable income inequality. Taking a closer look at the effects of the individual tax measures, however, reveals some marked differences.

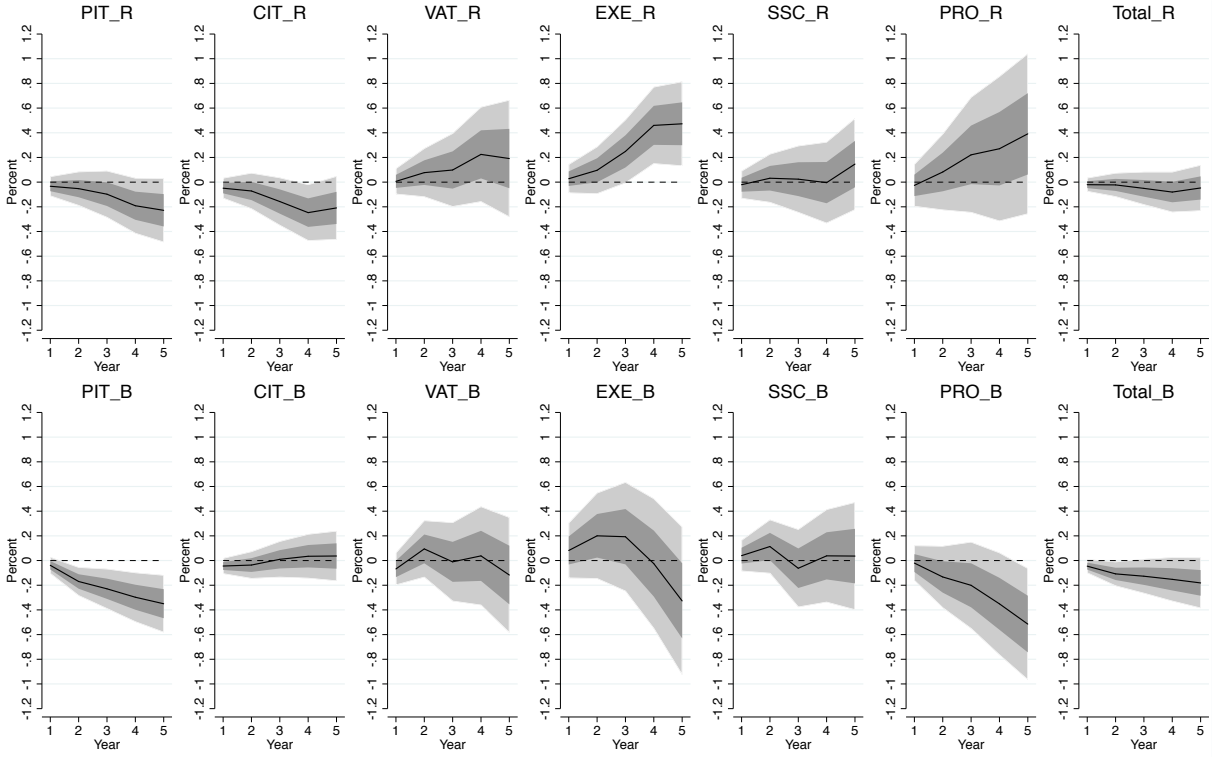
As can been seen from the first diagram of Figure 4, Panel A, the impact of a PIT rate increase significantly reduces the Gini coefficient of disposable income. The effect starts after two years and becomes statistically significant on a 95% confidence level after four years. By comparing this dynamic to the respective diagram in Panel B, it can be noticed that the Gini coefficient of market income shows a similar reaction (although not significant at 95% confidence level). Thus, the reduction of income inequality by PIT rate increases might be driven to some extent by changes of incentives, in line with Piketty et al. (2014). Regarding a base broadening, the equalizing effect is even more pronounced in the case of the Gini coefficient of market income than in the case of disposable income. For the market income Gini, the coefficient increases constantly to almost -0.4% and is statistically significant on a 95% confidence level throughout the whole period, while the effect on the disposable income Gini is only about half as strong and is only significant at a 68% confidence level.

Figure 4: Effects of Tax Changes on Gini Coefficient

Panel A: Response of Gini Coefficient of Disposable Income



Panel B: Response of Gini Coefficient of Market Income



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. "R" stands for rate changes and "B" stands for base changes. Disposable income refers to post-tax, post-transfer income, market income refers to pre-tax, pre-transfer income.

This further supports the assumption that the distributional impact of PIT changes is largely driven by incentives implying that higher taxation discourages people to strive for higher incomes. Overall, the equalizing effect of a base increase mirrors the argumentation from the previous literature that most tax exemptions of the PIT benefit high-income groups.

Regarding the effects of CIT changes on the Gini coefficient, there is a difference between rate and base changes, which holds more or less strictly for disposable income as well as for market income inequality. While CIT rate increases show a significant equalizing effect on the distribution of market income (Panel B), the effects have a similar sign, but are only half as large and insignificant for disposable income (Panel A). There is no easy explanation for this since one would rather expect a smaller effect for market income inequality by shifting of the tax burden (Fuest et al. 2018). Rather it seems that higher tax rates could discourage corporations and their management to strive for higher profits, ultimately reducing market income inequality. The findings contradict the assumption that growth-detrimental effects of rate increases translate into higher income inequality. CIT base increases show a neutral (market income) or even inequality-increasing (disposable income) effect, which goes again against conventional wisdom. One explanatory factor here might be the comparably strong negative

growth effect of CIT base increases that reduces the redistributive effect. Increasing CIT rates could be more effective in reducing income inequality than base broadening, because base increases in areas such as limiting loss-carry rules, or reducing R&D and investment promotion may have a greater impact on the competitiveness of corporations encouraging them to lower wages, reduce employment or shift production abroad. Complementarily, the increase of top rates, surcharges, rates for dividends and capital gains, which are all measures subsumed under the category of CIT rate changes may be more effective in reducing income inequality.

While changes of the VAT do not indicate significant consequences for income inequality, as would be expected when measuring inequality by income alone, changes of EXE show a more distinct and puzzling pattern: An increase of the EXE rate is related to a statistically significant increase of the Gini coefficient in the case of disposable income (Panel A) as well as in the case of market income (Panel B). Although indirect taxation is regarded as having regressive effects, these effects should neither be observable in market incomes nor in disposable incomes, but only in consumption and wealth inequality. Similarly, the significant decrease of the Gini coefficient of disposable income following an increase of the EXE base is puzzling. Moreover, the dynamics of the Gini coefficient of market income in response to an EXE base increase rather appears arbitrary as it first increases and then decreases.

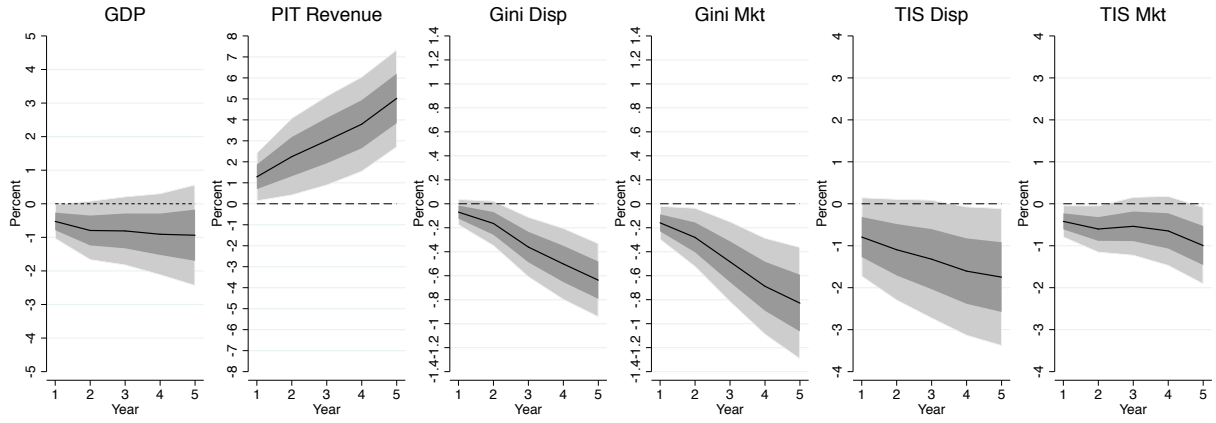
Regarding the neutral reaction of the Gini coefficient of market income to changes of SSC, there is no sign that increasing the rate or base raises income inequality via a shift of the tax burden from employers to employees. Instead, a widening of the base leads to an insignificant increase of the Gini coefficient of disposable income. It is conceivable that SSC base increases imply the incorporation of employees of lower income groups that have been exempted from SSC duties before. In contrast, rate increases do not show a distinct effect on disposable income inequality.

The effects of PRO rate changes are largely insignificant with wide error bands that could be driven by the low number of instances of such changes. It could also be due to the fact that most changes to property taxes will not affect incomes directly as they refer to durables and owner-occupied housing. In case of an increase of the PRO base, there is a strong decline of the Gini coefficient of market income, which turns significant at the 95% confidence level in the fifth year. This again might be driven by a reduction of incentives to strive for greater wealth. There is also a weaker and delayed decline of the Gini coefficient of disposable income observable following a PRO base increase that kicks in after three years but remains insignificant throughout.

5.3 Effects of PIT Top Rate Changes

Figure 5 looks at the effects of the PIT top rate. As presented within the literature review, the role of the top rate of PIT is of special interest when it comes to the trade-off between economic growth and income inequality. However, the cited studies do not find evidence for a real trade-off since their findings do not indicate that tax changes of the PIT top rate have an impact on economic growth. On the other hand, they find significant effects on income inequality. Considering the empirical results at hand, the previous findings cannot be confirmed in the same way. As the first diagram of Figure 5 illustrates, an increase of the PIT top rate has a significantly negative effect on the GDP: Compared to other tax type changes in Figure 3, the effect is larger. In order to assess the benefit for the fiscal budget, the second diagram shows the effect on PIT revenues:[9] Despite the dampening of economic growth, PIT revenues are sharply increasing during the five-year period. From a budgetary perspective, raising the PIT top rate is thus an effective instrument to raise funds. Considering the matter of distribution, it is also well suited to reduce income inequality both at disposable and market income level. The Gini coefficients in Figure 5 decline clearly and significantly. In accordance with the results of Figure 7 below, changes to the top-10% income share of disposable and market income even show a larger effect pointing in the same direction, which is however measured with much less precision. The distinct reaction of the measures of market income supports the conclusion of Piketty et al. (2014) who emphasize the role of incentive changes when analyzing the effects of PIT top rate changes.

