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Cross-Country Evidence on the Revenue Impact of Tax Reforms

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ABSTRACT: Many countries face the challenge of raising additional tax revenues without hurting economic growth. Comprehensive, cross-country information on the revenue impact of tax policy changes can thus support informed decision-making on viable reforms. We assess the likely revenue impact of various tax policy changes based on a sample of 21 advanced and emerging market economies, using granular information from the IMF Tax Policy Reform Database v.4.0. Our findings suggest that the revenue yield of a tax policy change varies significantly depending on the tax instrument adopted (e.g., VAT or personal income tax) and the nature of the change (i.e., rate, base). For example, in our sample, base-broadening changes to personal and corporate income taxes as well as to excise and property taxes have generally a more significant and long-lasting revenue yields than rate changes. By contrast, rate changes appear to have a relatively more significant revenue impact in the case of VAT and social security contributions. We also observe an asymmetry in the revenue impact of most tax policy measures when controlling for the direction of tax changes (i.e., its significance varies depending on whether taxes are increased or decreased). While our results are based on qualitative information of tax policy changes (i.e., dummy variables), the revenue yields of rate measures are not materially different from those that would be obtained using quantitative information on the size of the change.

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WORKING PAPERS

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Prepared by David Amaglobeli, Valerio Crispolti, and Xuguang Simon Sheng[2]

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Contents

Introduction

This paper investigates the potential revenue impact of different tax policy changes using the Tax Policy Reform Database (TPRD), a novel measure-based database (Amaglobeli and others, 2018)[3]. Revenue responses to tax policy changes depend on many factors, such as the type of tax system in place, the institutional capacity, and the state of the economy. However, one of most important factors is the nature of the tax policy change itself. For example, while a tax rate cut will directly lower revenue intake, it could also encourage more economic activity, hence expand the tax base. Estimating the revenue response to a tax policy change, therefore, requires granular information on the nature of this change, including on the tax instrument used (e.g., VAT or personal income tax), the type of change adopted (e.g., tax base, tax rate), and its timing and size.

The TPRD provides a systematic documentation of main features of tax policy changes for six different tax types–personal income tax (PIT), corporate income tax (CIT), value-added and sale taxes (VAT), excise (EXE), social security contributions (SSC), and property tax (PRO). Such features, *inter alia*, include information on the type of change (i.e., base, rate changes), its timing (i.e., exact announcement and implementation dates), and its significance (i.e., major or minor change, the size of rate changes, when possible). The database covers 23 advanced and emerging market economies over the last four decades.[4]

Taking advantage of the granular information provided in the TPRD, we construct new measures of tax policy shocks for the period of 1990-2018 for 21 countries.[5] While considering both major and minor tax policy changes, we focus on the impact of major shocks as these account for about 80 percent of all documented tax changes in the database.

We assess the impact of tax policy changes on tax revenues using Jordà (2005)'s local projections method. Our baseline results are based on tax shocks identified in the year when a tax change is announced.[6] Our main empirical findings suggest that the revenue yield of tax policy changes varies significantly across taxes and types of changes, with tax rate changes generally having a more transitory revenue impact than tax base changes for most taxes. Specifically, base broadening changes in PIT, CIT, EXE, and PRO have on average a more significant and long-lasting impact on tax collection than rate changes. At the same time, rate hikes have relatively more significant effects on taxes in the case of VAT and SSC measures. Our results broadly hold if we include minor tax policy changes in the analysis or identify tax shocks using implementation as opposed to announcement years. However, the revenue impact of tax measures is asymmetric as its statistical significance changes depending on the direction of tax changes considered (i.e., increases/decreases in tax liabilities). Finally, our analysis suggests that the responsiveness of tax revenues to the announcement of a tax rate changes does not materially change if instead of using qualitative information on the tax shocks (i.e., extensive margins) we use the size of the announced rate changes (i.e., intensive margin).

Our baseline results are subject to some caveats and should be interpreted with caution. Namely, our findings are based on measures of tax policy shocks derived from qualitative indicators, which record the presence of a tax change (i.e., extensive margins) but not its magnitude (see Section 4.5 for measures of tax

[3] The TPRD v.4.0 is publicly accessible at www.tprdportal.org. The portal was developed by Papa Niang with financial support from the IMF Office of Innovation and Change.

[4] The countries included 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*.

[5] Restricting the analysis to the period 1990-2018 allows to use more precise information on the timing of tax measures—i.e., exact day, month and year (for more information, see Amaglobeli and others, 2018). We also exclude from the analysis China and India due to limitation in the data.

[6] While the TPRD provides information on the motivation underlying some types of tax change (i.e., CIT changes aimed at promoting investment) as illustrated in Table A. 1 and Table A. 2, this information is not available consistently from OECD reports across time and countries, and hence cannot be used consistently in an identification strategy for tax shocks..

policy shocks based on numerical information on the size of the announced tax rate changes). Consequently, our baseline results do not provide estimates of tax multipliers nor of their relative differences across tax heads. Our results, however, do offer evidence on whether a given tax change has statistically significant effects on tax collection.[7]

Our work is closely related to studies that estimate the macroeconomic impact of tax policy changes. Mertens and Ravn (2012) show that unanticipated and anticipated tax shocks have distinct macroeconomic effects, since taxpayers are likely to adjust their behavior before tax measures are implemented, if these are known in advance. Gechert and Groß (2019) conclude that measures to broaden the tax base are less harmful to economic growth than tax hikes. Dabla-Norris and Lima (2018) find that during fiscal consolidations, tax base-broadening measures lead to smaller output and employment declines compared to measures to increase tax rates. Unlike these studies, however, our analysis focuses on the revenue impact of tax policy changes while accounting for anticipation effects and controlling for contemporaneous changes in taxes. We leave the study of the macroeconomic effects of the tax policy changes documented in the TPRD v.4.0 to future research.

The revenue yield of tax policy changes has been the focus of a number of studies. For example, Mertens and Ravn (2013) find that increases in PIT are most effective in raising tax revenues but increases in CIT are approximately revenue neutral for the United States. Kawano and Slemrod (2016) document a tendency for CIT base changes to offset the revenue effects of CIT rate changes for OECD countries. Earlier studies on CIT, such as Clausing (2007) and Devereux (2007), obtain similar results. However, the lack of comprehensive, cross-country information on different tax policy changes significantly constraints the comparison of estimated revenue effects and the development of informed advice on viable reforms.

The structure of the paper is as follows. Section 2 briefly describes main features of the updated version of the TPRD and discusses the strategy to obtain an indicator of annual tax policy changes for each type of tax. Section 3 describes the econometric strategy to derive the revenue yield of various tax reforms. Section 4 discusses our empirical findings and performs a few robustness checks. Section 5 offers some concluding remarks.

[7] In this respect, our approach does not differ from that followed in IMF (2016).

The Tax Policy Reform Database

The Database in a Nutshell

We use data from an updated version of the TPRD accessible at www.tprdportal.org.[8] Compared to earlier versions (Amaglobeli and others, 2018), the TPRD v.4.0 includes several new features. First, the time coverage has been extended from 2014 to 2019 for most countries. Second, the classification of tax rate and base changes has been extended to all tax types.[9] Third, most rate measures in the database include information on the size of the announced rate change, generally expressed in percentage points.

The TPRD v.4.0 documents 3,462 tax policy measures, equivalent to an average of 4.7 tax measures per country per year (Table 1). Most measures are tax base changes (about 60 percent of the total identified measures), the majority of which consists of decreases in tax liabilities (about ⅔ of all tax base changes). By contrast, the composition of rate changes appears to be more balanced between rate increases and decreases. More than 80 percent of all identified tax measures are defined as "major" tax changes or reforms in a single year, with a majority of these introduced as part of a package.[10] Among major reforms, the most common changes are decreases in the tax base introduced as part of a policy package in a single year (accounting for almost 20 percent of all identified tax measures), followed by single-year tax base increases in policy packages (12 percent of total identified measures). Major rate increases introduced as part of a package in a single year represent 11 percent of all identified rate measures. About 80 percent of tax rate measures in the database contain information on the size of the announced change (Table A. 2).

Table 1. Distribution of Tax Policy Changes in the TPRD v.4.0

(Number of policy changes)

		Major							Minor							Grand Total
		BASE			RATE			Total	BASE			RATE			Total	
		DEC	INC	Total	DEC	INC	Total		DEC	INC	Total	DEC	INC	Total		
Single year	Not in package	245	143	388	108	105	213	601	47	23	70	30	52	82	152	**753**
	Package	672	428	1100	335	380	715	1815	103	75	178	72	169	241	419	**2234**
	Total	917	571	1488	443	485	928	2416	150	98	248	102	221	323	571	**2987**
Multi year	Not in package	21	6	27	22	17	39	66	6	2	8	4	7	11	19	**85**
	Package	106	64	170	131	35	166	336	16	5	21	13	20	33	54	**390**
	Total	127	70	197	153	52	205	402	22	7	29	17	27	44	73	**475**
Grand Total		**1044**	**641**	**1685**	**596**	**537**	**1133**	**2818**	**172**	**105**	**277**	**119**	**248**	**367**	**644**	**3462**

Source: Tax Policy Reform Database, Organisation for Economic Co-operation and Development (OECD), International Bureau of Fiscal Documentation (IBFD).

[8] We used the same sources and followed the same steps described in Amaglobeli and others (2018) to update the TPRD

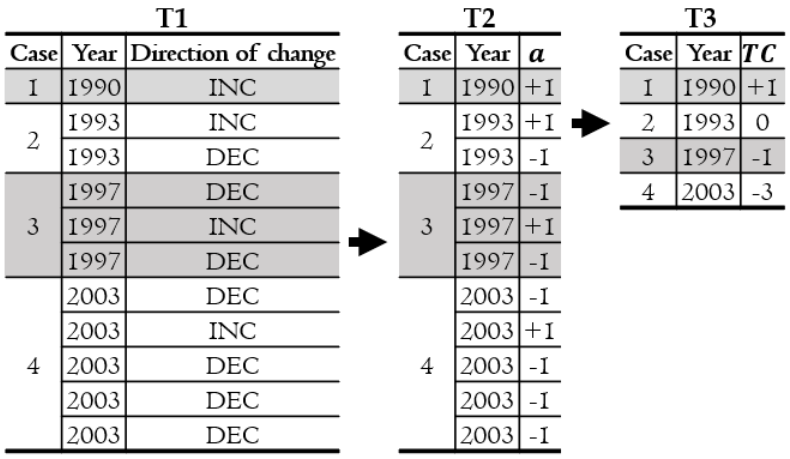
[9] See Table A. 1 for an exhaustive list of tax rate and base categories for each type of taxes.

