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Abstract

Little is known about how policymakers adjust tax policies in response to crises. We use novel and granular data on reforms of tax rates and tax bases for six tax types (22 developed and emerging economies, 1962-2014) and examine tax policies in late stages of crises. Our sample covers 217 severe crises, including financial crises, natural disasters, and economic recessions. The results show that governments tend to increase taxes after crises. The effect is particularly large for financial crises and natural disasters. Tax increases occur mostly during the first post-crisis year and mainly affect corporate and personal income taxes and the VAT. Paradoxically the extent of the tax hikes is decreasing in the pre-crisis level of public debt.

Keywords: National crises; tax reforms; tax policies; Natural disasters; Financial crises; economic recessions; public debt

JEL Codes: H20; H25; C23

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1 Introduction

In national crises, governments face difficult choices about fiscal policies. In the early phase, there is usually a consensus that governments should let automatic stabilizers work and cut taxes or increase spending to revive the economy. Such policies often increase public debt (Tagkalakis, 2013; Alesina and Giavazzi, 2013). But when the crisis has bottomed out and budget deficits and public debt are growing, a controversial debate begins about how the deficit can be reigned in and who 'pays' for the cost of the crisis. The discussion about post-crisis consolidation was particularly intense during the Covid 19-pandemic. For instance, the IMF argued that *"beyond the initial recovery phase* [...] *governments will look to unwind their fiscal interventions and gradually tackle the record-high public debt levels through fiscal consolidation measures"* (de Mooij et al., 2020, pp 1-2).[1] Others, however, warn that more fiscal stimulus is needed until the economy has fully recovered.[2] Rather than contributing to the debate about the optimal fiscal policy, this paper investigates how politicians have adjusted taxes in response to crises in the past. Due to a lack of harmonized cross-nationally comparable data on tax reforms almost nothing is known about how governments conducted their tax policies in reaction to previous crises.

In this paper, we provide first empirical evidence on tax policy in the recovery phases of crises using data from the new tax reform database compiled by Fuest et al. (2021). This data allows us to evaluate how crises influence tax policies at the national level, where the key tax decisions are made in most industrialized countries. The dataset provides indices on tax reforms that are harmonized across countries and includes detailed information on tax reforms regarding tax rates and tax bases for six types of taxes, including 22 advanced and emerging market economies observed over the past six decades (1962-2014). We collect large-scale data on the crisis history of all countries included in the tax dataset. Considering three types of national crises (financial crises, natural disasters, and economic recessions), we identify 217 crises events (a total of 18% of all country-year observations in our sample). We also uncover substantial geographic and temporal heterogeneity in the occurrence of crises that we exploit for causal identification. Linking tax data to our collection of national crisis episodes, our

[1] Budget deficits may be reduced by cutting public expenditure or raising (tax) revenues. Cutting public expenditure has been shown to be the more successful strategy to consolidate budgets (e.g., Alesina and Ardagna, 2010; Alesina et al., 2015; Dörr et al., 2019; Gründler and Potrafke, 2019).

[2] For instance, in March 2021, the OECD (2021, p. 3) stated: *"premature tightening of fiscal policy must be avoided"*.

main results are as follows. First, we find that governments, on average, increase taxes after national crises. The increase is particularly large after financial crises, natural disasters, and economic crises with high intensity and less pronounced for economic recessions that provoked a small or moderate decline in GDP growth. Second, the tax policy reaction in response to crises is stronger for tax rates than for tax bases, but we also observe generally broadening tax bases after crises. This pattern is at stark contrast to the overall trend towards more narrowed tax bases observable during the past six decades (Fuest et al., 2021). Third, our results suggest that, surprisingly, the extent to which taxes are raised after crises is not increasing in the pre-crisis debt level. If we consider all types of crises, we even observe that the tendency for post-crisis tax increases is slightly higher in countries with low pre-crisis debt levels. A possible explanation is that countries with high pre crisis debt levels experience slower recoveries (Schularick and Taylor, 2012), suggesting that they may be more reluctant to raise taxes too early. Considering specific types of crises, we find that the baseline pattern re-appears, whereas tax increases after natural disasters are more likely in countries with high debt-to-GDP ratios. Finally, we find substantial heterogeneity in post-crisis taxation across tax types. While financial crises are often followed by increases in corporate income taxes and value added taxes, natural disasters and strong economic crises mostly led to an increase in personal income taxes.

Our empirical analysis on post-crisis tax reforms follows several steps. We start by describing summary statistics of tax rate and tax base reforms and compare reform activity in crisis years and non-crisis years. This analysis shows that there are stark differences in tax reforms across periods with and without crises and uncovers distinct tendencies towards tax increases in the aftermath of national crises. We proceed by portraying case studies to examine how the empirical patterns appear during specific crisis episodes and to study the mechanisms underlying post-crisis tax increases. The case studies reveal two major channels that explain why tax rates often increase after crises. First, there is often great need for fiscal consolidation after national crises, especially when the cost of handling a crisis was high. National consolidation efforts are also often accompanied by pressure applied by supra-national lenders to reform tax systems. Second, national crises sometimes initiate a "window of opportunity" for necessary reforms, which would face insurmountable political opposition during non-crisis years.