Figure 5: Effects of PIT Top Rate Changes



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. “Disp” is disposable income referring to post-tax, post-transfer income and “Mkt” is market

[9] A detailed analysis of the effects of the tax types on the respective revenues is presented in the robustness section.

income referring to pre-tax, pre-transfer income. “Gini” is the gini coefficient and TIS is the top income share reaching from the 90th to the 100th percentile.

5.4 Joint Evaluation of Tax Measures

Table 3 summarizes the results of the analysis to allow for the comparison of the individual tax measures regarding their effects on economic growth and income inequality in a systematic manner. In doing so, measures that are beneficial or at least not harmful for growth and equality can be separated from those that fall into the trade-off scheme by showing diverging effects on both dimensions and the ones that are detrimental to both. We use the 95 % confidence bounds as a watershed.

Table 3: Estimation Results and Categorization of Tax Changes

Tax Measure	Effect on GDP Growth	Effect on Gini Disp Equality	Effect on Gini Mkt Equality
PIT_R	−	+	+
PIT_Top R	−	+	+
CIT_R	−	~	+
VAT_R	~	~	~
EXE_R	~	−	−
SSC_R	~	~	~
PRO_R	~	~	~
Total_R	−	~	~
PIT_B	~	~	+
CIT_B	−	−	~
VAT_B	+	~	~
EXE_B	~	+	~
SSC_B	~	~	~
PRO_B	~	~	+
Total_B	~	~	+

Notes: “R” stands for rate changes and “B” stands for base changes. “Disp” is disposable income referring to post-tax, post-transfer income, “Mkt” is market income referring to pre-tax, pre-transfer income. “+” shows a statistically significant (for the 95% confidence interval) positive effect (an *increase* of GDP or a *decrease* of the Gini coefficient), “−” is a negative effect (vice versa) and “~” is a statistically insignificant (neutral) effect.

According to Table 3, there is no clear “win-win” or “lose-lose” constellation, except for the borderline case of CIT base broadening which seems to be detrimental to growth and

equality of disposable income. Increasing tax *rates* is at best neutral to both goals, or it constitutes a trade-off scenario by decreasing income inequality and lowering income growth at the same time. Some base broadening measures are at least positive in one category and neutral in others.

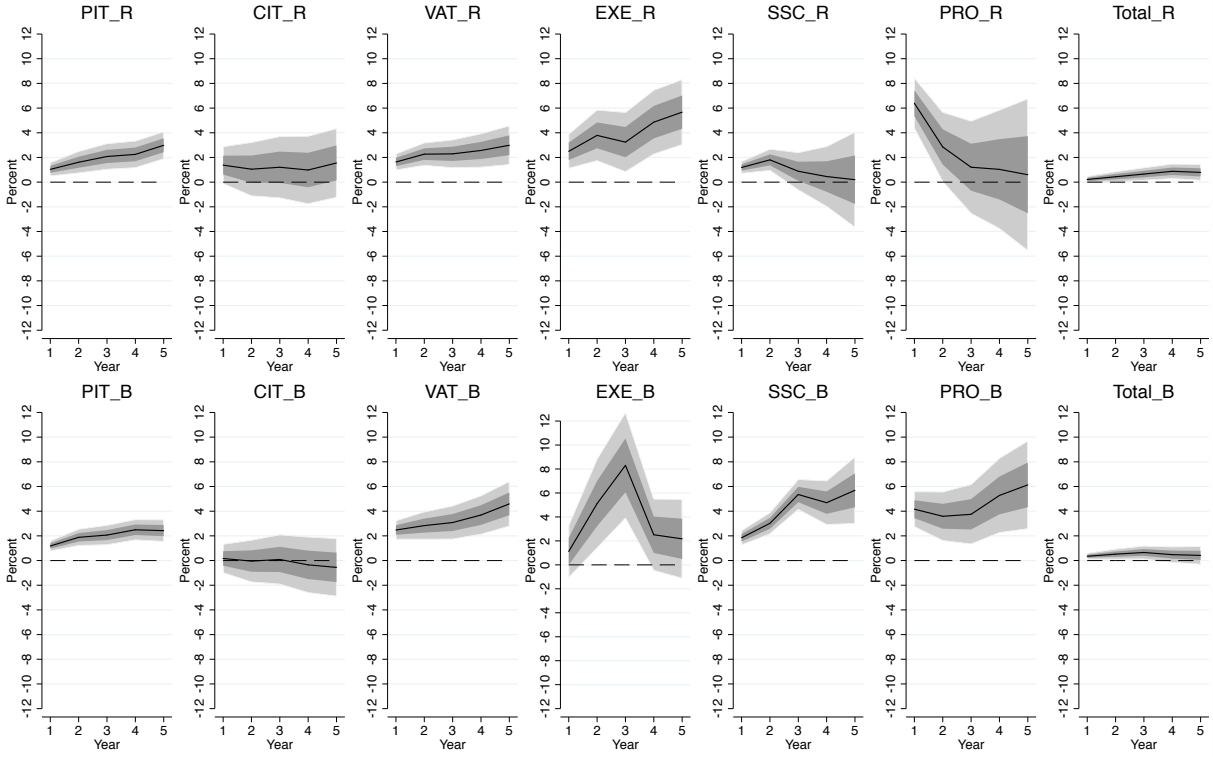
Considering the individual tax measures, PIT rate increases (including the PIT top rate) behave very much in line with theoretical predictions and are well-suited to decrease income inequality at the cost of a reduction of economic growth. CIT rate changes are somewhat similar, even though the effect is stronger for market income inequality and largely neutral for disposable income inequality. Increases in the rates of VAT, EXE, SSC and PRO are all slightly negatively affecting growth in line with the theoretical reasoning, but the response is statistically insignificant. Except for EXE rate increases, which imply a rather strong and hard-to-explain increase in both market and disposable income inequality, the impact of VAT and PRO rate changes is rather neutral to *income* inequality. This is plausible given the standard measure of income inequality that does not take into account regressive effects on consumer prices which put a higher burden on low-income households. In the case of SSC, inequality effects are neutral as well and this might cover opposing channels.

Conversely, base broadening can generate more favorable effects. A broadening of the PIT base insignificantly raises economic growth, while decreasing both disposable (insignificantly) and market (significantly) income inequality. Contrarily, the most unfavorable measure in this regard constitutes the broadening of the CIT base since it negatively affects economic growth and increases disposable income inequality with slightly decreasing effects to market income inequality. An increase of the VAT base seems to improve economic growth, while not exacerbating income inequality. EXE and PRO base broadening indicate a decrease of income inequality, while not reducing economic growth. SSC tax base broadening generally seems to be neutral to growth and inequality.

5.5 Robustness

So far, the effects of tax changes on economic growth and income inequality are examined by means of the baseline specifications. In order to verify these findings as far as possible within the present setting, several checks and modifications of the baseline model are conducted subsequently. Despite minor anticipation effects and a more uncertain response of top income shares, the results prove to be robust to the controls overall.

Figure 6: Effects of Tax Changes on Tax Revenues



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. "R" stands for rate changes and "B" stands for base changes.

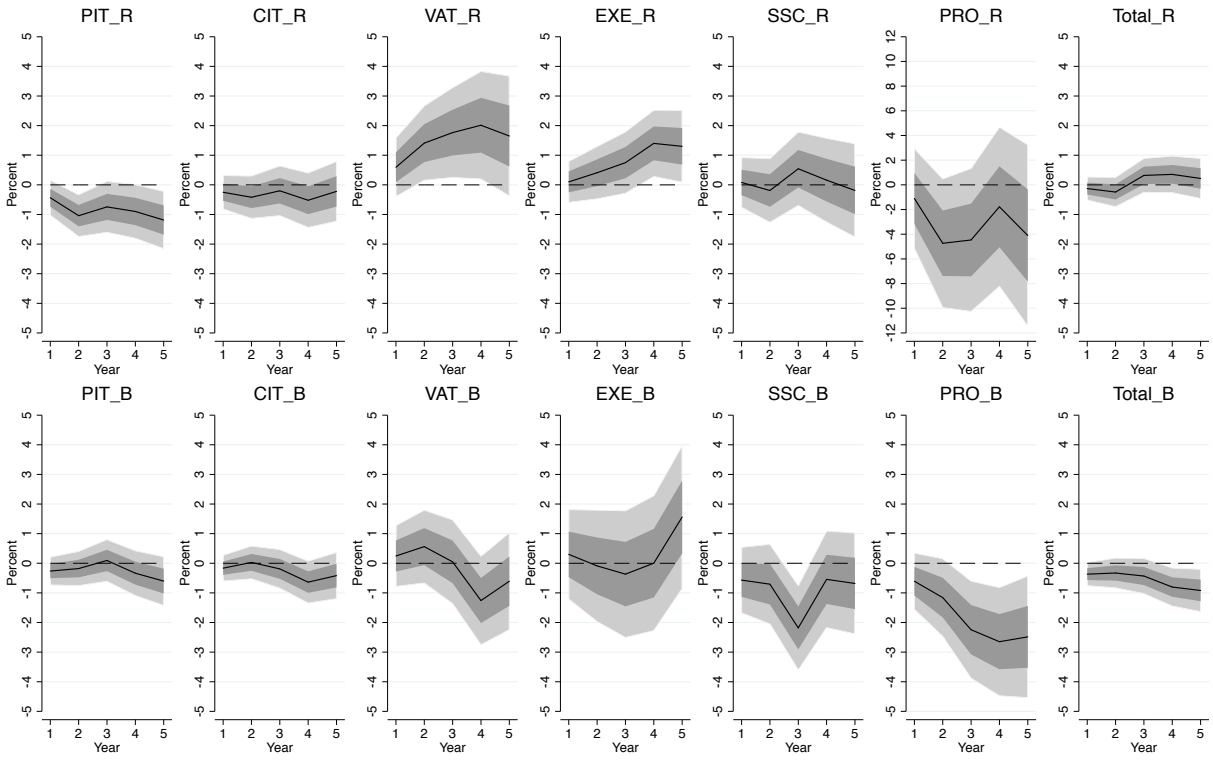
Tax revenues: To check the plausibility of the shocks in the TPRD, quantitative data on tax revenues are regressed on the tax change variables used in the analysis. This test may also identify tax type changes that are more likely to raise government revenues for purposes of consolidation. Of course, one has to keep in mind that other tax revenues may be affected simultaneously. The data is obtained from the OECD and is processed in the same way as the other dependent variables that are estimated as impulse response functions from local projections. Figure 6 illustrates the effects of tax type changes on the particular tax type revenues. First of all, there is no distinct difference between rate and base increases observable in total: both significantly raise revenues. However, some single changes appear to be less effective than others. Taken together, PIT, VAT and EXE changes seem to be effective instruments in terms of raising revenues, regardless of tax rate or base increases. Conversely, CIT rate increases only slightly raise revenues and CIT base increases even show a slight negative tendency. This corresponds to the findings in Mertens and Ravn (2012) for the USA, who find CIT cuts to be almost revenue neutral. When turning to SSC and PRO, base broadening yields a lasting effect of increasing revenues, while rate increases reach a turning

point after which the percentage increase of revenues converge to the zero line. This behavior could be related to the more growth-detrimental characteristics in both cases.