[10] As discussed in Amaglobeli and others (2018), a rate change is classified major when its absolute value is greater than or equal to 1 percentage point. In the case of tax base measures, a change is recorded as major when it is expected to impact a large segment of taxpayers or has the potential to mobilize or forgo considerable revenue.

Constructing a Tax Change Indicator

Following Gechert and Groß (2019), we count the number of major tax reforms announced within a year and construct a tax change (TC) indicator variable for each country.[11] We use the announcement year to date each tax change so as to minimize issues related to "fiscal foresight" (Leeper and others, 2013)[12]. For illustration purposes, we simulate the cases of tax changes and use a flowchart to demonstrate how we convert the raw data into a ready-to-use qualitative variable (Figure 1). T1 is the simulated input data that mimic the raw data on tax changes as presented in the database. T3 is the final output. The step of moving from T1 to T2 codes the input data using function $a = \begin{cases} 1, & if\ INC \\ -1, & if\ DEC \end{cases}$ and stores the output in the last column of T2. Since there could be more than one tax change announced in the same year (e.g., cases 2, 3 and 4 in T1), we aggregate them in the step of T2 to T3 and store the resulting output in the last column of T3, that is, $TC = \sum a$. We apply the same coding procedure for each reform type, tax type, country and announcement year.

Figure 1. Illustration for Coding Major Tax Policy Changes



T1

Case	Year	Direction of change
1	1990	INC
2	1993	INC
	1993	DEC
3	1997	DEC
	1997	INC
	1997	DEC
4	2003	DEC
	2003	INC
	2003	DEC
	2003	DEC
	2003	DEC

T2

Case	Year	a
1	1990	+1
2	1993	+1
	1993	-1
3	1997	-1
	1997	+1
	1997	-1
4	2003	-1
	2003	+1
	2003	-1
	2003	-1
	2003	-1

T3

Case	Year	TC
1	1990	+1
2	1993	0
3	1997	-1
4	2003	-3

Table 2 shows a heatmap of our tax change indicator, TC, for base and rate changes at the aggregate level of all tax types and countries.[13] The green color becomes darker when TC is positive and larger (i.e., rate hikes or base broadenings). The red color, on the other hand, becomes darker when TC is negative and smaller.

Rate hikes or base broadenings on average are rarely observed for CIT reforms throughout the sample period, confirming a general trend observed across most economies in the last four decades (IMF, 2019). A similar pattern holds for PIT reforms till 2009, after which rate hikes or base broadenings become more prevalent in line with the evidence from Gerber and others (2018).

[11] We consider both major and minor tax policy changes in Section 4.2.

[12] Firms and households may alter their behavior before the implementation of tax reforms (Mertens and Ravn, 2012). Thus, using implementation year to date tax change may lead to biased estimates.

[13] Note that we use the country-year data to analyze the revenue effect of each tax type and reform type.

Table 2. Heatmap of Tax Policy Changes Represented by our Tax Change Indicator

Year	CIT base	CIT rate	PIT base	PIT rate	VAT base	VAT rate	SSC base	SSC rate	EXE base	EXE rate	PRO base	PRO rate
1990	-3	-4	-16	-5	0	2	0	-2	-2	2	1	2
1991	1	-6	-1	2	1	5	-2	6	0	7	0	1
1992	-11	-8	-7	-1	1	-2	3	5	0	1	2	0
1993	-6	-1	-2	8	2	3	2	3	0	7	0	1
1994	-7	-1	-4	-3	2	4	-1	1	0	1	2	0
1995	-9	-2	-8	-1	0	4	-2	2	0	1	-2	0
1996	1	-2	-6	-3	-1	1	0	0	1	5	-1	0
1997	-4	-12	-8	-11	0	-1	3	-3	0	0	-2	-1
1998	1	-5	-11	-9	-1	-1	0	0	0	5	2	0
1999	-8	-9	-10	-7	0	0	2	0	-1	2	-2	2
2000	-7	-16	-12	-10	-2	-3	0	0	0	-1	1	-1
2001	-6	-5	-11	-2	1	4	3	0	1	1	0	1
2002	-9	-7	-10	-3	2	3	1	4	1	1	0	0
2003	-5	-10	-8	-5	2	0	-2	1	0	0	1	-1
2004	-7	-6	-9	-2	0	0	-3	0	0	-1	0	0
2005	-1	-3	-4	0	-1	4	0	-1	0	1	-1	1
2006	0	-3	-2	-9	0	-1	0	0	0	0	1	-1
2007	4	-3	-13	-1	-2	-1	-3	-3	1	0	1	0
2008	-9	0	-12	0	0	-2	-1	-1	1	-1	-2	-2
2009	-2	-2	-4	-6	-3	-1	-1	3	-1	3	0	0
2010	-3	-4	2	1	0	6	0	0	0	4	2	0
2011	-1	3	-3	4	2	3	1	2	2	3	1	0
2012	-6	-1	1	6	1	3	0	0	-1	3	3	1
2013	-12	-3	2	3	-1	3	-2	0	3	0	1	-1
2014	-12	-5	-13	-3	0	2	-6	1	0	2	0	0
2015	-4	-3	-2	1	2	2	-4	2	0	1	-1	0
2016	6	-8	-2	-2	-2	-1	-1	0	2	2	0	0
2017	1	-2	4	-5	1	0	-1	0	3	1	1	0
2018	1	-2	-2	0	1	0	-2	0	1	0	0	0
Total	-117	-130	-171	-63	5	36	-16	20	11	50	8	2

Notes: “base” stands for base change and “rate” stands for rate change. The green color becomes darker when TC is positive and higher (i.e., rate hikes or base broadenings). The red color becomes darker when TC is negative and lower.

Source: Tax Policy Reform Database, OECD, IBFD.

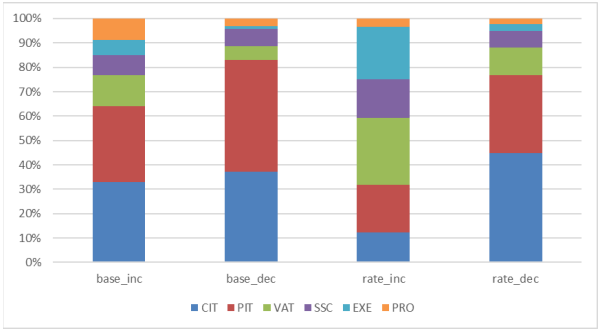
For the remaining tax types, the direction of changes over time is mixed but leans toward base broadenings or rate increases (except for SSC base reforms).

We further distinguish the TC indicator in terms of directions of tax changes and calculate the pairwise correlation within each tax type (Table A. 3). We find that CIT base broadenings are moderately correlated with its rate cuts (correlation of 0.35), implying that governments tend to attenuate the effects of CIT rate reductions on revenues.[14] There is no clear evidence of such an association for other tax types. PIT base changes are positively and significantly associated with the same-direction rate changes.

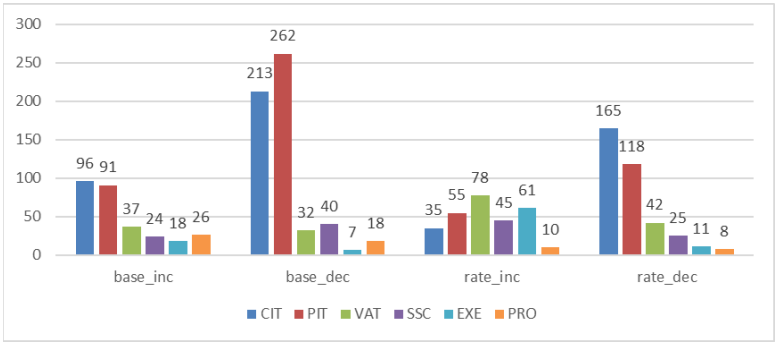
Figure 2(a) shows that PIT, CIT and VAT together account for the largest share in major policy changes. Meanwhile, Figure 2(b) indicates that the same three taxes account for about 85 percent of both rate decrease and base narrowing.

Figure 2. Distributions of the Coded Major Tax Policy Reforms

(a) Percentage of changes by tax types, reform types, and directions



(b) Number of changes by tax types, reform types, and directions



Source: Tax Policy Reform Database, OECD, IBFD.

Macro Variables

Data on total tax revenues are obtained from the OECD.[15] In this study, we prefer the ratio of tax revenues to GDP over the nominal level of tax revenues for two main reasons. First, tax revenues tend to increase as nominal GDP grows, hence changes in nominal tax revenues may not properly capture effects of policy changes. Second, the tax-to-GDP ratio is relatively stable, unless there is a major change in tax policy. Data on unemployment, GDP, and government consumption expenditure also come from the OECD database.

[14] This result is consistent with earlier evidence from Kawano and Slemrod (2016) who find that corporate tax base changes in OECD countries are more likely to occur in years when there is a change to the corporate tax rate.

[15] Data are available from the following website https://www.oecd-ilibrary.org/economics/data/oecd-economic-outlook-statistics-and-projections_eo-data-en. Total tax revenue data include social security contributions and trade related revenues. Although our analysis only covers domestic tax revenues, we were not able to exclude trade-related taxes (e.g., custom duties, export levies) from total tax revenues due to data limitations. This is, however, unlikely to bias our results as trade-related taxes account for a very small share of tax collection in advanced and some emerging countries.