Post-crisis increases in taxes may be driven by confounding factors that correlate

simultaneously with the occurrence of crises and tax reforms. We estimate a generalized Difference-in-Differences model and account for the confounding influence of time-invariant country-level characteristics, period-specific events and cross-national trends in taxation, and selection on observable time-varying factors. To rule out the possibility of reversed causality, i.e. that tax policies initiated or amplified national crises, we focus on the time when tax policies have first been announced rather than the time when tax reforms have been implemented.[3] We also employ the methodology of Oster (2019) to assess the likelihood that the results are driven by selection on unobservables, finding that the degree of confounding of omitted variables must be implausibly large to explain away the results. The key identifying assumption of the generalized Difference-in-Differences model is that absent of the occurrence of national crises, tax policies in treated and non-treated countries would have developed in parallel. We employ an event study design to assess the plausibility of this assumption and to examine the temporal dynamics of the crisis effect on tax policies. The event study reveals parallel trends in pre-crisis years between treated and non-treated countries, and shows that national crises increase taxes primarily in the first year after a national crisis.

Examining heterogeneity across individual types of taxes, we find that governments particularly increase corporate income taxes and value added taxes after financial crises, while natural disasters and strong economic crises are mainly followed by an increase in personal income taxes. The heterogeneity in post-crisis tax policies underscores the need to have fine-grained data on multiple types of taxes, as focusing on single tax types would not be sufficient to detect heterogeneous effects on the composition of tax systems initiated by national crises.

Contribution to the literature: Our study contributes to the literature that examines how fiscal policy is adjusted in response to economic crises (see, e.g., Alesina and Giavazzi, 2013). While a large literature examines fiscal policies during economic and financial crises (Rendahl, 2016; Akerlof et al., 2014; Blanchard et al., 2009; Poterba, 1994), there are hardly any studies that specifically focus on taxation policies after crises. An important reason for this lack of evidence is that granular and cross-nationally comparable data on tax reforms have not been available. Some studies investigate tax policies after specific crises, particularly the global financial crisis of

[3] Fuest et al. (2021) show that there have been no anticipation effects prior to the first official announcement of tax reforms.

2007-08 (e.g. Prammer, 2011 and Bozio et al., 2015). Our study is a first step towards broadly examining tax policies after national crises. Our key contribution here is showing that, perhaps surprisingly, many national crises are followed by an increase in taxes.

A related literature computes fiscal multipliers that measure how expenditure and tax policies influence economic growth. Some studies have also examined whether fiscal multipliers are larger during economic recessions than in other years (e.g., Blanchard and Perotti, 2002; Alesina and Ardagna, 2010; Auerbach et al., 2010; Auerbach and Gorodnichenko, 2012; Blanchard and Leigh, 2013, 2014; Alesina et al., 2015; Drautzburg and Uhlig, 2015; Duca, 2017; Ramey and Zubairy, 2018; Ramey, 2019). Our study provides complementary evidence on this strand of literature by showing that taxes are often increased in years after national crises. This pattern may explain why fiscal multipliers are often higher during economic recessions than in other years. A detailed investigation of such a relationship remains, however, for future research.

Our study is also related to the literature that examines how national crises affect economic outcomes. This literature has shown that national crises have a large impact on post-crisis growth rates of GDP, particularly regarding natural disasters (e.g. Loayza et al., 2012; Strobl, 2012; Cavallo et al., 2013) and financial crises (see, e.g., Hardy and Sever, 2021; Romer and Romer, 2017). Little is known, however, how crises influence policy measures that may, in turn, affect a post-crisis recovery of the economy. We contribute to this literature by documenting substantial tax increases after financial crises and natural disasters, which potentially also affect post-crisis economic growth.

2 Data and summary statistics

2.1 Data on tax reforms

Researchers who aim to empirically examine the causes and consequences of tax reforms face two challenges when compiling data on tax policies. First, comparing tax systems across countries is notoriously difficult, and cross-nationally comparable data on taxes are sparse. The reason is that tax systems are complex and the economic impact of taxes depends on their design regarding tax rates, tax bases, administrative practices, fines for tax evasion and many other institutional details. A "naive" comparison of tax rates between countries would hence deliver an incomplete picture. While some data on tax rates exists, little is known about other parameters that are decisive for the

generosity or strictness of tax systems. Second, tax reforms may affect multiple types of taxes. Examining the causes and consequences of tax reforms using data on single tax types may deliver confounded results when other types of taxes are affected by the tax reform as well. To tackle the challenges regarding tax data, we use the new Tax Reform Index (TRI) compiled by Fuest et al. (2021). The TRI is based on large-scale qualitative information from more than 900 OECD Economic Surveys and 37,000 tax-related news from the International Bureau of Fiscal Documentation collected by Amaglobeli et al. (2018). This data includes 3,285 tax reforms in 23 countries over the period 1930-2014 (data on pre-1960 periods is available only for few countries and with large gaps).[4] The TRI dataset covers detailed sub-indices that measure changes in tax rates and tax bases for six types of taxes: personal (PIT) and corporate (CIT) income taxes, value added and sale taxes (VAT), social security contributions (SSC), excises (EXE), and property taxes (PRO).[5]

The TRI also includes two aggregate indicators, one for tax rates and one for tax bases, which aggregate the information on individual tax types into one indicator that reflects overall reforms of the tax system. To assess tax reforms in the overall tax system, we compile a complementary index that combines the aggregate index for tax rates and tax bases. This index captures any change in the tax system, but it does not reflect the source of the reform.