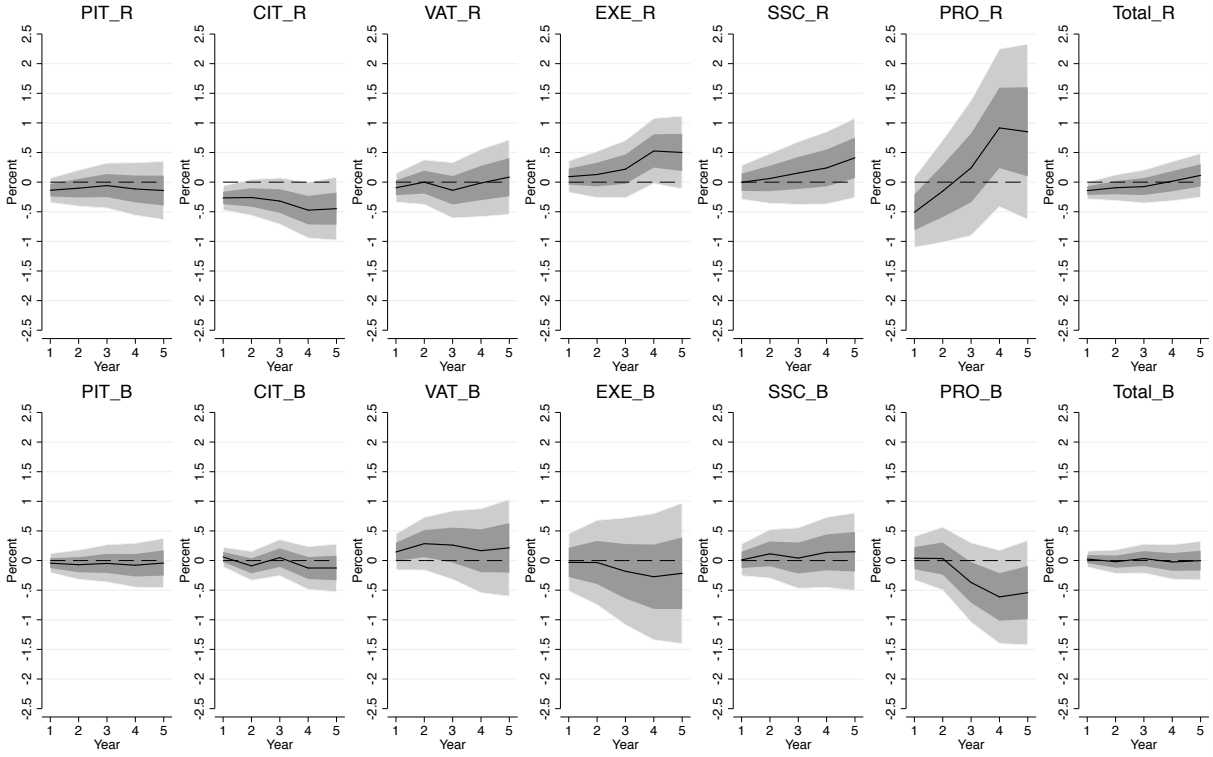
Top income shares: The Gini coefficient is only one measure of inequality, so a verification with other measures seems to be in order. We chose the top-10% income shares, but other measures like the top-5% or top-1% give qualitatively similar results, even though they display larger error bands. The top-10% market income shares are available for the same set of countries. Nevertheless, the series for some countries are taken from various definitions of income shares. In this case, we include dummy variables that account for structural breaks in the definition of the dependent variable. Moreover, top disposable income share data are available only for the USA, Canada and the UK, thus limiting the comparability of the findings. Results are shown in Figure 7. When comparing the two market income inequality measures that largely cover the same countries, the effects are rather similar. However, the reaction to PIT shocks remains insignificant for both base and rate changes. It should, however, be noted that (plausibly) the reaction of the top-10% income share is much stronger in the case of an increase in the PIT top rate, as depicted by Figure 5.

Figure 7: Effects of Tax Changes on Top Income Shares (P90-P100)

Panel A: Response of Top Income Shares (P90-P100) of Disposable Income



Panel B: Response of Top Income Shares (P90-P100) of Market Income



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. "R" stands for rate changes and "B" stands for base changes. Disposable income refers to post-tax, post-transfer income, while market income refers to pre-tax, pre-transfer income.

Base changes in general do not change the market income top-10% share significantly. With respect to disposable income, the effects for the subsample of the USA, Canada and the UK and the top-10% share are not too different either. Regarding the Total category of all tax changes, base broadening is now more beneficial to equality.

A substantial distinction is that CIT base broadening is more likely to reduce the top-10% income share which would be more in line with theoretical reasoning than the significant increase in the Gini. The strong and unexplained reactions of disposable income Ginis to EXE rate and base changes are less pronounced in the case of top-10% measures. On the other hand, PRO tax hikes of rate and base are more clearly reducing inequality, which could point to a stronger weight of wealth and inheritance taxes for the top-10% share. Further, among the developed countries, it is known that the Anglo-Saxon liberal market economies rely somewhat stronger on property taxes than most other advanced economies (Joumard et al. 2012). Maybe the property tax schemes of these countries also diverge regarding their composition which could explain the different direction of the result. SSC base broadening lowers the top-10%

disposable income share at least temporarily, which is more in line with theoretical reasoning. When measured by the top-10% disposable income share, inequality is significantly increasing after a rise in the VAT, which would not be expected from theoretical reasoning.

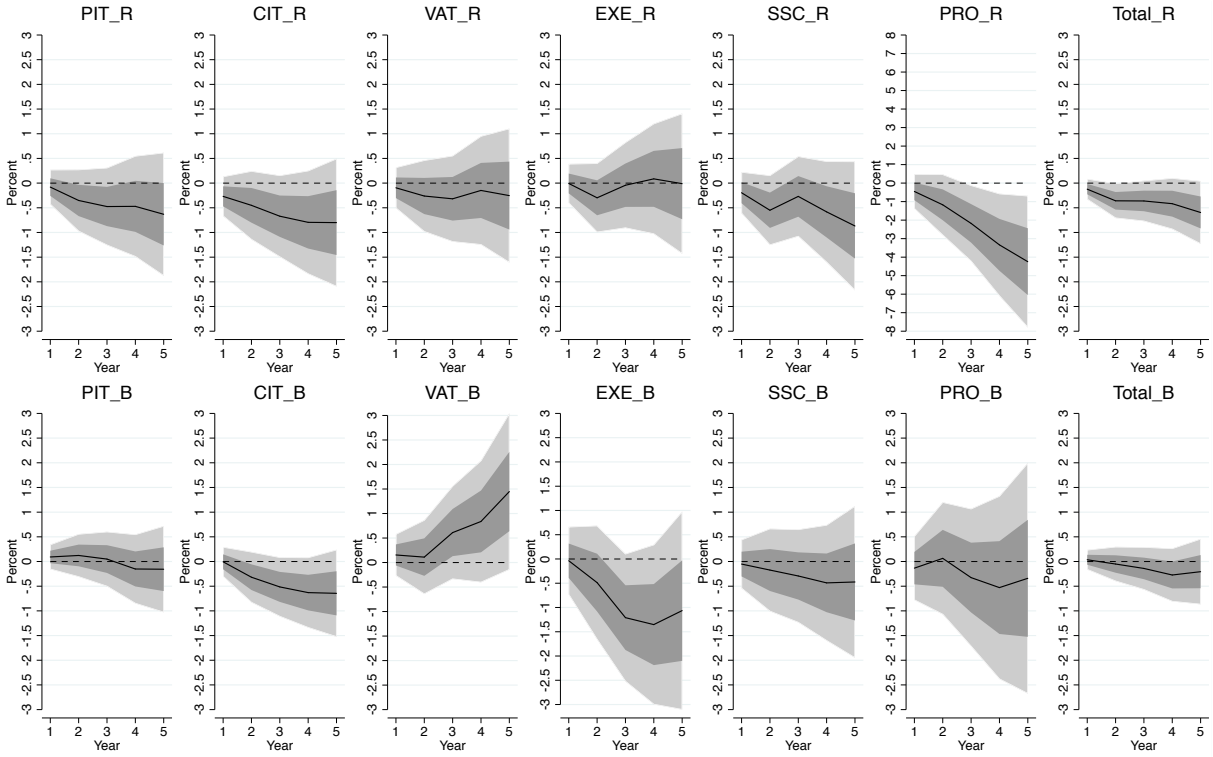
Anticipation effects: When tax measures are announced long before implementation, there could be prior reactions of households and firms that the econometrician would miss when using the shocks at implementation date. However, neither theoretically nor empirically the effects are clear as there are plausible channels that work in opposite directions: The permanent income hypothesis suggests that taxpayers reduce their consumption when they receive the news of a permanent tax increase in order to make up for the loss of future income which translates into a reduction of economic activity. When the actual tax change hits, no further reactions of the taxpayers are expected (Romer and Romer 2010). Conversely, the intertemporal substitution effect predicts a frontloading of taxpayers' spending because future expenses will be charged heavier after implementation. Likewise, after implementation, incentives to buy or work (depending on the tax type) are reduced and economic activity decreases. A third hypothesis is that the announcement of tax increases is assumed to raise taxpayers' confidence in fiscal sustainability, which in turn increases the propensity to spend and invest, thereby increasing output (Romer and Romer 2010). It is unlikely that income inequality is affected systematically by fiscal foresight effects.