Econometric Method

Our analysis focuses on 21 countries from the TPRD v.4.0. We exclude China and India due to lack of availability of macro data for 1990-2018. We use Jordà (2005)'s local projections method to investigate the effects of tax policy changes on tax revenues. Specifically, we estimate the following regression:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i + \gamma_t + \lambda_h TC_{i,t} + \sum_{j=1}^{3} \beta_j^h \Delta y_{i,t-j} + \theta_h' \boldsymbol{X}_{i,t} + \varepsilon_{i,t+h} \quad (1)$$

We are interested in $y_{i,t+h} - y_{i,t-1}$, the tax revenue change from $t-1$ to $t+h$ where h denotes forecasting horizons. $TC_{i,t}$ is our tax policy change indicator for country i at year t. Accordingly, the coefficient λ_h captures whether a specific tax change has a statistically significant effect on the tax-to-GDP ratio.[16] $X_{i,t}$ is a vector of control variables, including GDP growth, unemployment and government expenditure (see Clausing, 2007).[17] Following Dabla-Norris and Lima (2018), we also control for same-tax, contemporaneous base changes when estimating the effects of rate changes, and vice versa. We include both country fixed effects α_i and time effects γ_t in the regression. We estimate equation (1) for each tax type and separate rate changes from base changes.

The benchmark regression captures the response of the tax-to-GDP ratio to the announcement of a tax policy change starting from year 0 (i.e., the announcement year) until year 5.[18] We estimate the regression coefficients using OLS and report impulse response functions with both 90 percent and 68 percent confidence intervals. We compute the standard errors using the Driscoll-Kraay (1998)'s formula that is robust to heteroscedasticity, autocorrelation and cross-country dependence.

Impact on Tax Revenues

Baseline Results

Figure 3 plots the impact of major tax policy changes on total tax revenues from year 0 to year 5.[19] A one-step increase means one additional major rate hike or base broadening announced within a year. Our results suggest that the size and temporal profile of the revenue yield vary across taxes and types of changes. Specifically, in our sample we find that:

Announcements of CIT increases are associated with a somewhat transitory rise in tax collection, suggesting that companies have quickly adapted their business to reduce the tax burden. The limited impact of CIT increases on tax collection is broadly consistent with earlier results from Kawano and Slemrod (2016).

[16] Importantly, it is not possible to compare the size of the coefficients across tax changes due to the nature of the TC variable (i.e., dummy variable). We leave it to future research to identify exogenous tax shocks and estimate tax multipliers by exploring the motivation behind tax policy changes and utilizing the quantitative information on tax rate changes.

[17] We follow a parsimonious approach in determining the set of controls for equation (1). For example, while economic theory would suggest adding inflation among the controls to capture possible "bracket creep" effects, our baseline results were not significantly affected by such addition.

[18] About 52 percent of all tax changes documented in the database are announced and implemented within the same year, 41 percent are implemented with a one-year lag, and the remaining 7 percent are implemented on a longer horizon.

[19] We consider the response of total tax revenues to a tax change rather than that of revenues specific to each tax change to control for potential spillovers effects from one tax to other taxes, (e.g., PIT increases affecting demand for goods and services and hence VAT, or PIT changes affecting corporate policies, including dividend payments, financing choices, investment, and labor and hence CIT) as discussed in Chetty and Saez, 2005; Yagan, 2015; Alstadsæter, Jacob and Michaely, 2017; Boissel and Matray 2022. We nevertheless performed the same type of analysis focusing on the response of specific taxes to changes in their tax rate or base and found that the results are not materially different from those based on the response of total tax revenue (results available upon request).

More specifically, tax revenues appear to have responded on impact to announcements of CIT base-broadening measures, with collection peaking one year after announcement. By contrast, the revenue response to CIT rate changes is more uncertain. This difference in the response of the tax-to-GDP ratio to changes in CIT rate may reflect a number of factors. First, changes in the CIT rates may be more visible and easier to understand than changes to the CIT base. Hence, companies may react more quickly to announcements of CIT rate changes so as to adapt their business and reduce the tax burden. Second, more than half of all tax changes are announced and implemented within the same year, making more likely that CIT base changes—which generally are less visible—affect tax collection on impact. Third, tax rate changes are relatively infrequent in the sample, implying higher uncertainty surrounding coefficient estimates.

Announcements of PIT increases are associated with relatively large and persistent increases in the tax-to-GDP ratio, possibly reflecting the relative broad base of this tax in most of the countries in the sample. However, gains in tax collection appear to be more significant and persistent after announcements of PIT base-broadening measures rather than PIT rate hikes.[20] While changes in the PIT would affect labor supply through both wealth effect and an intertemporal substitution, the differential response of tax revenues to PIT rate and base changes may also reflect the ability of agents to understand the impact of such changes on their purchasing power. In this respect, announcement of PIT increases may prompt immediate tax avoidance behaviors if the implication of a PIT change (rate vs. base) are more visible (i.e., easier to understand).

Announcements of VAT increases are generally associated with significant improvements in tax collection, suggesting that VAT is a mainstay of the tax system in most countries in the sample. Notably, announcements of VAT rate increases are more likely to be followed by significant and protracted increases in the tax-to-GDP ratio than announcements of base broadening. This finding, while broadly consistent with IMF advice suggesting that VAT base-broadening measures likely have significant effects on tax collection (Keen 2013), may suffer from the small number of announcements of VAT base broadening in the sample (about ¼ of all documented VAT changes).[21]

Announcements of rises in SSC are also associated with sizable surges in the tax-to-GDP ratio. Unlike for CIT and PIT, however, tax collection seems to respond more significantly to announcements of SSC rate increases than of SSC base-broadening measures. This may reflect the fact that many countries in the sample have recalibrated the SSC base by introducing measures to expand the SSC coverage (e.g., increase in the share of wage subject to SSC) while at the same time exempting some categories from SSC (e.g., exemptions for young, low-skilled workers).[22]

Announcements of increases in EXE are generally followed by large and persistent increases in tax collection, especially in the case of base-broadening measures. This likely reflects the fact that many countries in the sample have substantially increased the spectrum of products subject to excise in recent decades, with a view to address issues of negative externalities, for example related to pollution and health (e.g., the introduction of an excise on sugar-sweetened beverages in Mexico in October 2013).

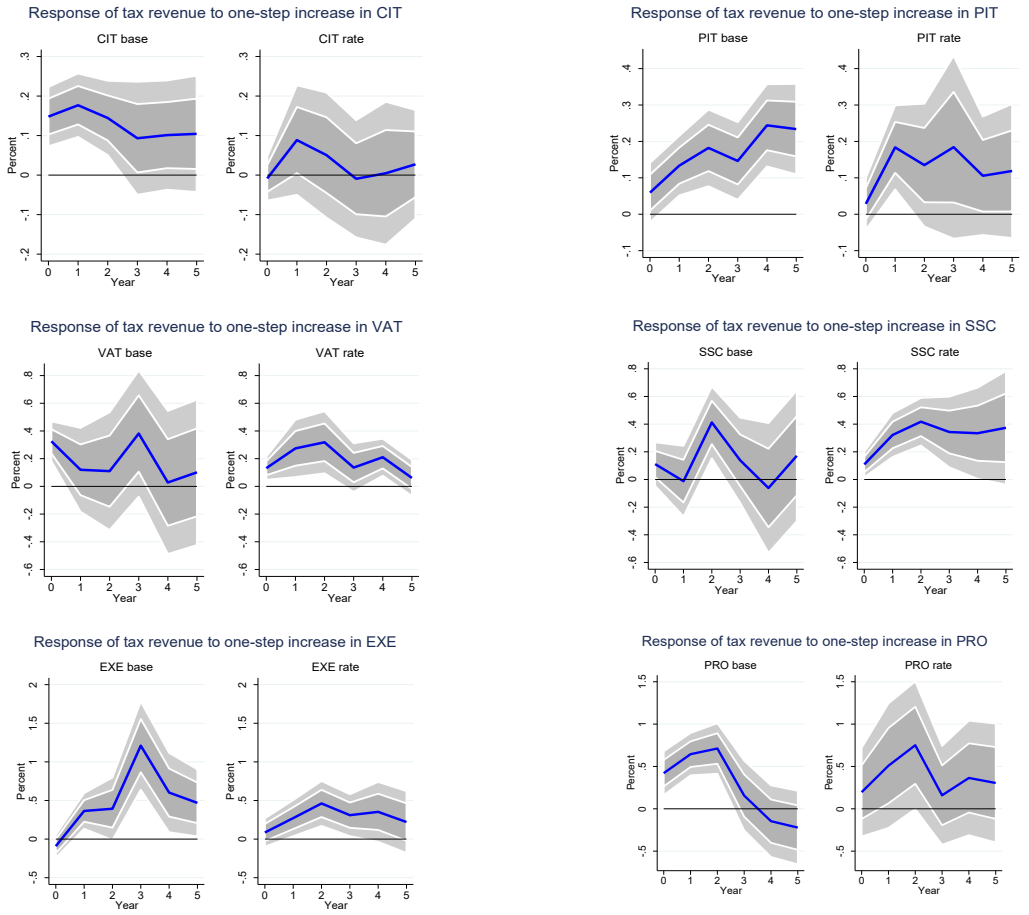
Announcements of hikes in PRO are typically associated with limited and short-lived tax improvements. Such improvements generally taper off after two years from announcement in the case of base-broadening PRO measures. This may reflect the temporary nature of many of these changes in the sample as well as the fact that about ⅓ of these changes concern financial assets that can generally escape taxation more easily.

[20] In the TPRD, a PIT rate change includes any rate change in the following categories: top rate, bottom rate, statutory rates (i.e., neither the top nor the bottom), surcharges, capital gains, dividends, and other (see Table A. 1).

[21] It is also worth noting that the revenue impact of a VAT base broadening depends on the underlying VAT system. In cases where the VAT has a lot of exemptions, leading to cascading, base broadening might actually lead to a short-term loss in VAT revenues (even though the rationale for the policy changes is to increase mobilization). Therefore, measuring the revenue impact of a VAT base broadening might be more complex than that of other taxes.