Methodology underlying the tax reform indicators: Let Δs_{it}^{r} be the change in the tax rate for tax type r, announced in country i at time t.[6] When examining post-crisis tax reforms, it is important to consider the announcement date to ensure that tax reforms have not been announced already *before* a crisis. Consider further that $|\tilde{s}_{it}|$ is the qualitative information about the strength of a reform ("major" or "minor").[7] The tax reform index $\mathfrak{S}_{it}^{r} \in [-2, +2]$ for tax type r is defined as

[4]The 23 countries are: Australia, Austria, Brazil, Canada, China, the Czech Republic, Denmark, France, Germany, Greece, India, Ireland, Italy, Japan, Luxembourg, Mexico, Poland, Portugal, Spain, South Korea, Turkey, the United Kingdom and the United States.

[5]We include SSC when discussing tax types to consider the entire financial burden on households and to account for feedback effects between taxes and social security contributions.

[6]A key question is to which time period a tax reform should be assigned. The IMF Tax Reform Database includes information on both the announcement year and the implementation year. In most cases, these years are identical, but we also observe differences between the two. The TRI is based on the announcement year to avoid distorting anticipation effects. Also, tax reforms are likely to change the economic behavior of agents already after they have been announced.

[7]The dataset compiled Amaglobeli et al. (2018) includes a qualitative assessment of the IMF on the strength of tax reforms.

$$\mathfrak{S}_{it}^{r} = \begin{cases} -2, & \text{if } \Delta s_{it}^{r} < 0 \text{ and } |\tilde{s}_{it}| = \text{“major”} \\ -1, & \text{if } \Delta s_{it}^{r} < 0 \text{ and } |\tilde{s}_{it}| = \text{“minor”} \\ \pm 0, & \text{if } \Delta s_{it}^{r} = 0 \\ +1, & \text{if } \Delta s_{it}^{r} > 0 \text{ and } |\tilde{s}_{it}| = \text{“minor”} \\ +2, & \text{if } \Delta s_{it}^{r} > 0 \text{ and } |\tilde{s}_{it}| = \text{“major”}. \end{cases} \tag{1}$$

The index assumes a value of 0 when no tax changes occurred, a value of +1 (-1) when the tax reform gave rise to a minor increase (decrease) in tax rates, and a value of +2 (-2) when there has been a major increase (decrease) in tax rates. The same strategy is employed to measure reforms of the tax base. The TRI also includes variants of the tax indices with alternative coding schemes that impose no upper or lower bound on the index scale, adding up all major and minor reforms. For more details, see Fuest et al. (2021).

Taxonomy: The TRI includes 14 indices, six indices for tax rates (one for each tax type), six indices for tax bases (one for each tax type), and two aggregate indices that reflect overall changes in tax rates and tax bases of a nations' tax system. To ease communication, we use the following convention: the name of each index consists of five letters. The first three letters refer to the abbreviation of the individual tax type (e.g. VAT = value added tax). The fourth and fifth letters indicate whether the index measures tax rates (in which case the suffix is "RI") or tax bases ("BI"). The indicator on tax rates for the value added tax is hence denoted by "VATRI".

2.2 Data on national crises

We distinguish between three types of national crises, including financial crises, natural disasters, and economic crises. Accounting for these types allows us to disentangle tax reactions in response to cyclical downturns with reactions to crises that do not necessarily have economic origins. We collect large-scale data on the crisis history of each country included in our sample and inspect each identified crisis episode in greater detail. This analysis leaves us with 217 incisive crisis events (a total of 18% of all country-year observations included in our sample).

2.2.1 Financial crises

To measure financial crises, we expand and update the data for the occurrence of financial crises (labeled "Systematic Financial Crises") available in the Jorda-Schularick-Taylor Database (JSTD) (Jordà et al., 2017). The dataset provides annual data for 17 advanced economies since 1870. We follow the approach and coding scheme of JSTD and collect new data to expand the coverage for all countries in our sample, adding data for Austria, Brazil, China, Greece, India, Ireland, South Korea, Luxembourg, Mexico, Poland, Portugal and Turkey. We also update the data for the years from 2008 to 2014 for all countries in the JSTD dataset.[8] We then verify the crises episodes identified by the data-driven approach by analyzing the events that occurred in the individual countries in greater detail using books, newspaper articles, and scholarly articles. This analysis leaves us with a total of 61 financial crises.