In order to control for such effects, we re-estimate the effects on GDP by using only those tax shocks that have been implemented without a lag (in line with Mertens and Ravn 2014). Before comparing the estimation results, it is useful to consider the descriptive statistics presented in Figure 9 in the Appendix to evaluate the possible magnitude of the anticipation effect. Panel A depicts the proportion of tax changes that have no implementation lag (and therefore cannot be anticipated) compared to those with a positive implementation lag (which may be anticipated). The illustration shows that most tax changes covered by the TPRD have an implementation lag which could bias the result noticeably, if anticipation matters. Further, the distribution of the implementation lags displays that the overwhelming majority of lags does not exceed one year. Given our data frequency of one year, implementation lags that are shorter than one year should not matter too much.

GDP effects after the tax shocks without implementation lag are given in Figure 8. The results suggest that anticipation effects are not that important or that the discussed channels cancel each other out. In general, the effects are close to the baseline results, even though the confidence intervals are somewhat larger, which could be due to the smaller sample of shocks considered here. Relevant differences occur only in the cases of broadening the EXE base or

increasing the PRO rate. Without implementation lags, they seem to hit the economy harder than in the baseline case, pointing to relevant substitution or confidence effects. In the case of an EXE base increase that is announced in advance, consumers might buy more of the commodities before the increase becomes effective, thereby offsetting the following decrease in demand. In the case of PRO rate hikes, it could be surmised that taxpayers try to adapt to the forthcoming tax increase and shift or transform their property in order to avoid the additional tax burden. If tax changes are implemented immediately, the taxpayers could not apply these strategies which in turn strains economic growth more.

Figure 8: Effects of Tax Changes on GDP: No Implementation Lag



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. "R" stands for rate changes and "B" stands for base changes.

Controlling for other tax measures: As already discussed earlier, the correlation matrix of the rate and base changes shows that most measures are implemented rather independently of each other. Nevertheless, unfavorable constellations could be a source of potential bias. To exclude this scenario, the estimation of the effects of tax changes is conducted by incorporating all tax rate and base changes as control variables. The results which are presented in Figure 10 in the Appendix clarify that the results obtained from the baseline specifications are not biased by other contemporary tax changes. A comparison with the baseline findings of Figure 3 and 4

shows that the results only change negligibly when adding the control variables. Therefore, it can also be ruled out that the surprising findings of the rise of GDP in response to a VAT base expansion or the different reactions of the Gini coefficient of disposable income to EXE rate and base increases can be accounted for by other contemporaneous tax changes.

Construction of the tax shock variables: As discussed in Section 3, the construction of the tax shocks involves some judgment calls, both on the side of Amaglobeli et al. (2018) when coding the dataset and on our side when coding the five-state variable $T_{i,t}^{d,r}$ as given in equation (1). Due to the lack of quantitative information on the volume of the tax changes, $T_{i,t}^{d,r}$ is constructed to capture at least the qualitative information given the separation between minor and major tax changes. In order to see whether the construction influences the results, estimations are repeated by using the tax change variables $b_{i,t}^{d,r}$ and $btri_{i,t}^{d,r}$. While both variables only include major changes, the first one cumulates all the major changes of the respective tax measure of a country within a year; the latter represents a three-state ordinal variable. The results, depicted in Figures 11 and 12 in the Appendix, are similar to the baseline case. As one would expect, the coefficients are smaller in the cumulative case $b_{i,t}^{d,r}$ (as one step would be only one tax change at a time), and larger in case of $btri_{i,t}^{d,r}$ (as one step could comprise several major tax changes), but the qualitative results are not changing substantially.

Included lags of the dependent variables: Finally, in Figure 13 in the Appendix, we re-estimate the effects by increasing the number of included lags of the dependent variable on the RHS from three to five lags (see again equation (2) in Section 4). Again, the results prove to be robust to this modification. Further tests incorporating two and four lags also show no substantial differences.

6. Concluding Remarks

The differentiation between individual tax types as well as between tax rate and base changes provides fruitful insights when estimating the effects of tax changes on economic growth and income inequality. Generally, the findings do not contradict the hypothesis that a tax hike involves a trade-off between growth and equality rather than a "win-win" case. Usually, a tax hike is likely to entail a negative GDP effect combined with less income inequality. However, there is a more nuanced picture when looking at tax changes in more detail.

A key takeaway is that the broadening of the tax base seems to be less detrimental to economic growth than increasing the tax rate. This finding is in line with Dabla-Norris and Lima (2018) and it corresponds to theoretical considerations arguing that base broadening may

reduce tax distortions. In opposition to rate increases, there is only one case – the CIT – where an expansion of the tax base leads to a significant decline of the GDP. This might be due, for example, to a decline of competitiveness or a shift of production to low-tax economies.

There is evidence that tax changes do not only influence income inequality via redistribution of disposable income. Rather the pronounced reaction of the Gini coefficient of market income after a PIT rate and base hike, a CIT rate hike and a PRO base broadening suggests that at least a considerable part of the effect can be attributed to other factors: tax increases may affect the market income distribution directly via a weakening of the incentives to strive for higher earnings or profits (Piketty et al. 2014) and our data also point in this direction. Furthermore, it is supposed that raising taxes can influence market income indirectly when employers pass on the additional tax burden to their employees through lower wages (Fuest et al. 2018). Such shifts in the tax incidence do not seem to be very important according to our results, except, maybe, for the case of PRO rate changes after which market income inequality increases to some extent, while disposable income inequality is less affected, possibly due to the tax' redistributive effects. Another channel that is often discussed would be that tax hikes could produce unemployment, thereby increasing market income inequality. However, this would presuppose "lose-lose" cases where GDP and market income inequality would worsen at the same time. Such cases are not found in our estimates. There is actually only one case – EXE rate hikes – where market income inequality increases significantly.

When turning to the precise effects of tax changes on income inequality, the results show that PIT rate increases reduce both the Gini coefficient of disposable and market income in line with theoretical reasoning. The effects are, plausibly, even more pronounced when considering PIT top rate changes only. Regarding CIT rate changes the effects are less pronounced, but point in the same direction. On the other hand, according to our findings, EXE rate increases significantly raise income inequality. In contrast, the findings regarding an increase of the PRO rate correspond to the literature's assumption that it widens income inequality due to a strong reliance on real estate charges.

The major aim of this paper was to identify tax changes that escape the logic of a trade-off by serving either economic growth or a reduction of income inequality without harming the other – or, at best, serving both. Some tax measures stand out: PIT, EXE and PRO base increases leave economic growth fairly unaffected, while reducing income inequality. Likewise, VAT base increases and a reduction in the CIT base promote economic growth, while not widening income inequality. However, one has to keep in mind that indirect taxes like VAT and EXE put a higher burden on spending of low-income households, which may either be compensated by

lower consumption or lower saving, thus increasing consumption or wealth inequality, while not affecting standard measures of income inequality. Thus, a PIT base increase or a CIT base reduction may be preferable. In contrast, PIT and CIT rate increases constitute typical trade-off cases by reducing income inequality but dampening economic growth.

Of course, our categorization is still rather broad and single measures within the categories maybe more preferential or detrimental than the average effects that we measure. For example, as discussed within the literature section, broadening the base can both mean to abolish tax privileges for high-income groups as well as to discard reduced rates or voucher programs benefitting low-income groups. Hence, the exact choice of the incorporated tax measures decides on the ultimate impacts of a tax reform.

Our analysis has two limitations: First, we cannot readily identify those legislations that have been implemented to counteract the development of output itself, which would pose an endogeneity problem and could lead to biased estimates. Since there is empirical evidence of both pro- and anticyclical policies that would bias the GDP effects in opposite directions as well as many cases with an acyclical stance, the obtained bias may be of limited nature. Second, the tax database only includes qualitative information on the size of shocks, such that we can only qualitatively compare the effects.

Future research could also examine the effects of tax changes regarding the progressivity of the tax structure and a non-linear relation between the level of the tax rate and the intensity of their effect on economic growth and income inequality. Likewise, it would be interesting to analyze tax increases and decreases separately as recent studies suggest that the effects may not be symmetrical. Moreover, it would be interesting to decompose the impact on macroeconomic components to investigate the detailed effect of each individual tax measure on consumption, investment and the unemployment rate.

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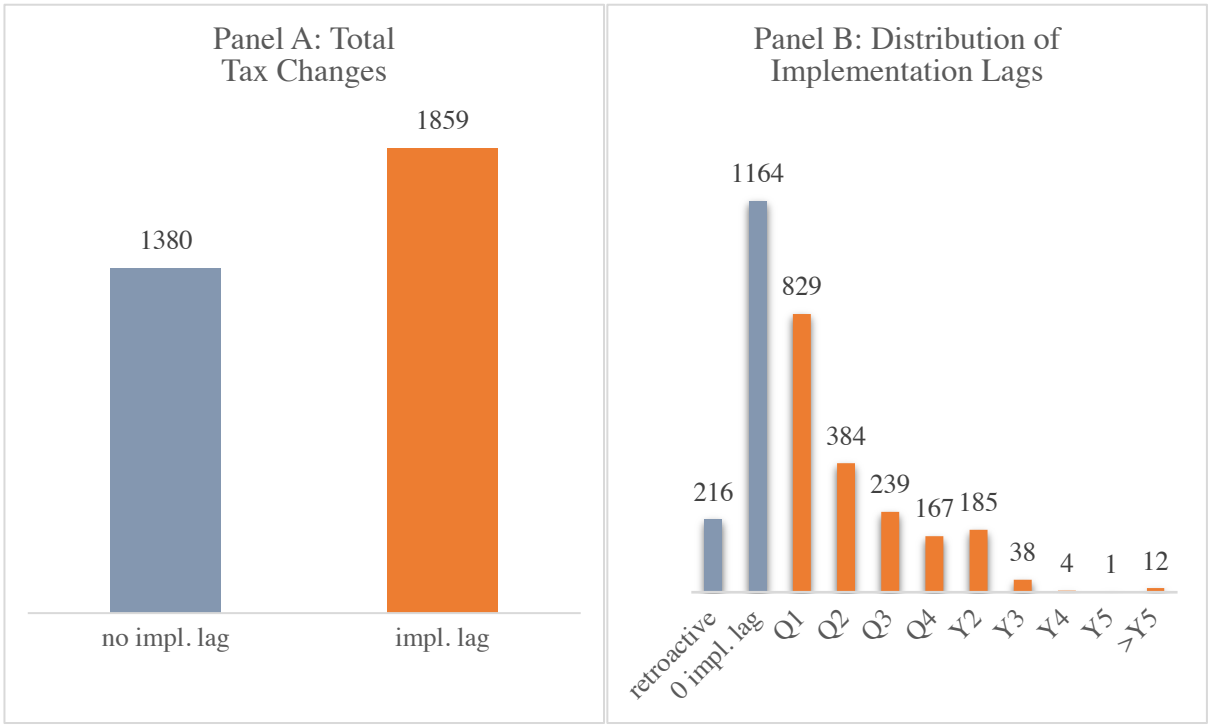
Table 4: Correlation Matrix of Tax Changes