[22] The econometric strategy followed here does not allow to control for compositional effects for given type of changes (i.e., the number of +1 and -1 within a year exemplified in Figure 1). The compositional effects could be investigated bringing into the analysis the information on the categories of tax changes included in the TPRD v.4.0, which will be the focus of our future research.

Figure 3. Baseline Results - Response of Tax-to-GDP Ratio to 1-Step Increase (Broadening) in Tax Rate (Base)



Note: Dark grey areas represent 68 percent confidence intervals, and light grey areas represent 90 percent confidence intervals.
Source: Tax Policy Reform Database, OECD, IBFD.

Accounting for Both Major and Minor Tax Policy Changes

In this section, we change our coding strategy to check whether our findings still hold after extending the analysis to minor tax policy changes,[23] which represent about 20 percent of all documented changes in the TPRD v.4.0.

We construct a five-state tax policy change indicator and denote it as TC_ALL to maintain a consistent labeling. TC_ALL now takes the value of ±2 if a tax change is considered as a major change, ±1 if it is a minor change, and 0 if changes fully cancel out or there is no change. We adopt a similar coding scheme as before but with some modifications, which are discussed in detail in Appendix B.

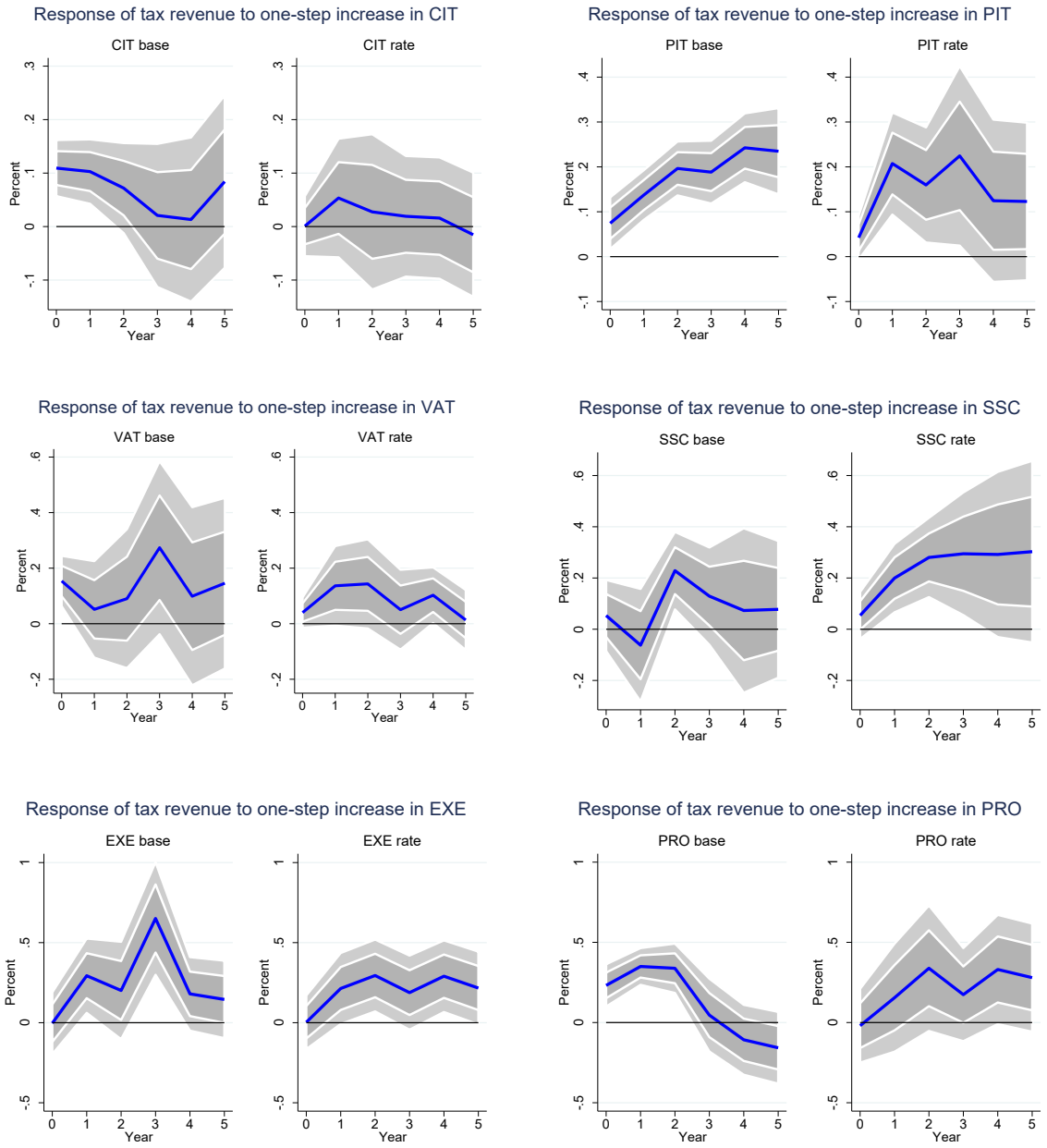
Importantly, now one-step increase in the shock indicator captures a minor policy change from 0 to 1 as well as a major change from 1 to 2. The results based on our shock indicator (ranging from -2 to 2) should therefore be interpreted with caution.

Figure 4 presents the response of the tax-to-GDP ratio to announcements of both major and minor tax policy changes and confirms that the inclusion of minor tax changes does not change qualitatively our earlier

[23] See footnote 10 for a definition of major and minor tax changes or Section C in Amaglobeli and others (2018).

findings. As expected, however, the addition of minor policy changes in the analysis led to somewhat smaller estimates of the tax gains following a tax policy announcement.[24]

Figure 4. Response of Tax-to-GDP Ratio to 1-Step Increase (Broadening) in Tax Rate (Base): Major and Minor Tax Changes



Note: Dark grey areas represent 68 percent confidence intervals, and light grey areas represent 90 percent confidence intervals.
Source: Tax Policy Reform Database, OECD, IBFD.

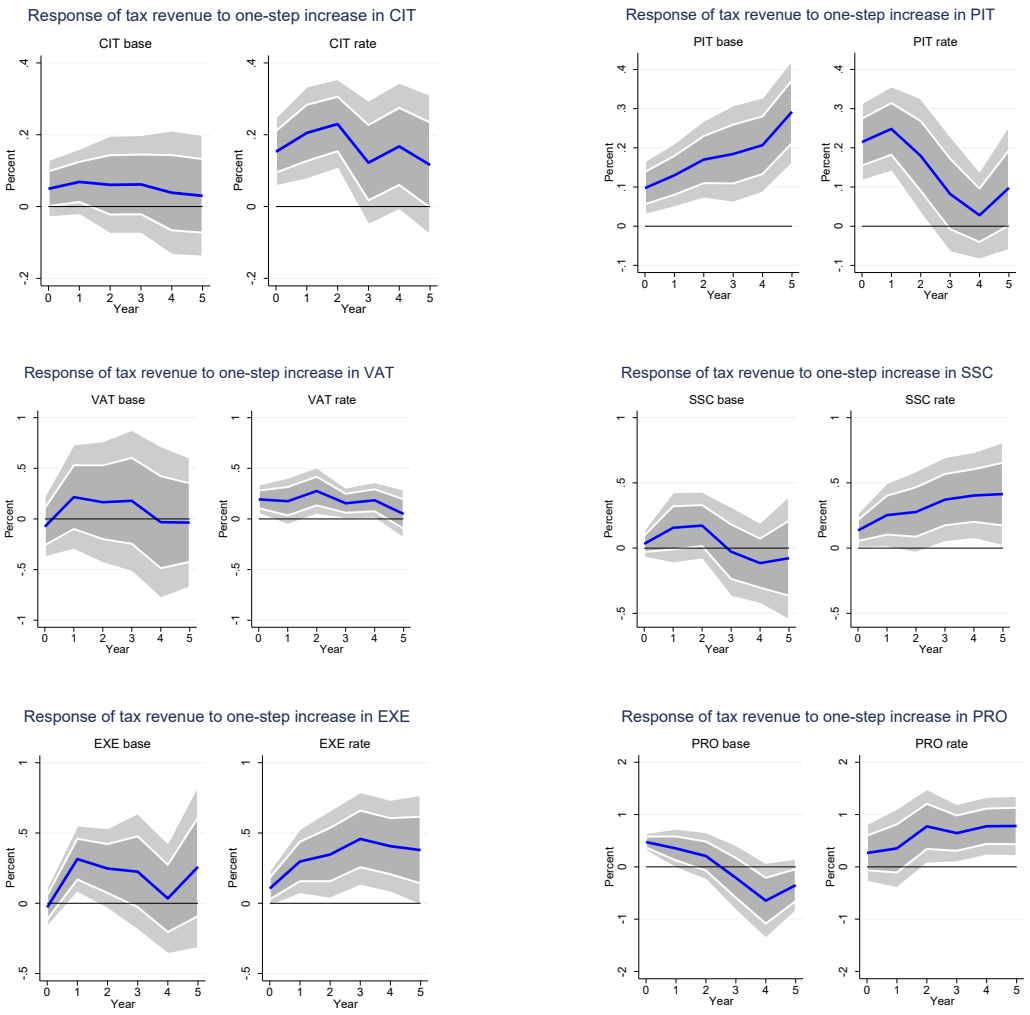
[24] Alternatively, we include minor tax policy changes as additional control variables in equation (1). Specifically, we define minor tax policy changes, TC_minor, following the same procedure in Figure 1, except using the step size of +0.5 or -0.5 (instead of +1 or -1 for major tax policy changes). Adding TC_minor does not change the main results regarding the revenue impact of major tax policy changes. These results are available upon request.

Using the Implementation Year to Date Tax Policy Changes

Our baseline estimates minimize problems of "fiscal foresight" (Leeper and others, 2013) by identifying tax policy changes based on the years in which these are announced. However, about 50 percent of all major tax changes are implemented in the years following the announcement year. In this section, we therefore check whether our findings significantly change when tax shocks are identified by their respective implementation years.