2.2.2 Natural disasters

For natural disasters, we use data from the Emergency Events Database ("EM-DAT") compiled by Centre for Research on the Epidemiology of Disasters (2011). The dataset includes data of more than 22,000 international disasters that occurred over the last 120 years. We focus on major events that have nationwide impacts, including droughts, earthquakes, epidemics, floods, storms, and wildfires. We do not consider other disaster types that affected individual sub-national regions only, such as industrial explosions or transport accidents. To select natural disasters with significant impact, we first construct a measure of economic damage caused by the individual events. In order to qualify a natural disaster as significant, we relate the CPI-adjusted damages caused by the disaster to real GDP for each natural disaster. As a threshold beyond which natural disasters are classified as significant, we use the value of the economic damage variable for the United States in 2005 as an anchor. In 2005, the hurricanes "Katrina", "Wilma" and "Rita" caused severe damage to the US economy. The impact of the disasters in 2005 amounted to about 1% of the US real GDP. Employing this value as a threshold, we identify a total of 29 major natural disasters.

[8] The data collect efforts by Caprio and Klingebiel (1999); Kaminsky (1999); Kaminsky and Reinhart (1999); Bordo et al. (2001); Caprio and Klingebiel (2002); Lo Duca et al. (2017) have been utilized to extend the JSTD.

2.2.3 Economic Crises

To identify economic crises, we apply the Hodrick-Prescott Filter (HPF) (Hodrick and Prescott, 1981, 1997) to the time series of real GDP for each country in the dataset. Data on GDP is taken from the Penn World Table 9.1, which is an updated version of the methodology introduced in Feenstra et al. (2015).[9]

The economic crisis dummy variable is created by setting a threshold for negative anti-cyclical swings. We calculate this threshold based on the standard deviation of y_t. Our analysis uncovers a total of 127 economic crises.

Intensity of economic crises: As a complementary strategy, we also consider the intensity of economic crises by multiplying the dummy variable for economic crises by the rate of GDP growth in the year of these crises. To facilitate the comparison to the other crisis measures, we re-code this variable to match a 0-1 scale, with higher values reflecting more extreme downturns.

2.3 Crisis-influenced years

Crises occur at different parts of the year. For instance, the dotcom bubble started bursting in spring 2000, the 1997 Asian financial crisis began in July 1997, the global financial crisis of 2007-08 reached its climax with the bankruptcy of Lehman Brothers on September 15, 2008, and the SARS-CoV-1 outbreak in Asia began mid-November 2002. For policymakers, the possibility to conduct tax policies in response to these crises in the same year strongly differs across cases due to temporal heterogeneity in the occurrence of crises. Also, crises are often long-lasting, and the assumption that crisis events influence policy making only in the year of its initial occurrence is probably far-fetched. To tackle these challenges, we define the year when the crisis has broken out and the year after its outbreak as "crisis-influenced years". This approach has similarity with the temporal structure employed for the compilation of previous

[9]Consider the real GDP of a country over the period $t = (1, ...T)$. The HPF decomposes the time series in a trend and cyclical component via

$$\min_{g_t} \left(\sum_{t=1}^{T} (y_t - g_t) + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \right) \tag{2}$$

where g_t is the trend component of y_t and λ is the penalizing parameter that determines the degree of smoothing the time series. We follow Ravn and Uhlig (2002) and assume $\lambda = 6.25$, which has been shown to deliver a suitable de-trending when annual data is employed.

datasets.[10].

Measuring the number of post-crisis years that are influenced by the crises in our dataset is difficult, and crises may differ in the number of post-crisis years they affect. We specify the temporal structure of the crises as described above because of two reasons. First, the possibility of confounding events increases with the number of crisis-influenced years. When assuming a longer time span as being influenced by crises, the likelihood that tax policies are influenced by other factors increases. Second, we cross-validate our temporal specification in a complementary event study analysis where we are agnostic about the number of years influenced by crises. This analysis shows that tax reforms are usually conducted one year after the initial occurrence of a crisis but not later.

2.4 Crises in the World, 1962–2014

Figure (1) shows the occurrence of crises for our sample of 22 countries between 1962–2014. The figure shows the total number of crises that occurred per crisis type during the individual years in the full sample of countries. We also construct an aggregate measure that adds all crisis types per country-year, and re-code this measure to obtain a value of 1 if there has been any type of crises (0 otherwise).