Variables	(1) PIT_R	(2) CIT_R	(3) VAT_R	(4) EXE_R	(5) SSC_R	(6) PRO_R	(7) Total_R	(8) PIT_B	(9) CIT_B	(10) VAT_B	(11) EXE_B	(12) SSC_B	(13) PRO_B	(14) Total_B
(1) PIT_R	1.000													
(2) CIT_R	0.358* 0.000	1.000												
(3) VAT_R	0.110* 0.000	0.088* 0.002	1.000											
(4) EXE_R	0.067* 0.019	0.106* 0.000	0.121* 0.000	1.000										
(5) SSC_R	0.081* 0.005	0.044 0.124	0.045 0.117	0.046 0.105	1.000									
(6) PRO_R	0.059* 0.040	0.069* 0.017	0.058* 0.043	0.072* 0.011	0.017 0.542	1.000								
(7) Total_R	0.603* 0.000	0.584* 0.000	0.433* 0.000	0.371* 0.000	0.329* 0.000	0.145* 0.000	1.000							
(8) PIT_B	0.142* 0.000	0.045 0.113	0.033 0.248	-0.072* 0.012	-0.044 0.125	0.039 0.176	0.078* 0.006	1.000						
(9) CIT_B	0.041 0.152	0.061* 0.033	0.014 0.624	0.015 0.603	-0.012 0.680	-0.008 0.791	0.027 0.338	0.299* 0.000	1.000					
(10) VAT_B	0.053 0.066	-0.003 0.919	0.083* 0.004	0.030 0.292	-0.036 0.206	0.025 0.382	0.067* 0.020	0.077* 0.007	0.115* 0.000	1.000				
(11) EXE_B	0.066* 0.021	0.017 0.543	-0.118* 0.000	0.006 0.830	0.023 0.420	-0.046 0.108	0.048 0.093	-0.058* 0.043	-0.020 0.487	0.110* 0.000	1.000			
(12) SSC_B	0.023 0.421	0.033 0.257	-0.034 0.239	0.005 0.851	0.035 0.217	0.050 0.078	0.024 0.396	0.030 0.297	0.042 0.141	0.078* 0.006	0.076* 0.008	1.000		
(13) PRO_B	0.053 0.064	0.038 0.182	-0.029 0.313	-0.020 0.487	-0.009 0.754	0.093* 0.001	0.024 0.401	0.063* 0.027	0.031 0.280	0.025 0.386	0.066* 0.021	0.023 0.415	1.000	
(14) Total_B	0.145* 0.000	0.078* 0.006	0.036 0.213	-0.035 0.219	-0.013 0.662	0.030 0.292	0.099* 0.001	0.718* 0.000	0.645* 0.000	0.279* 0.000	0.072* 0.012	0.233* 0.000	0.188* 0.000	1.000

Notes: * shows significance at the .05 level, R stands for rate changes and B stands for base changes. The first number denotes the correlation coefficient, the second denotes the p-value.

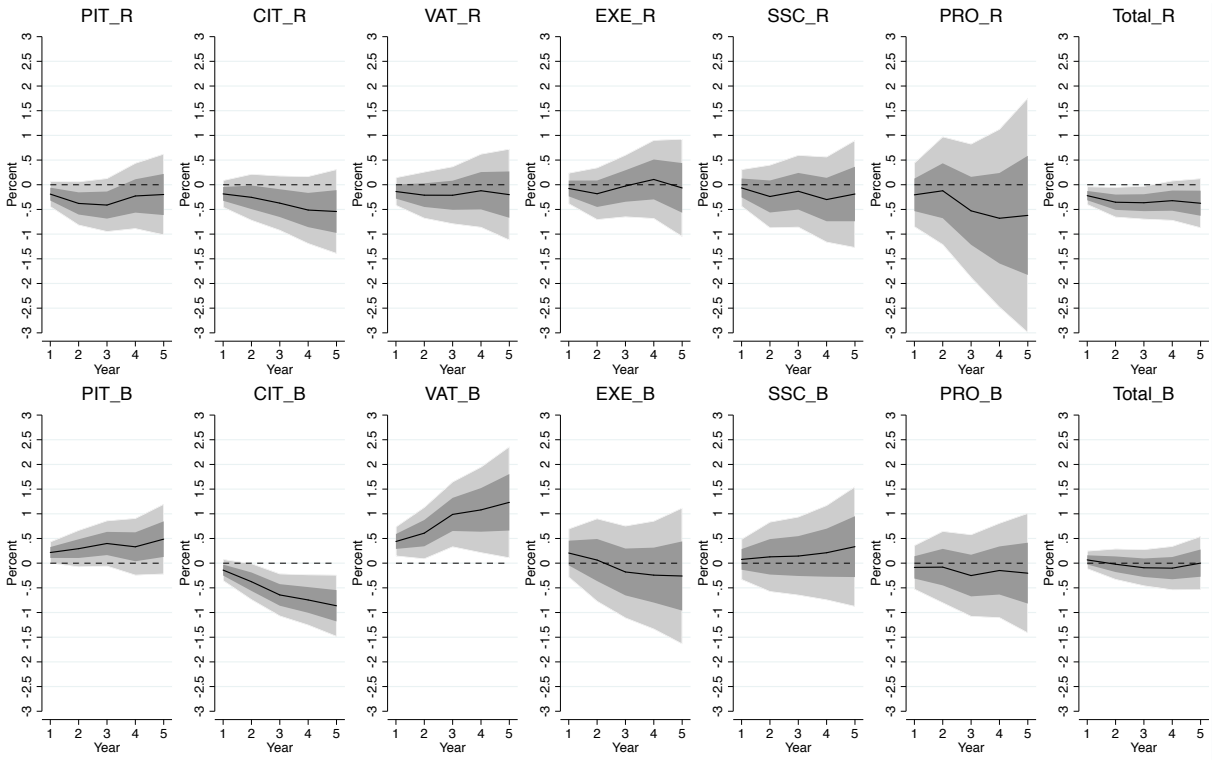
Figure 9: Amount and Distribution of Implementation Lags



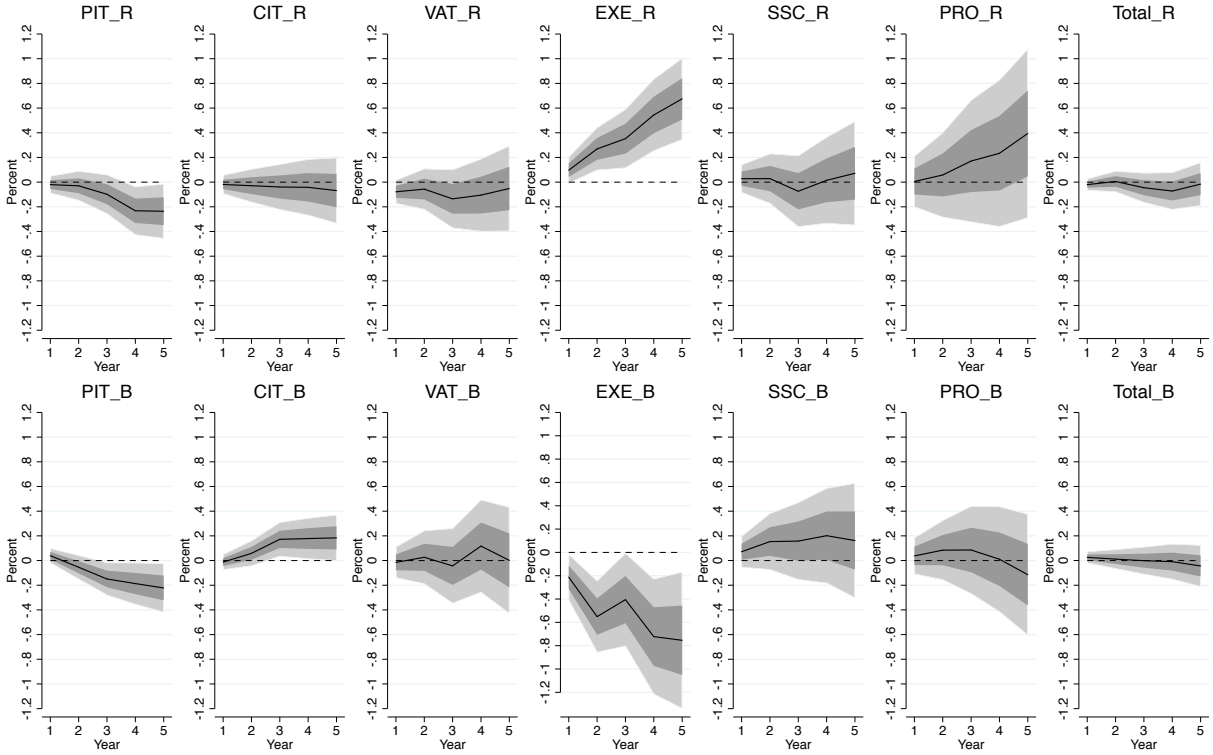
Notes: Q refers to Quarter, Y refers to Year.