Figure 5 presents the revenue impact of tax shocks (i.e., tax policy changes) dated using implementation rather than announcement years. Our results suggest that "fiscal foresight" can play an important role in shaping the revenue response to tax measures. Namely, compared to the baseline results, the tax-to-GDP ratio is now less responsive to changes in VAT and EXE—pointing to significant anticipation effects. Similarly, tax collection appears to be less responsive to increases in SSC and PRO. However, compared to the baseline, the impact of CIT and PIT changes based on implementation years seems to partially support the intuition that taxpayers may better understand the impact of rate changes on their tax liabilities compared to that of base changes (Section 4.1).

Figure 5. Response of Tax-to-GDP Ratio to 1-Step Increase (Broadening) in Tax Rate (Base): Using Implementation Year



Note: Dark grey areas represent 68 percent confidence intervals, and light grey areas represent 90 percent confidence intervals.
Source: Tax Policy Reform Database, OECD, IBFD.

Accounting for Direction of Policy Changes

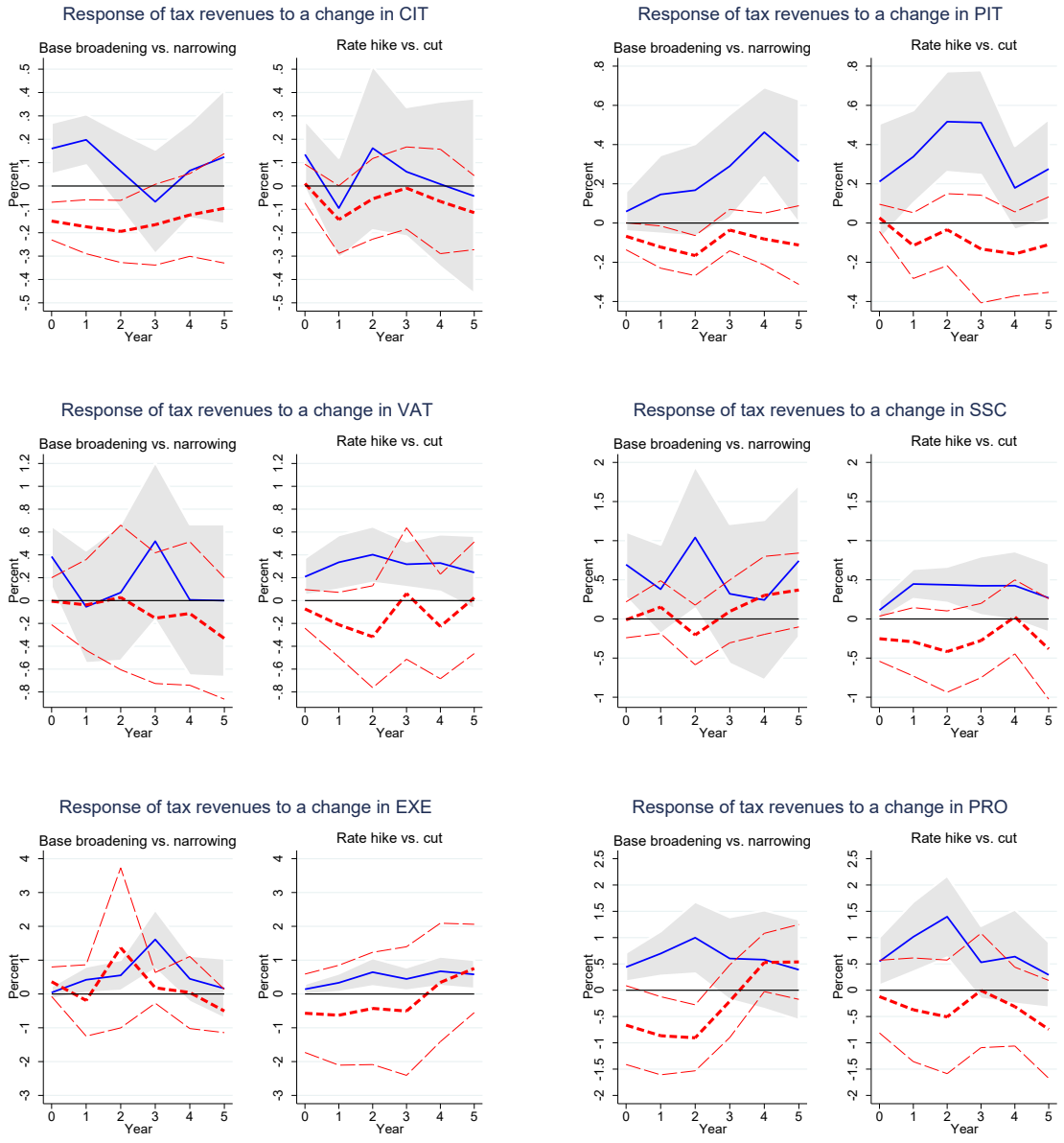
Until now, our analysis treated increases and decreases in taxes symmetrically by including *TC* as a single indicator. In this section, we explore whether the behavior of tax revenue collection varies depending on the direction of tax changes (i.e., the revenue impact is asymmetric). To do so, we separate the *TC* variable into two parts: *TCI* capturing base-broadening or rate-increasing changes and *TCD* representing base-narrowing or rate-decreasing measures. We then estimate the following equation:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i + \gamma_t + \lambda_h TCI_{i,t} + \varphi_h TCD_{i,t} + \sum_{j=1}^{3} \beta_j^h \Delta y_{i,t-j} + \theta_h' \boldsymbol{X}_{i,t} + \varepsilon_{i,t+h}, \quad (2)$$

where $\boldsymbol{X}_{i,t}$ includes controls for base expansions and narrowing (rate hikes and cuts) when TCI and TCD capture the separate effect of rate hikes and cuts (base expansions and narrowing). In addition, $\boldsymbol{X}_{i,t}$ includes other control variables as in equation (1). The impulse response functions are plotted in Figure 6. The blue solid lines show the revenue impact of a base broadening or rate hike, while red dashed lines show that of a base narrowing or rate cut. Confidence intervals are set at the conventional 90 percent level.

Figure 6 suggests that in our sample tax revenues responded asymmetrically to announcements of most tax changes. Specifically, the tax-to-GDP ratio seemed to react positively to announcements of a rate hike or a base broadening in VAT, EXE or SSC; while being unlikely to respond to announcements of a rate cut or a base narrowing. Similarly, tax collection showed an asymmetric response in the case of announcements of rate increases in PIT and PRO. By contrast, the tax revenue reacted symmetrically to announcements of CIT rate or base changes as well as of PIT and PRO base changes. We intend to investigate the asymmetric effects of various tax changes in future research.

Figure 6. Response of Tax-to-GDP Ratio to 1-Step Tax Change of Different Directions



Note: The blue solid lines show the revenue responses to a one-step base broadening or rate hike. The red dashed lines correspond to a one-step base narrowing or rate cut. The 90 percent confidence intervals are included.
Source: Tax Policy Reform Database, OECD, IBFD.

Extensive and Intensive Margins of Tax Rate Changes

Our baseline results are based on the extensive margin of tax policy changes (i.e., qualitative changes). However, the TPRD v.4.0 provides also precise information on the announced size (generally expressed in percentage points) of most tax rate changes documented in the sample (Figure A. 1 provides the distributions of such tax rate changes).[25] In this section, we exploit the numerical information on rate changes (i.e., intensive margins) to gauge the potential bias that we may suffer in assessing the statistical significance of the revenue

[25] This restricts the analysis to 659 tax rate changes which excludes rate changes for which the TPRD v.4.0 provides information in the form of a range (e.g., from xx to yy percentage points) or in units different from percentage points (e.g., cents/liter).

impact of tax policy changes, using qualitative information on tax shocks (i.e., extensive margins). Table 3 shows the mean and standard deviation of coded intensive margin (IM) and extensive margin (EM) changes over our sample period.

Table 3. Mean and Standard Deviation for Coded Tax Policy Changes

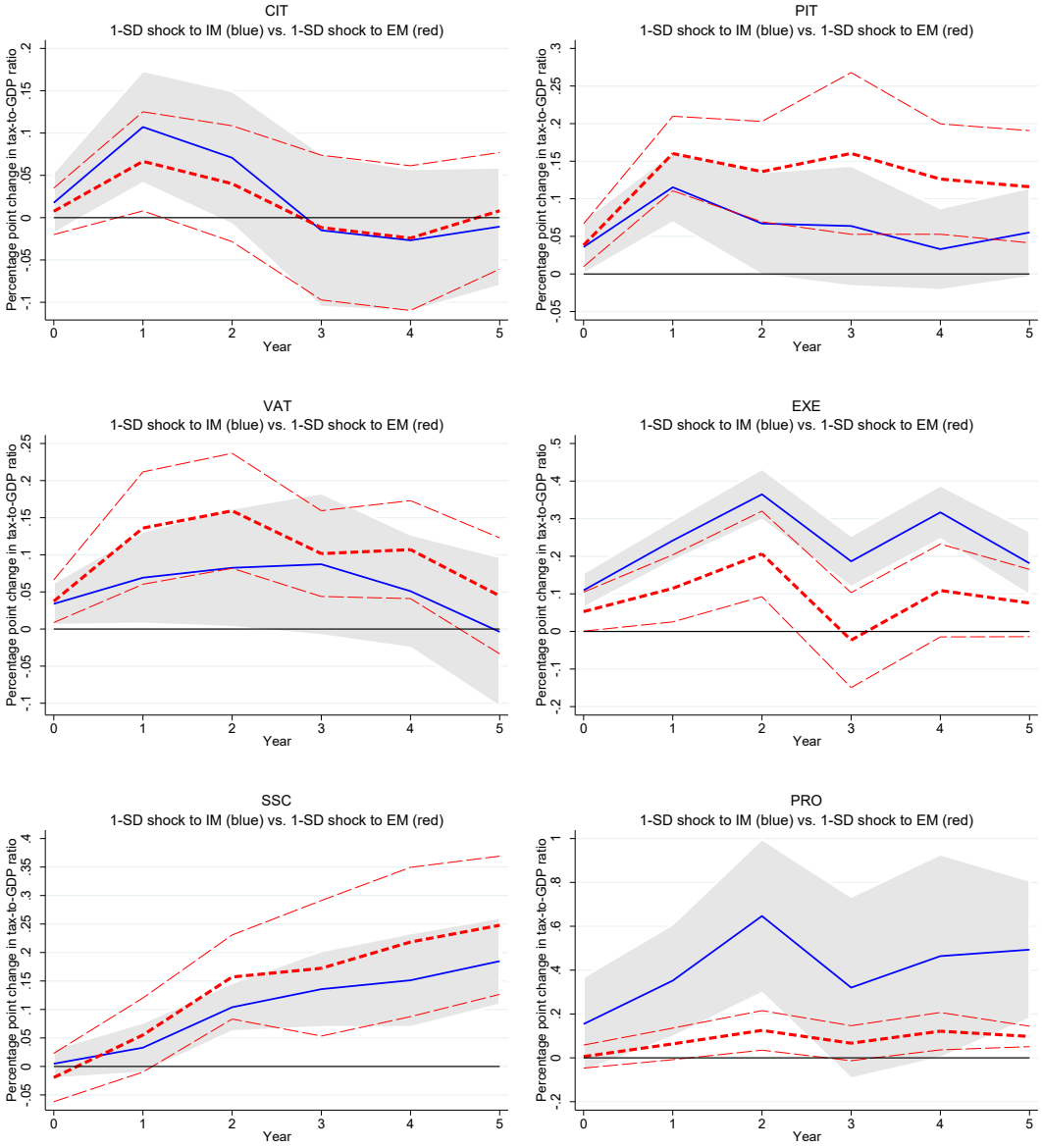
Tax type	EM mean	EM sd	IM mean	IM sd
CIT	-0.17	0.67	-0.98	5.43
PIT	-0.11	0.70	-0.49	4.39
VAT	0.05	0.50	0.03	3.43
SSC	0.04	0.44	0.20	3.80
EXE	0.03	0.24	1.35	14.65
PRO	0.01	0.18	0.38	5.50