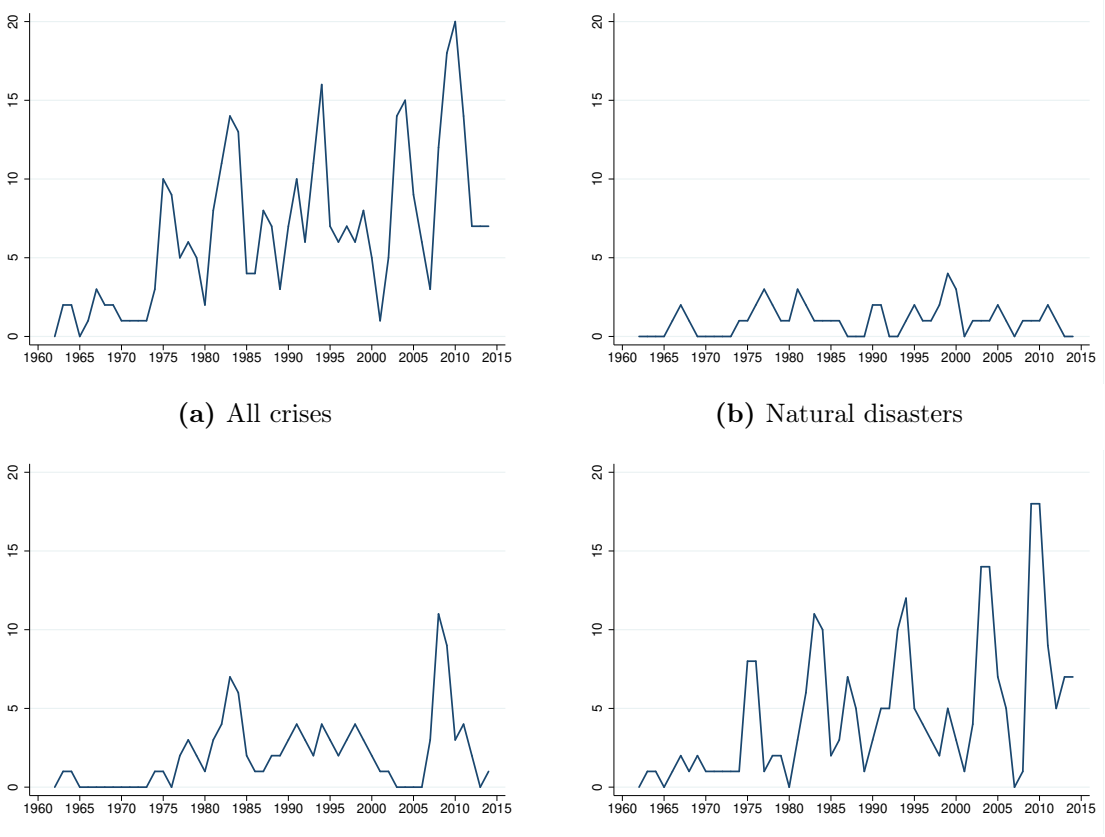
We observe substantial heterogeneity in the occurrence of crises across crisis types. For financial crises, the global financial crisis of 2007-08 is a major outlier, affecting the majority of countries in our sample. Apart from the global financial crisis, there are no trends visible regarding the number of countries that are hit by financial crises in our sample. In a similar vein, the frequency of natural disasters remains relatively constant over the period 1962–2014, with only few countries being affected by natural disasters per year. We find, however, an overall increase in the number of countries that are struck by economic recessions over time. The increasing vulnerability to economic crises also results in a positive trend of the aggregate crisis measure.

2.5 Temporal and geographic heterogeneity

A key requirement for the empirical analysis on post-crisis tax reforms is that there is sufficient temporal and geographic variation in the occurrence of national crises. Figure

[10]For instance, the democracy dataset of Bjørnskov and Rode, 2020 follows a similar coding rule to classify the temporal nature underlying the occurrence of coups d'états.

Figure 1 NUMBER OF CRISES PER YEAR, FULL SAMPLE, 1962–2014



(a) All crises

(b) Natural disasters

(c) Financial crises

(d) Strong economic crises

Notes: The figure shows the frequency of crises for the sample of 22 countries (observed between 1962–2014) that are included in the tax reform dataset of Fuest et al. (2021). The figure shows the evolution of natural disasters, financial crises and economic crises over time. "All crises" sums all types of crises per year in the sample. The variable assumes a value of 1 in case that any crisis has occurred in a given year (zero otherwise).

(2) shows that there is considerable heterogeneity in how countries have been affected by the three types of crises included in our dataset. There is also much heterogeneity in the consolidated index that aggregates all types of crises into a single indicator (Figure 2a).

3 Mean comparisons and case study evidence

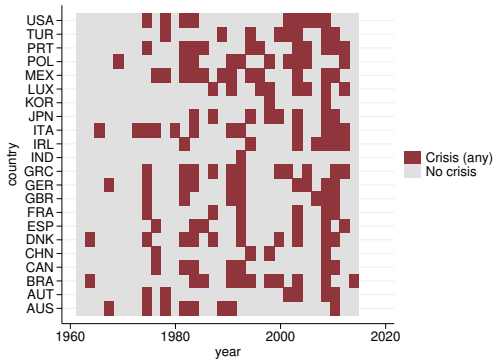
As a first step to study the relationship between national crises and tax reforms, we examine unconditional correlations between the outbreak of national crises and the tax reform indices. To this end, we compare means in tax reform activity in years with and without economic crises, distinguishing between tax rates and bases, types of taxes, and types of crises. We proceed by investigating case studies of individual crisis episodes to examine the mechanisms underlying post-crisis tax reforms.