Figure 10: Effects of Tax Changes: Control for All Tax Changes

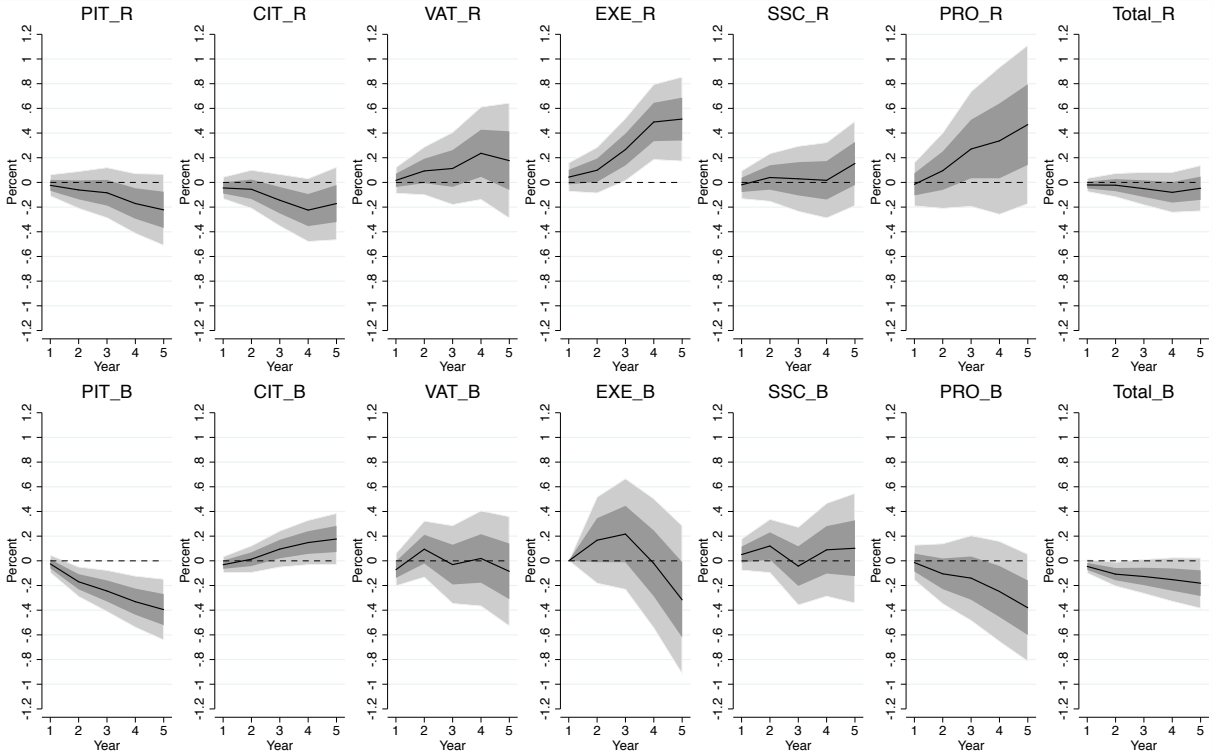
Panel A: Effects of Tax Changes on GDP



Panel B: Effects of Tax Changes on Gini Coefficient of Disposable Income



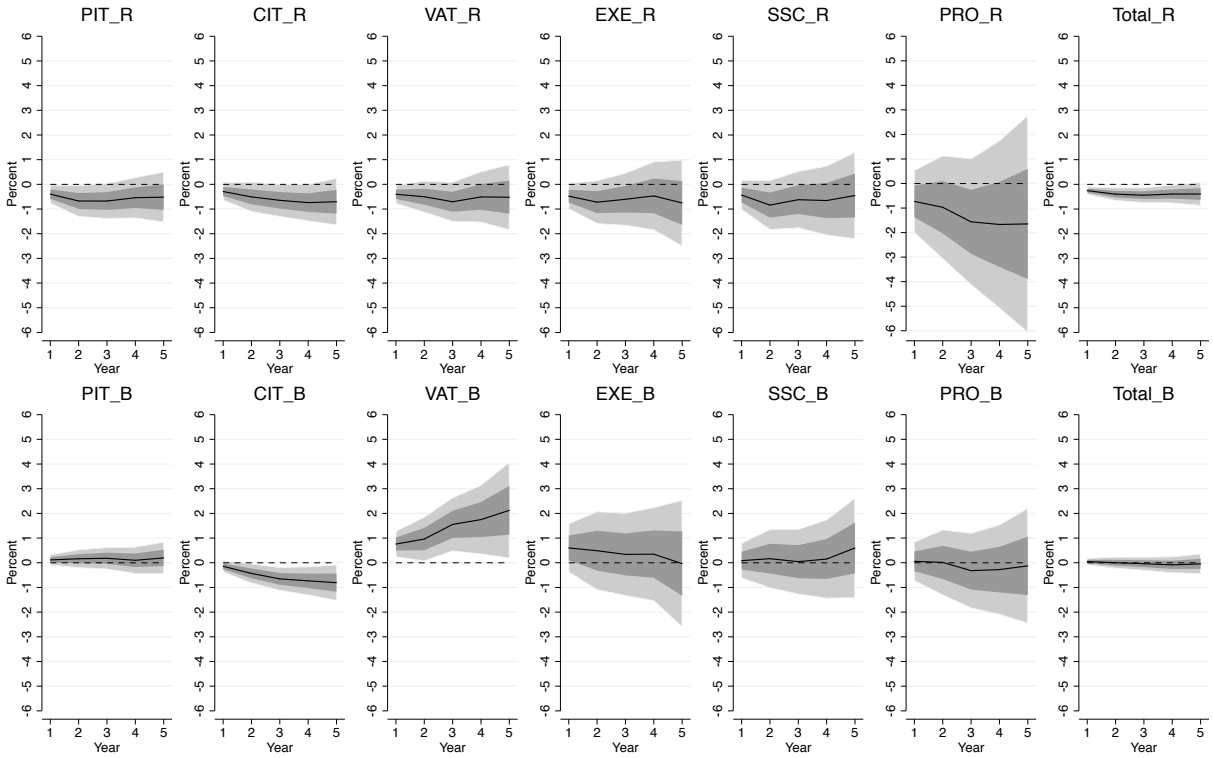
Panel C: Effects of Tax Changes on Gini Coefficient of Market Income



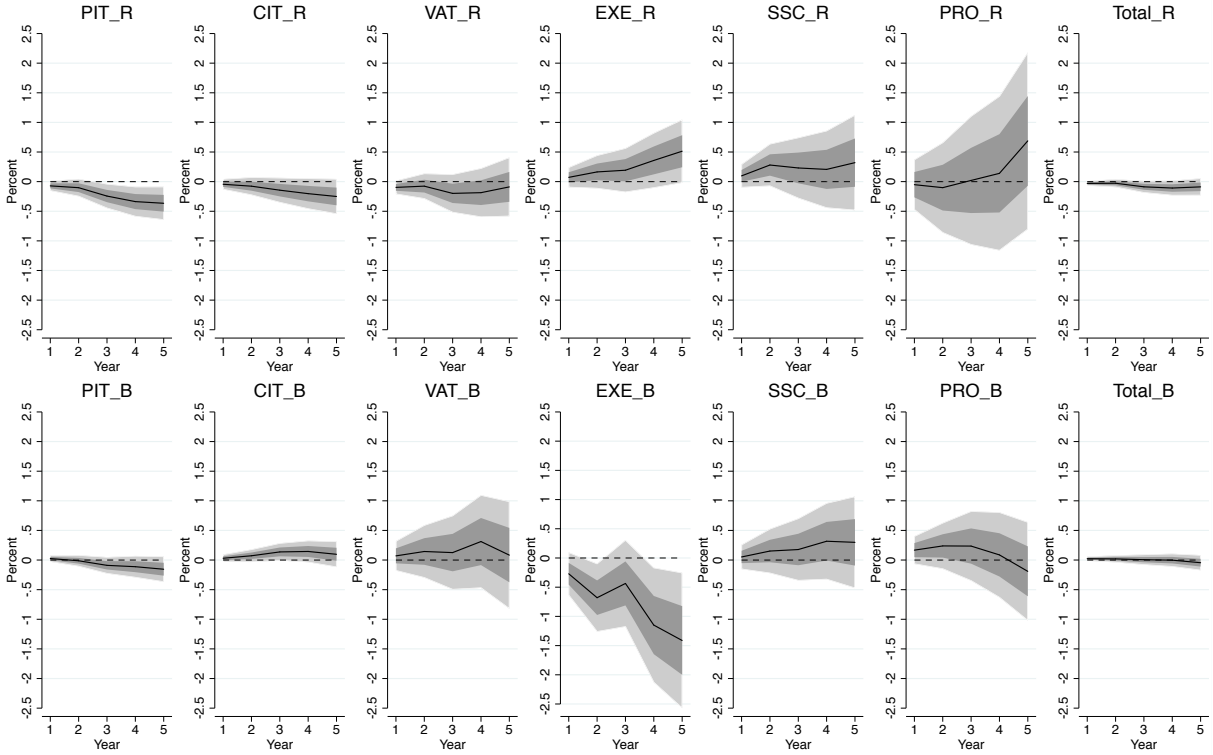
Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. “R” stands for rate changes and “B” stands for base changes.