Note: There are rare cases where coded intensive margin (IM) and extensive margin (EM) changes take opposite signs for a given tax type in the same year. As an example, consider three documented VAT rate measures in Italy in 1997. The corresponding raw entries are {IM: 1pp, 4pps, -6pps} and {EM: +1, +1, -1}, and our coding generates an IM change of -1 percentage point for VAT rate measure and an EM change of +1 for VAT rate measure.

To ease comparison, we standardize both intensive and extensive margins for each tax type to have zero mean and unit standard deviation. We perform local projections to estimate the impact of the tax rate changes on tax-to-GDP ratio as in equation (1), with $TC_{i,t}$ being either $EM_{i,t}$ or $IM_{i,t}$—the standardized tax rate change indicator for country i at year t. It is worth noting here that, while the coefficient in the regression based on extensive margins ($EM_{i,t}$) only indicates the statistical significance of the tax response to a tax measure, the coefficient in the regression based on intensive margins ($IM_{i,t}$) captures also the size of such a response.

Figure 7 compares the revenue impact of a one-standard-deviation tax rate increase based on intensive margins (blue line) with that based on extensive margins (red line). Using quantitative information does not materially change our earlier findings on the responsiveness of tax collection to tax rate changes, while generally improving the precision of our estimates (i.e., narrower confidence bands). Specifically, we find that the response of the tax-to-GDP ratio to announcements of CIT and SSC rate hikes and to some extent VAT based on intensive margins cannot be distinguished apart from those based on extensive margins (i.e., blue and red confidence bands fully overlap). The revenue impact of PIT, excise and property taxes rate increases also seems to be broadly consistent with that based on extensive margins, although its significance and persistence appear to be somewhat weaker than that from our baseline results. We find that for excise and property taxes the impact on revenues is higher on intensive than extensive margins, while for PIT the impact is mostly felt on the extensive margin. This would suggest that the size of excise and property tax rate changes is larger than that based on extensive margin, while the opposite is true for PIT.

Figure 7. Response of Tax-to-GDP Ratio to a One-Standard-Deviation Tax Rate Increase in Extensive (EM) or Intensive Margin (IM)



Note: The 68% confidence levels are reported with Driscoll-Kraay standard errors.

Conclusions

We assess the revenue impact of various tax policy changes in 21 advanced and emerging economies, using granular information from the IMF Tax Policy Reform Database v.4.0. Our findings suggest that the revenue yield of tax policy changes is likely to vary substantially across taxes and types of changes, with tax rate measures generally showing more transitory effects on tax revenues than tax base changes. This is the case in our sample for announcements of PIT, CIT, EXE, and PRO changes. At the same time, rate hikes appear to have relatively more significant effects on tax collection in the case of VAT and SSC measures. Importantly, our analysis suggests that the revenue impact of most tax policy changes is asymmetric: its statistical significance changes depending on the direction of tax changes considered (i.e., expected increases/decreases in tax liabilities). While our main findings are based on qualitative information of tax policy changes (i.e., dummy variables), in the case of tax rate changes, the estimated revenue yields are not materially different from those that would be obtained using quantitative information—such as the size of a tax change (i.e., intensive margins).

In future research, we intend to deepen the analysis on the asymmetric effects of tax changes; further explore the potential of the quantitative information in the TPRD v.4.0 with a view to precisely estimate revenue yields (e.g., by controlling for the revenue share of a particular tax type in the total revenue); and to advance the debate on macroeconomic effects of different tax changes (e.g., tax multipliers).

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Appendix A

Table A.1. Distribution of Tax Changes by Tax Type, Reform Change, and Category

	Total changes		
tax type/change type/category	number of observations	count of country years	average number of measures
PIT	**1199**	**480**	**2.5**
RATE	**373**	**236**	**1.6**
Statutory rates	89	77	1.2
Top rate	95	86	1.1
Bottom rate	58	55	1.1
Surcharges	57	54	1.1
Capital gains	27	26	1.0
Dividends	11	11	1.0
Other	36	33	1.1
BASE	**826**	**410**	**2.0**
Standard relief	264	209	1.3
Child relief	77	72	1.1
Capital gains	53	47	1.1
Interest relief	42	41	1.0
SSC, pension, insurance relief	35	33	1.1
Other relief	355	282	1.3
CIT	**1043**	**452**	**2.3**
RATE	**366**	**246**	**1.5**
Statutory rates	55	45	1.2
Top rate	95	87	1.1
SMEs	33	33	1.0
Surcharges	51	44	1.2
Capital gains	36	33	1.1
Dividends	14	13	1.1
Other	82	74	1.1
BASE	**677**	**376**	**1.8**
R&D promotion	48	42	1.1
Investment promotion	226	186	1.2
Loss-carry rules	25	23	1.1
Capital gains	73	66	1.1
Thin capitalization	31	30	1.0
Other base changes	274	210	1.3
VAT	**391**	**248**	**1.6**
RATE	**241**	**170**	**1.4**
Standard rate	89	85	1.0
Reduced rate	32	29	1.1
Other	120	101	1.2
BASE	**150**	**118**	**1.3**
Exemptions on food	9	8	1.1
Exemptions on medical supply	1	1	1.0
Other base changes	140	116	1.2
SSC	**367**	**185**	**2.0**
RATE	**208**	**126**	**1.7**
Employee	93	80	1.2
Employer	74	69	1.1
Other	41	35	1.2
BASE	**159**	**106**	**1.5**
Employee	59	52	1.1
Employer	71	61	1.2
Other	29	27	1.1
EXE	**329**	**178**	**1.8**
RATE	**275**	**154**	**1.8**
Alchool products	41	41	1.0
Tobacco	60	57	1.1
Oil products	98	84	1.2
Other	76	68	1.1
BASE	**54**	**42**	**1.3**
Alchool products	2	2	1.0
Tobacco	5	5	1.0
Oil products	23	22	1.0
Other	24	22	1.1
PRO	**133**	**104**	**1.3**
RATE	**37**	**35**	**1.1**
Real estate	21	20	1.1
Financial assets	6	6	1.0
Other	10	10	1.0
BASE	**96**	**80**	**1.2**
Real estate	43	37	1.2
Financial assets	18	17	1.1
Other	35	33	1.1
Grand Total	**3462**	**735**	**4.7**

Source: Tax Policy Reform Database, OECD, IBFD.

Table A.2. Detailed Information of Tax Changes by Type, Reform Change and Category