3.1 Unconditional correlations

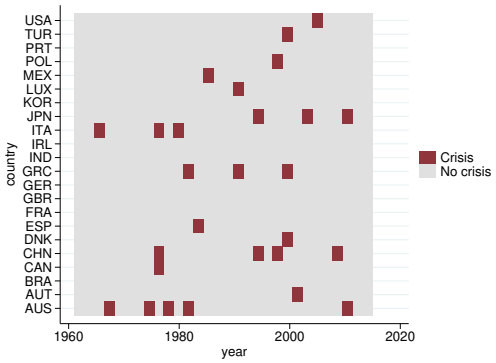
Tax rate changes after crises: Figure (3a) shows average changes in our tax rate index in crisis years and non-crisis years, pointing to stark differences in tax policies in the aftermath of crises. In the full sample, the average change in the aggregate tax rate index during non-crisis years is -0.025 points, indicating that tax rates decreased in non-crisis years. In crisis years, however, the average tax rate index is 0.026, indicating that tax rates increased in crisis-influenced years. The difference in the index between crisis and non-crisis years (0.051 index points) is around 13.6% of the standard deviation of the aggregate tax rate index.

Figure (B-1) in the appendix distinguishes post-crisis tax reforms for the six individual tax types included in the TRI dataset. We find substantial heterogeneity in post-crisis tax reforms across types of taxes. First, the patterns for the aggregate tax rate index reappear for the value added tax, excises, and social security contributions. For these tax types, we observe increases in tax rates in the aftermath of crises that are stronger than in non-crisis years, where the changes are close to zero. The difference between crisis years and non-crisis years is most strongly pronounced for the VAT. Second, we observe almost no difference between tax rate changes in crisis and non-crisis years for the corporate income tax and property taxes. Third, While tax rates for personal income taxes, on average, decrease in both crisis and non-crisis years, the decrease is less pronounced after the occurrence of national crises.

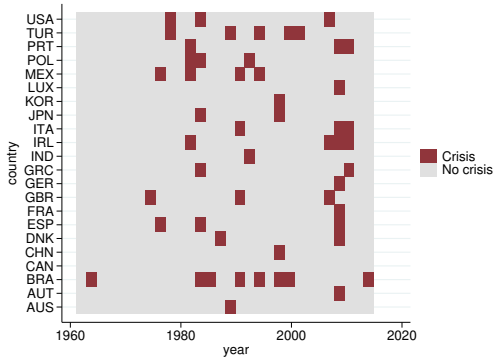
Figure 2 TEMPORAL AND GEOGRAPHIC HETEROGENEITY IN THE OCCURRENCE OF CRISES, 1962–2014



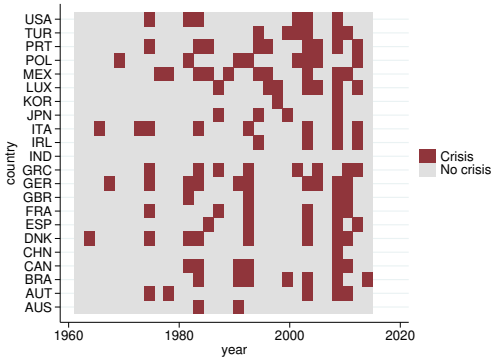
(a) All crises



(b) Natural disasters



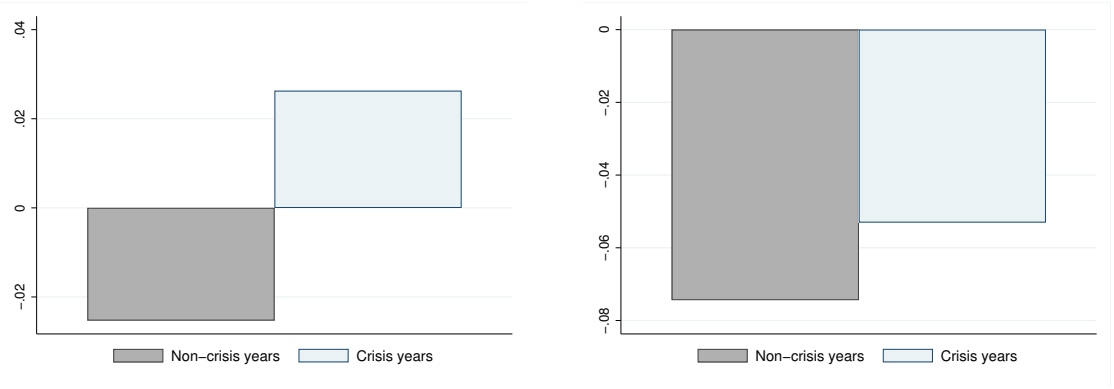
(c) Financial crises



(d) Economic crises

Notes: The figure shows the occurrence of crises for all 22 countries (observed between 1962–2014) that are included in the tax reform dataset of Fuest et al. (2021). The figure shows the evolution of natural disasters, financial crises and economic crises over time and across countries. "All crises" sums all types of crises per year in the sample. The variable assumes a value of 1 in case that any crisis has occurred in a given year (zero otherwise).