Figure 11: Effects of Tax Changes: Using Only Major Changes, Cumulative Scale

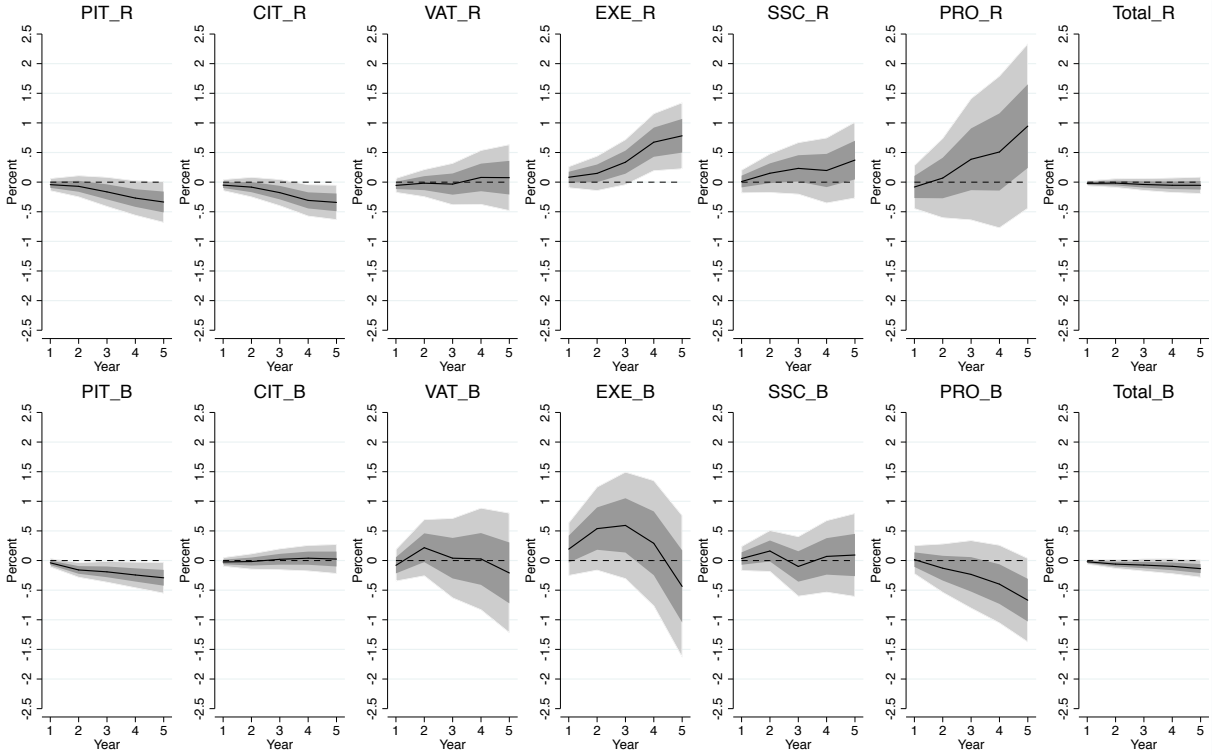
Panel A: Effects of Tax Changes on GDP



Panel B: Effects of Tax Changes on Gini Coefficient of Disposable Income



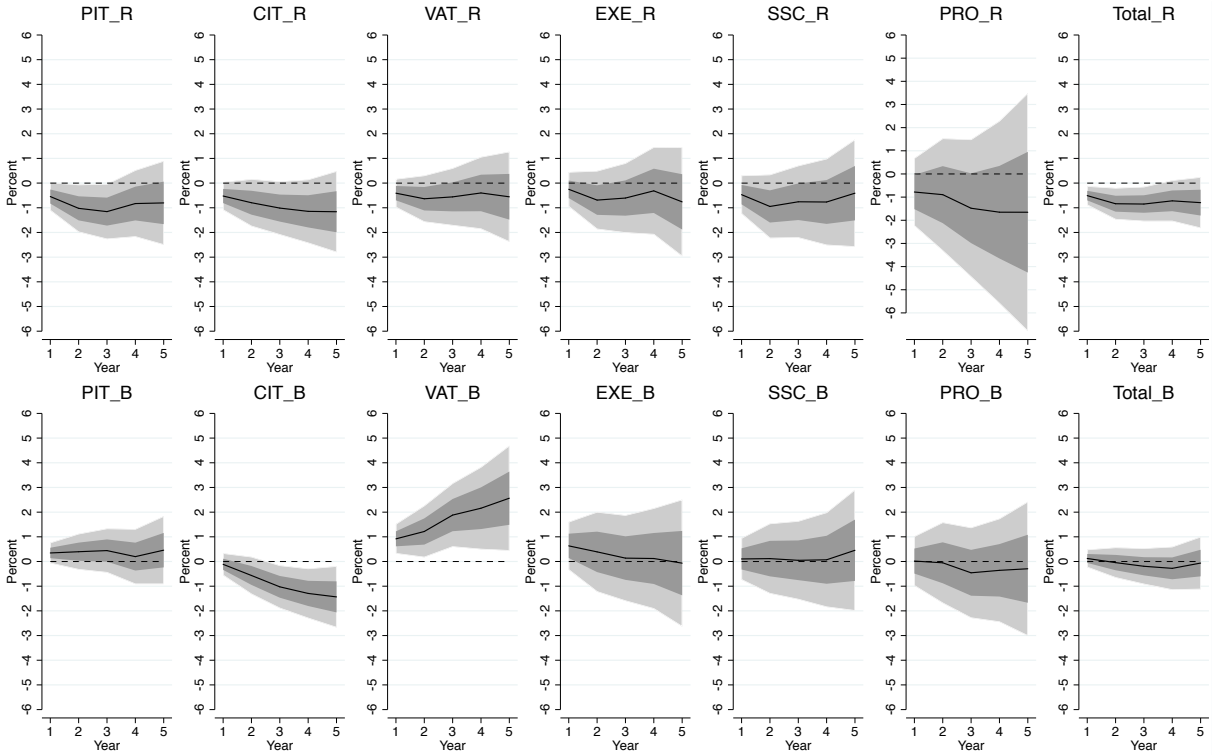
Panel C: Effects of Tax Changes on Gini Coefficient of Market Income



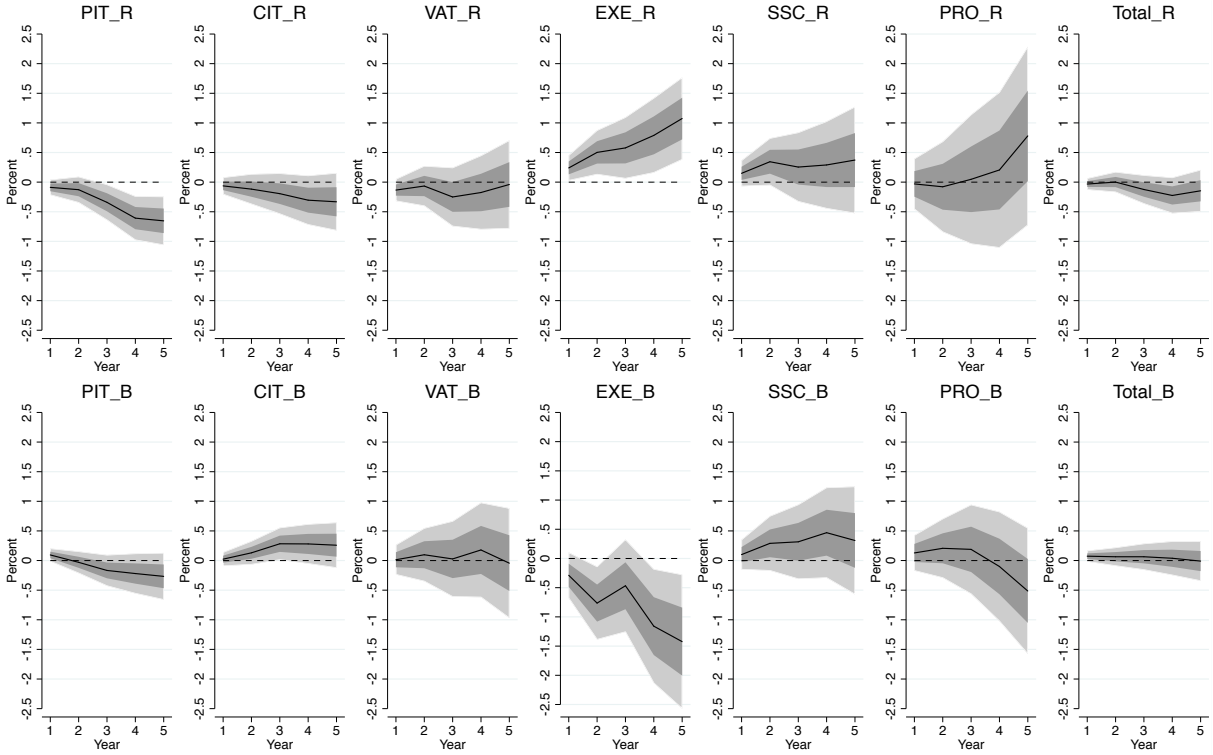
Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. "R" stands for rate changes and "B" stands for base changes.