	Quantitative information									Qualititative information								
	Increase			Decrease			Total quantitave changes			Increase			Decrease			Total qualitative changes		
tax type/change type/category	number of observations	count of country years	average number of measures	number of observations	count of country years	average number of measures	number of observations	count of country years	average number of measures	number of observations	count of country years	average number of measures	number of observations	count of country years	average number of measures	number of observations	count of country years	average number of measures
PIT	**112**	**86**	**1.3**	**210**	**44**	**4.8**	**322**	**205**	**1.6**	**270**	**188**	**1.4**	**607**	**51**	**11.9**	**877**	**425**	**2.1**
RATE	**112**	**86**	**1.3**	**210**	**44**	**4.8**	**322**	**205**	**1.6**	**15**	**15**	**1.0**	**36**	**24**	**1.5**	**51**	**46**	**1.1**
Statutory rates	17	17	1.0	54	33	1.6	71	60	1.2	3	3	1.0	15	12	1.3	18	18	1.0
Top rate	21	19	1.1	73	31	2.4	94	85	1.1	1	1	1.0	0	0	0.0	1	1	1.0
Bottom rate	14	13	1.1	37	26	1.4	51	48	1.1	0	0	0.0	7	7	1.0	7	7	1.0
Surcharges	35	34	1.0	13	12	1.1	48	46	1.0	6	6	1.0	3	3	1.0	9	9	1.0
Capital gains	12	11	1.1	9	7	1.3	21	20	1.1	4	4	1.0	2	2	1.0	6	6	1.0
Dividends	2	2	1.0	9	8	1.1	11	11	1.0	0	0	0.0	0	0	0.0	0	0	0.0
Other	11	11	1.0	15	13	1.2	26	25	1.0	1	1	1.0	9	8	1.1	10	9	1.1
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**255**	**179**	**1.4**	**571**	**50**	**11.4**	**826**	**410**	**2.0**
Standard relief	0	0	0.0	0	0	0.0	0	0	0.0	68	62	1.1	196	46	4.3	264	209	1.3
Child relief	0	0	0.0	0	0	0.0	0	0	0.0	12	12	1.0	65	33	2.0	77	72	1.1
Capital gains	0	0	0.0	0	0	0.0	0	0	0.0	20	20	1.0	33	22	1.5	53	47	1.1
Interest relief	0	0	0.0	0	0	0.0	0	0	0.0	19	18	1.1	23	18	1.3	42	41	1.0
SSC, pension, insurance relief	0	0	0.0	0	0	0.0	0	0	0.0	12	12	1.0	23	17	1.4	35	33	1.1
Other relief	0	0	0.0	0	0	0.0	0	0	0.0	124	115	1.1	231	49	4.7	355	282	1.3
CIT	**88**	**80**	**1.1**	**235**	**47**	**5.0**	**323**	**227**	**1.4**	**269**	**194**	**1.4**	**451**	**50**	**9.0**	**720**	**388**	**1.9**
RATE	**88**	**80**	**1.1**	**235**	**47**	**5.0**	**323**	**227**	**1.4**	**17**	**15**	**1.1**	**26**	**20**	**1.3**	**43**	**37**	**1.2**
Statutory rates	5	5	1.0	44	26	1.7	49	40	1.2	3	3	1.0	3	3	1.0	6	6	1.0
Top rate	17	16	1.1	78	33	2.4	95	87	1.1	0	0	0.0	0	0	0.0	0	0	0.0
SMEs	1	1	1.0	27	22	1.2	28	28	1.0	0	0	0.0	5	5	1.0	5	5	1.0
Surcharges	28	27	1.0	14	14	1.0	42	38	1.1	4	3	1.3	5	5	1.0	9	8	1.1
Capital gains	12	11	1.1	18	13	1.4	30	28	1.1	3	3	1.0	3	3	1.0	6	6	1.0
Dividends	2	2	1.0	12	7	1.7	14	13	1.1	0	0	0.0	0	0	0.0	0	0	0.0
Other	23	22	1.0	42	22	1.9	65	59	1.1	7	6	1.2	10	8	1.3	17	16	1.1
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**252**	**186**	**1.4**	**425**	**50**	**8.5**	**677**	**376**	**1.8**
R&D promotion	0	0	0.0	0	0	0.0	0	0	0.0	7	7	1.0	41	23	1.8	48	42	1.1
Investment promotion	0	0	0.0	0	0	0.0	0	0	0.0	72	69	1.0	154	47	3.3	226	186	1.2
Loss-carry rules	0	0	0.0	0	0	0.0	0	0	0.0	11	11	1.0	14	13	1.1	25	23	1.1
Capital gains	0	0	0.0	0	0	0.0	0	0	0.0	29	29	1.0	44	29	1.5	73	66	1.1
Thin capitalization	0	0	0.0	0	0	0.0	0	0	0.0	15	14	1.1	16	14	1.1	31	30	1.0
Other base changes	0	0	0.0	0	0	0.0	0	0	0.0	118	107	1.1	156	45	3.5	274	210	1.3
VAT	**130**	**96**	**1.4**	**84**	**34**	**2.5**	**214**	**149**	**1.4**	**99**	**88**	**1.1**	**78**	**39**	**2.0**	**177**	**137**	**1.3**
RATE	**130**	**96**	**1.4**	**84**	**34**	**2.5**	**214**	**149**	**1.4**	**18**	**18**	**1.0**	**9**	**9**	**1.0**	**27**	**27**	**1.0**
Standard rate	60	56	1.1	24	18	1.3	84	80	1.1	4	4	1.0	1	1	1.0	5	5	1.0
Reduced rate	21	19	1.1	10	8	1.3	31	28	1.1	1	1	1.0	0	0	0.0	1	1	1.0
Other	49	44	1.1	50	30	1.7	99	82	1.2	13	13	1.0	8	8	1.0	21	21	1.0
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**81**	**74**	**1.1**	**69**	**37**	**1.9**	**150**	**118**	**1.3**
Exemptions on food	0	0	0.0	0	0	0.0	0	0	0.0	4	4	1.0	5	5	1.0	9	8	1.1
Exemptions on medical supply	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	1	1.0	1	1	1.0
Other base changes	0	0	0.0	0	0	0.0	0	0	0.0	77	74	1.0	63	36	1.8	140	116	1.2
SSC	**92**	**63**	**1.5**	**40**	**22**	**1.8**	**132**	**89**	**1.5**	**125**	**75**	**1.7**	**110**	**40**	**2.8**	**235**	**136**	**1.7**
RATE	**92**	**63**	**1.5**	**40**	**22**	**1.8**	**132**	**89**	**1.5**	**52**	**34**	**1.5**	**24**	**14**	**1.7**	**76**	**49**	**1.6**
Employee	39	37	1.1	17	11	1.5	56	52	1.1	28	27	1.0	9	8	1.1	37	36	1.0
Employer	31	31	1.0	12	11	1.1	43	41	1.0	19	18	1.1	12	10	1.2	31	29	1.1
Other	22	19	1.2	11	9	1.2	33	28	1.2	5	5	1.0	3	3	1.0	8	8	1.0
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**73**	**48**	**1.5**	**86**	**37**	**2.3**	**159**	**106**	**1.5**
Employee	0	0	0.0	0	0	0.0	0	0	0.0	38	35	1.1	21	14	1.5	59	52	1.1
Employer	0	0	0.0	0	0	0.0	0	0	0.0	24	22	1.1	47	29	1.6	71	61	1.2
Other	0	0	0.0	0	0	0.0	0	0	0.0	11	11	1.0	18	13	1.4	29	27	1.1
EXE	**97**	**59**	**1.6**	**20**	**14**	**1.4**	**117**	**70**	**1.7**	**180**	**106**	**1.7**	**32**	**21**	**1.5**	**212**	**124**	**1.7**
RATE	**97**	**59**	**1.6**	**20**	**14**	**1.4**	**117**	**70**	**1.7**	**142**	**81**	**1.8**	**16**	**13**	**1.2**	**158**	**93**	**1.7**
Alchool products	9	9	1.0	1	1	1.0	10	10	1.0	29	29	1.0	2	2	1.0	31	31	1.0
Tobacco	20	20	1.0	0	0	0.0	20	20	1.0	39	37	1.1	1	1	1.0	40	38	1.1
Oil products	44	38	1.2	12	10	1.2	56	44	1.3	34	33	1.0	8	8	1.0	42	41	1.0
Other	24	22	1.1	7	5	1.4	31	27	1.1	40	37	1.1	5	5	1.0	45	42	1.1
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**38**	**29**	**1.3**	**16**	**12**	**1.3**	**54**	**42**	**1.3**
Alchool products	0	0	0.0	0	0	0.0	0	0	0.0	2	2	1.0	0	0	0.0	2	2	1.0
Tobacco	0	0	0.0	0	0	0.0	0	0	0.0	4	4	1.0	1	1	1.0	5	5	1.0
Oil products	0	0	0.0	0	0	0.0	0	0	0.0	17	17	1.0	6	5	1.2	23	22	1.0
Other	0	0	0.0	0	0	0.0	0	0	0.0	15	14	1.1	9	9	1.0	24	22	1.1
PRO	**16**	**16**	**1.0**	**11**	**8**	**1.4**	**27**	**26**	**1.0**	**53**	**48**	**1.1**	**53**	**32**	**1.7**	**106**	**86**	**1.2**
RATE	**16**	**16**	**1.0**	**11**	**8**	**1.4**	**27**	**26**	**1.0**	**6**	**5**	**1.2**	**4**	**3**	**1.3**	**10**	**9**	**1.1**
Real estate	5	5	1.0	8	7	1.1	13	13	1.0	4	3	1.3	4	3	1.3	8	7	1.1
Financial assets	5	5	1.0	1	1	1.0	6	6	1.0	0	0	0.0	0	0	0.0	0	0	0.0
Other	6	6	1.0	2	2	1.0	8	8	1.0	2	2	1.0	0	0	0.0	2	2	1.0
BASE	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**47**	**44**	**1.1**	**49**	**32**	**1.5**	**96**	**80**	**1.2**
Real estate	0	0	0.0	0	0	0.0	0	0	0.0	22	21	1.0	21	19	1.1	43	37	1.2
Financial assets	0	0	0.0	0	0	0.0	0	0	0.0	12	12	1.0	6	6	1.0	18	17	1.1
Other	0	0	0.0	0	0	0.0	0	0	0.0	13	13	1.0	22	18	1.2	35	33	1.1
Grand Total	**535**	**267**	**2.0**	**600**	**50**	**12.0**	**1135**	**460**	**2.5**	**996**	**430**	**2.3**	**1331**	**54**	**24.6**	**2327**	**661**	**3.5**

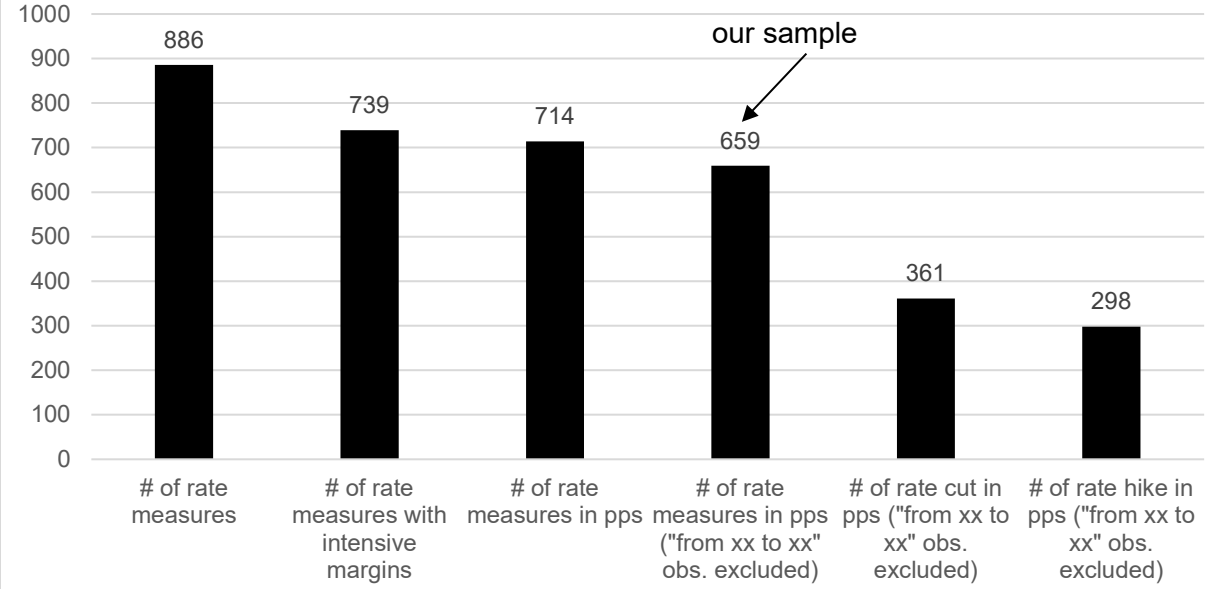
Source: Tax Policy Reform Database, OECD, IBFD.