Figure 3 AVERAGE CHANGES IN TAX RATES AND TAX BASES IN CRISIS YEARS AND NON-CRISIS YEARS, AGGREGATE INDEX, FULL SAMPLE, 1962–2014



(a) Tax Rate Index **(b)** Tax Base Index

Notes: The figure shows the average change in the aggregate tax rate (Figure 3a) and the aggregate tax base (Figure 3b) index in crisis years and non-crisis years, including all countries and years in our sample. "Crisis years" denote crisis-influenced years as described in Section (2.3). The aggregate tax rate and base indicators include all tax types and ranges from -2 to +2 (see Section 2.1 for a detailed description of the indicator).

Tax base changes after crises: Figure (3b) compares tax base changes in crisis years and non-crisis years. Consistent with the findings for tax rates, the figure uncovers differences in tax base reforms between crisis and non-crisis years. Whereas there is a distinct pattern towards more narrow tax bases over the past six decades (see also Fuest et al., 2021), the decline is weaker in crisis years and more pronounced in non-crisis years.

Again, we find considerable heterogeneity in post-crisis tax reforms across types of taxes (see Figure B-2 in the appendix). While the pattern for the personal income tax bases are closely comparable to the post-crisis reaction of the aggregate index, we observe almost no differences in tax base changes between crisis and non-crisis years for the corporate income tax and property taxes, and only small differences for excises and social security contribution. For the value added tax, however, we find that tax bases have *broadened* after crises and remained unchanged in non-crisis years.

Post-crisis tax reforms by types of crises: In Figure (4) we examine whether post-crisis tax reforms depend on the types of crises. This analysis reveals distinct patterns regarding post-crisis tax reactions. For all types of crises, tax rates increase

after the crises have occurred, whereas tax rate changes in other years tend to be close to zero or even negative. In a similar vein, the tendency to narrow tax bases is less pronounced for all types of crises in crisis years compared to non-crisis years. The differences between crisis years and non-crisis years is particularly pronounced for financial crises and natural disasters, and less so for economic crises.

Figure (B-3) in the appendix presents descriptive statistics for individual tax types. We observe differences in reform tendencies between crisis and non-crisis years for the value added tax, the personal income tax, and the corporate income tax; for brevity, we exclude the analyses for excises, social security contributions and property taxes (available upon request). The data points to strong post-crisis increases in the VAT regardless of the type of crises. For personal income taxes, however, the tax reaction depends on the type of crises. The personal income TRI increases after natural disasters and financial crises (compared to non-crisis years), but not after economic crises. The results are similar for the corporate income tax.

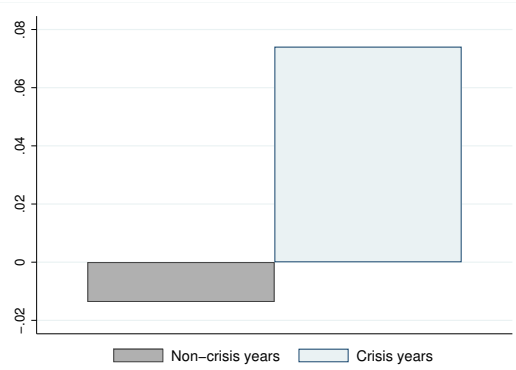
The patterns for tax bases resemble the post-crisis reform tendencies of tax rates (see Figure B-3 in the appendix). We find that tax bases broadened for the value added tax after any type of national crises, and again observe that the reaction for personal income taxes and corporate income taxes depends on the type of crises.

3.2 Case studies: tax reforms after crises

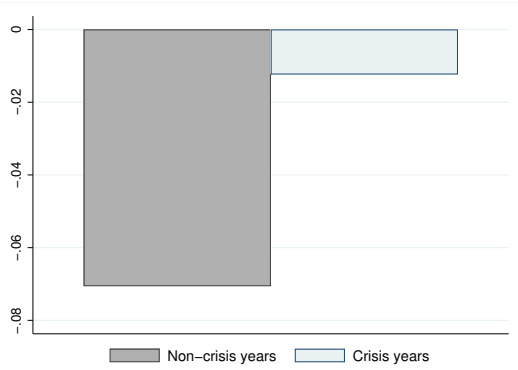
The unconditional correlations suggest that tax rates have been increased after crises. An open but important question is how this pattern emerges during specific crisis episodes. We therefore provide case-study evidence, discussing examples of five post-crisis tax reforms and describe how the TRI tax reform index codes the reforms. The analysis of these examples allows us to study the mechanisms underlying an effect of crises on tax reforms.