Figure 12: Effects of Tax Changes: Using Only Major Changes, Three-state Scale

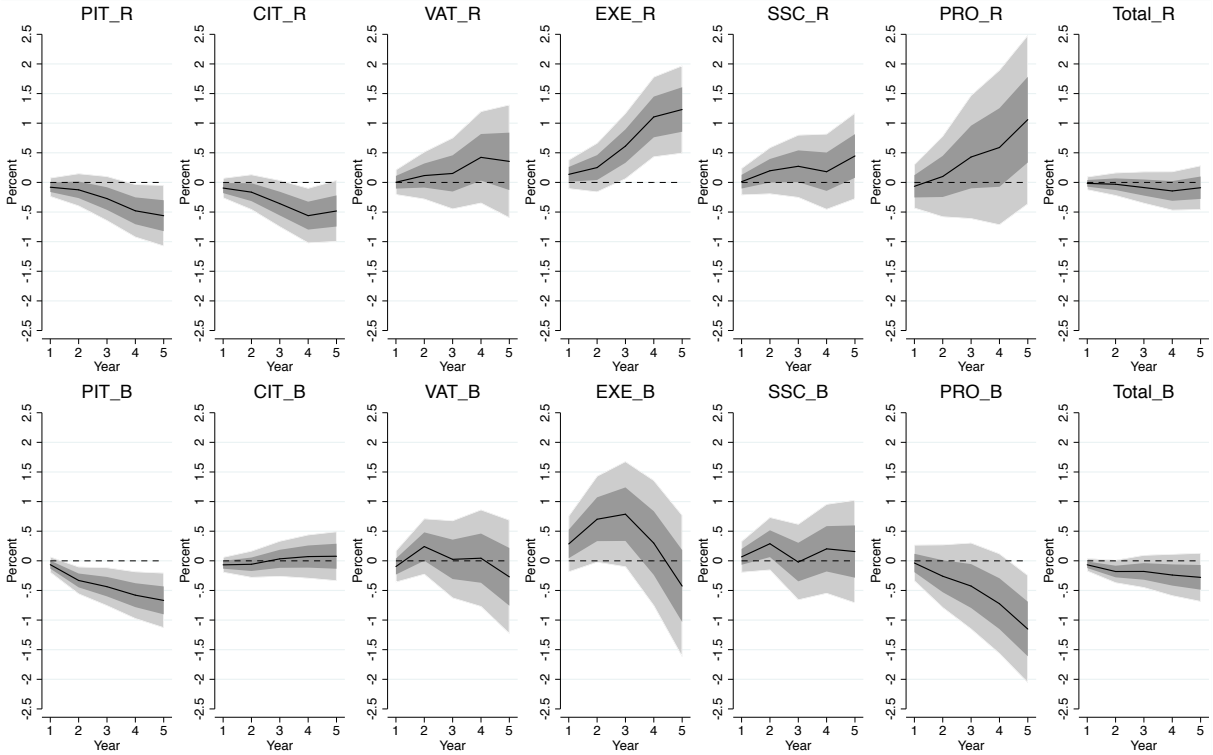
Panel A: Effects of Tax Changes on GDP



Panel B: Effects of Tax Changes on Gini Coefficient of Disposable Income



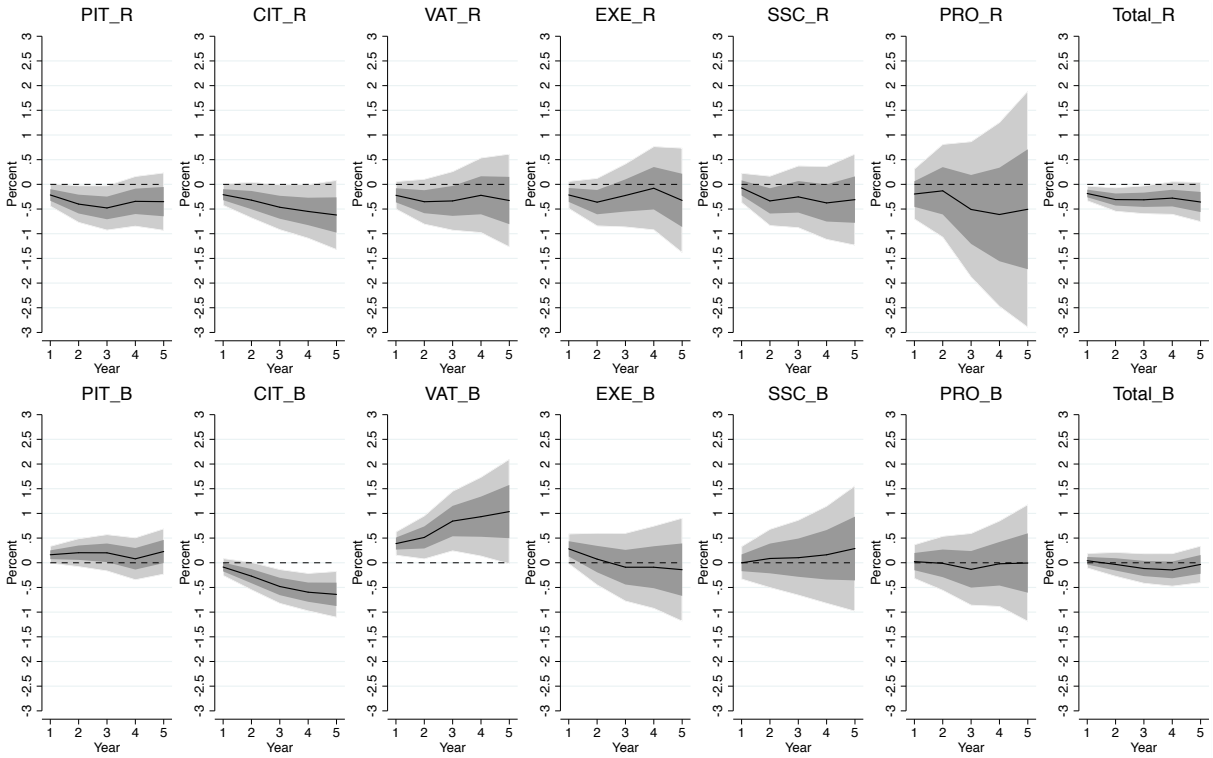
Panel C: Effects of Tax Changes on Gini Coefficient of Market Income



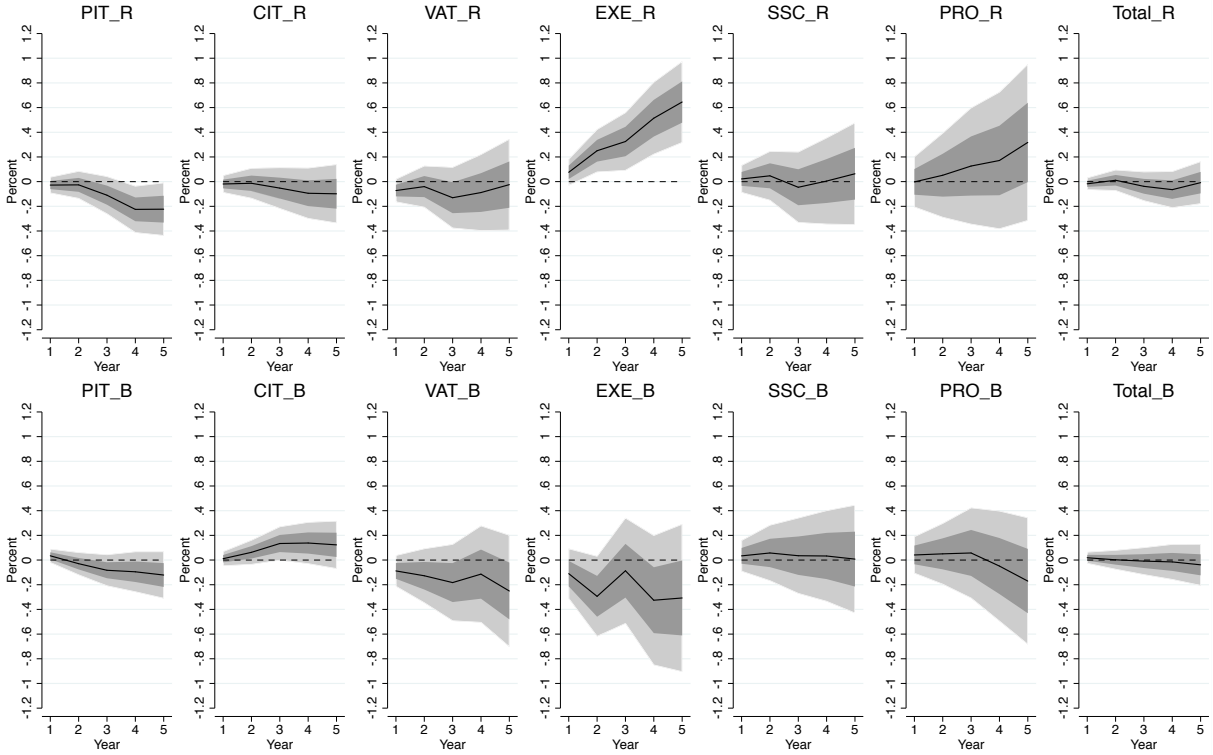
Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. “R” stands for rate changes and “B” stands for base changes.

Figure 13: Effects of Tax Changes: Using Five Lags of Dependent Variable

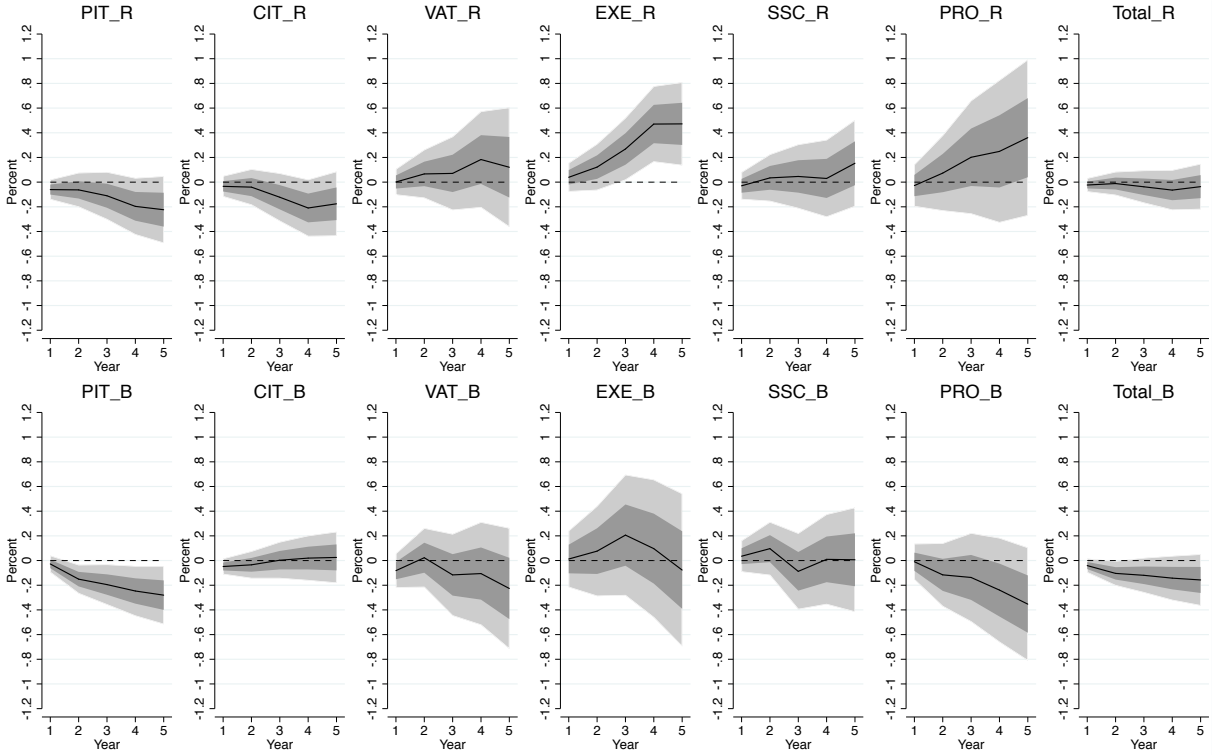
Panel A: Effects of Tax Changes on GDP



Panel B: Effects of Tax Changes on Gini Coefficient of Disposable Income



Panel C: Effects of Tax Changes on Gini Coefficient of Market Income



Notes: Dark grey areas refer to 68% confidence level (one standard error bands), bright grey areas to 95% confidence level. “R” stands for rate changes and “B” stands for base changes