Table A.3. Correlation Matrix of Tax Types

Variables	CIT_bi	CIT_bd	CIT_ri	CIT_rd	Variables	PIT_bi	PIT_bd	PIT_ri	PIT_rd
CIT_bi	1				PIT_bi	1			
CIT_bd	-0.13	1			PIT_bd	0.17	1		
CIT_ri	0.22	0.07	1		PIT_ri	0.46**	-0.11	1	
CIT_rd	0.35*	0.37**	0.15	1	PIT_rd	0.23	0.51***	-0.30	1
Variables	VAT_bi	VAT_bd	VAT_ri	VAT_rd	Variables	SSC_bi	SSC_bd	SSC_ri	SSC_rd
VAT_bi	1				SSC_bi	1			
VAT_bd	-0.12	1			SSC_bd	-0.10	1		
VAT_ri	0.18	0.15	1		SSC_ri	0.29	0.26	1	
VAT_rd	-0.27	0.35*	0.00	1	SSC_rd	-0.09	-0.06	-0.17	1
Variables	EXE_bi	EXE_bd	EXE_ri	EXE_rd	Variables	PRO_bi	PRO_bd	PRO_ri	PRO_rd
EXE_bi	1				PRO_bi	1			
EXE_bd	-0.10	1			PRO_bd	-0.09	1		
EXE_ri	-0.14	0.18	1		PRO_ri	0.07	0.24	1	
EXE_rd	-0.11	-0.07	0.03	1	PRO_rd	-0.09	-0.23	-0.20	1

Notes: "bi" stands for base broadening, "bd" stands for base narrowing, "ri" stands for rate hike, and "rd" stands for rate cut. *** p<0.01, ** p<0.05, * p<0.1.

Figure A.1. Distribution of Major Tax Rate Measures During 1990 – 2018

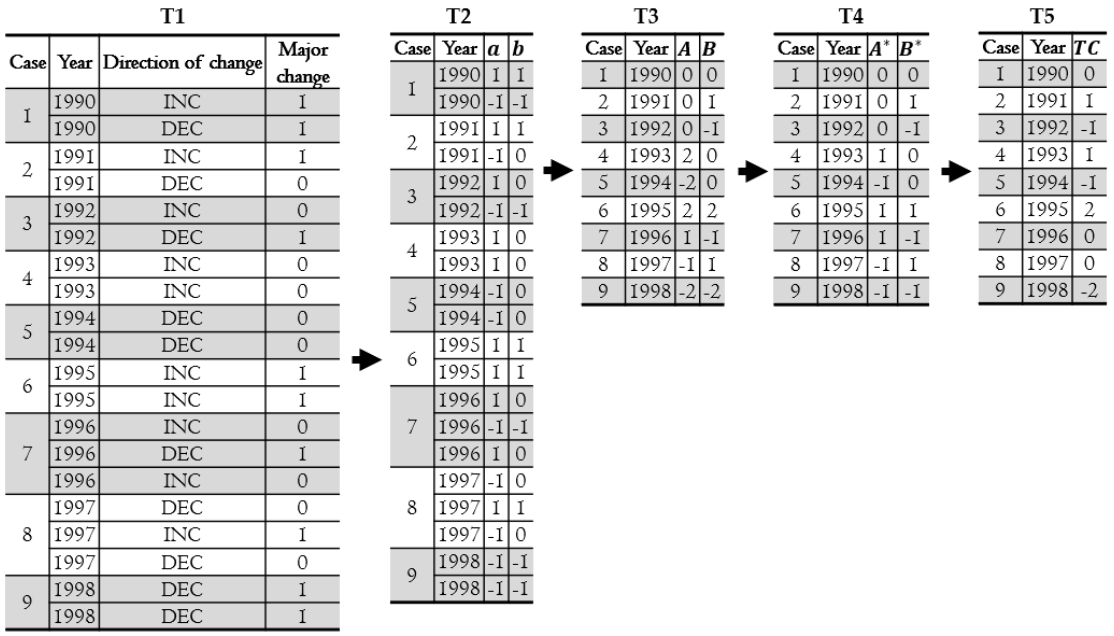


Appendix B

Coding Major and Minor Tax Policy Changes

After a thorough investigation of the database, we find nine possible cases for an appropriate coding scheme to capture. For illustration purposes, we simulate the cases of tax changes and use a flowchart to demonstrate how our coding works. The chart in Figure B. 1 illustrates the steps. For each case, at least two same-year tax changes are recorded. We skip the cases of a single policy change since the coding will be straightforward. We again use the tax change announcement year to date each tax change.

Figure B.1. Illustration for Coding Both Major and Minor Tax Policy Changes



T1

Case	Year	Direction of change	Major change
1	1990	INC	1
	1990	DEC	1
2	1991	INC	1
	1991	DEC	0
3	1992	INC	0
	1992	DEC	1
4	1993	INC	0
	1993	INC	0
5	1994	DEC	0
	1994	DEC	0
6	1995	INC	1
	1995	INC	1
7	1996	INC	0
	1996	DEC	1
	1996	INC	0
8	1997	DEC	0
	1997	INC	1
	1997	DEC	0
9	1998	DEC	1
	1998	DEC	1

T2

Case	Year	a	b
1	1990	1	1
	1990	-1	-1
2	1991	1	1
	1991	-1	0
3	1992	1	0
	1992	-1	-1
4	1993	1	0
	1993	1	0
5	1994	-1	0
	1994	-1	0
6	1995	1	1
	1995	1	1
7	1996	1	0
	1996	-1	-1
	1996	1	0
8	1997	-1	0
	1997	1	1
	1997	-1	0
9	1998	-1	-1
	1998	-1	-1

T3

Case	Year	A	B
1	1990	0	0
2	1991	0	1
3	1992	0	-1
4	1993	2	0
5	1994	-2	0
6	1995	2	2
7	1996	1	-1
8	1997	-1	1
9	1998	-2	-2

T4

Case	Year	A^*	B^*
1	1990	0	0
2	1991	0	1
3	1992	0	-1
4	1993	1	0
5	1994	-1	0
6	1995	1	1
7	1996	1	-1
8	1997	-1	1
9	1998	-1	-1

T5

Case	Year	TC
1	1990	0
2	1991	1
3	1992	-1
4	1993	1
5	1994	-1
6	1995	2
7	1996	0
8	1997	0
9	1998	-2

Step T1 to T2: Coding the Direction and Magnitude of a Change

This step codes the raw tax changes using equation (B.1). The function a codes all the directions of changes as ± 1, regardless of the magnitude, and stores the function output in the column a of T2. The function b goes one step further by coding the output stored in the column a as ± 1 if a tax change is considered as major and 0 otherwise. This conversion helps unify the information on both the direction and size of a tax change at a later stage.

$$a = \begin{cases} 1, & if\ INC \\ -1, & if\ DEC \end{cases} \quad and\ b = \begin{cases} 1, & if\ major = 1 and\ a = 1 \\ -1, & if\ major = 1\ and\ a = -1 \\ 0, & otherwise \end{cases} \qquad (B.1)$$

Step T2 to T3: Aggregation

Since there are multiple changes recorded within the same year, we aggregate them and store the resulting output in the columns A and B of T3, that is, $A = \sum a$ and $B = \sum b$.

Step T3 to T4: Dimension Reduction

This step transforms the output A and B in T3 into three-state variables A^* and B^* in T4, as shown in equation (B.2).

$$A^* = \begin{cases} -1, if\ A < 0 \\ 1\ , if\ A > 0 \\ 0\ , if\ A = 0 \end{cases} and\ B^* = \begin{cases} -1, if\ B < 0 \\ 1\ , if\ B > 0 \\ 0\ , if\ B = 0 \end{cases} \quad (B.2)$$

This procedure compresses multiple tax changes within the same year and assigns a value to A^* and B^* based on the sign of A and B. This dimension reduction is achieved at the cost of losing some useful information. To see this, Figure B.2 plots the distribution for A and B against A^* and B^*. On average, about 25% tax changes in A that are greater than 1 or less than -1 are replaced by 1 and -1, respectively. This number is about 20% for B.[26] Despite this limitation, the proportions of the coded tax changes are in line with those documented in the database, confirming that our coding scheme is properly designed for maintaining data integrity.

Step T4 to T5: Constructing the Five-State Tax Change Variable

This final step yields the five-state tax change variable, TC_ALL, by appropriately aggregating A^* and B^*, that is, $TC\_ALL = A^* + B^*$. Simply applying this coding procedure to each tax reform, tax type, country and year generates a full set of TC_ALL indicators.

[26] The coded tax changes after the step of T2 to T3 consist of 1941 observations, of which 486 observations are less than -1 or greater than 1 for A and 413 for B.

PUBLICATIONS

Cross-Country Evidence on the Revenue Impact of Tax Reforms

Working Paper No. **WP/2022/199**