Italy 1976: On 6 May 1976, the Friuli earthquake in northeastern Italy killed more than 900 people and left 100,000+ people homeless (Allen et al., 2009). Economic damages were severe and Italy, already struggling with the consequences of stagflation in the 1970s, saw its public debt massively increasing. The Andreotti government introduced an exceptional surtax on motor vehicles (estimated revenue: 300 billion Lire) and taxes on pools and lotteries (estimated revenue: 40 billion Lire) to meet exceptional expenditure necessary to tackle the economic damage caused by the earthquake

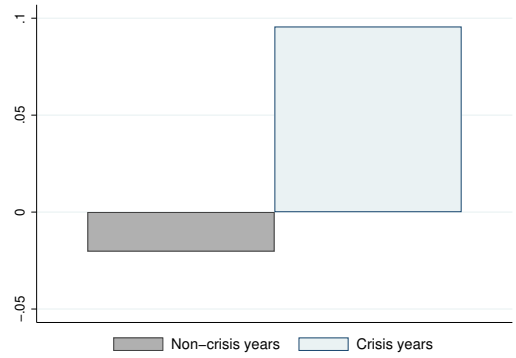
Figure 4 AVERAGE TAX RATE CHANGES BY TYPES OF CRISES, 1962–2014



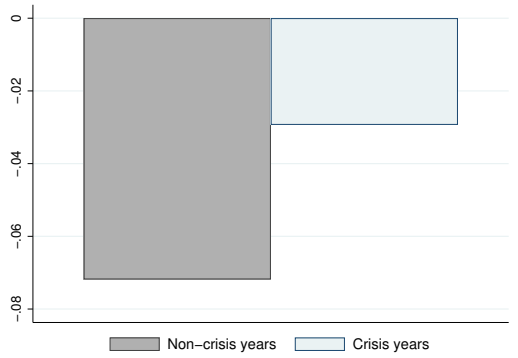
(a) Natural disasters: Rates



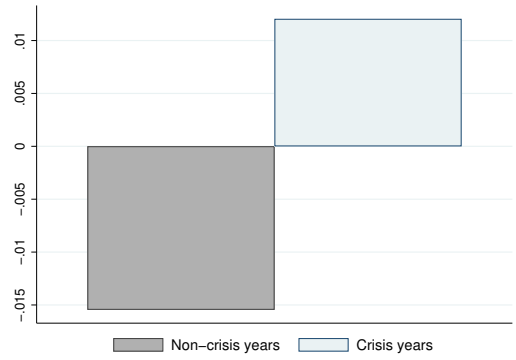
(b) Natural disasters: Bases



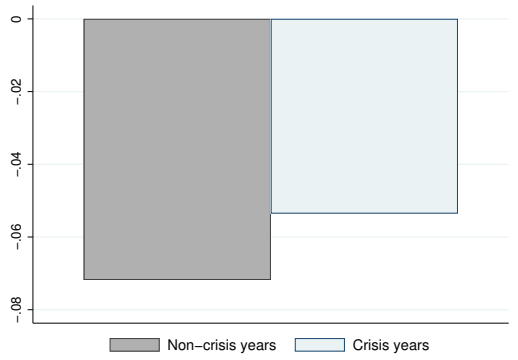
(c) Financial crises: Rates



(d) Financial crises: Bases



(e) Economic crises: Rates



(f) Economic crises: Bases

Notes: The figure shows the average change in our aggregate tax base index in crisis years and non-crisis years, distinguishing between types of crises. The figure includes all countries and years available in our sample. "Crisis years" denote crisis-influenced years as described in Section (2.3). The aggregate tax rate and base indicators include all tax types and ranges from -2 to +2 (see Section 2.1 for a detailed description of the indicator).

(Amaglobeli et al., 2018). To satisfy additional capital needs, the government temporarily increased the VAT base by a 10 percent tax on purchases of foreign currency and revalued the tax base of income from real estate (estimated revenue: 200 billion Lire) (Amaglobeli et al., 2018). These tax policies were accompanied by a reduction of social security contributions.

The announced changes in the Italian EXE rate are classified as a major increase. Similarly, the announced changes in the Italian VAT and PRO bases are coded as major increases and the announced change in the Italian SSC base is coded as a major decrease. Therefore, the EXERI, VATBI and PROBI assume a value of 2 for Italy for the year 1976. The SSCBI assumes the value -2 for Italy for the year 1976.

Germany 1982: In the early 1980s, Germany faced one of the worst economic recessions since World War II. The crisis was initiated, partly, by the consequences of the second oil crisis. In 1980, Germany spent about 20.5 billion USD more for oil from member countries of the Organization of Petroleum Exporting Countries (OPEC) than in 1979, but received about 10 percent less oil than one year before (Tagliabue, 1981). Inflation was running at five percent and Germany's current account deteriorated. Real GDP growth decreased from 1979 to 1982 and increased the need for fiscal consolidation. Already in 1980, the Schmidt government tried to consolidate the budget, but early policies remained unsuccessful (Hellwig and Neumann, 1987). Budget consolidation was pursued more forcefully by Schmidt's successor Kohl after 1982. The Kohl government also upheld the 1982 announced VAT increase (Deutscher Bundestag, 1982). The tax reform announced in 1982 was implemented on 1 July 1983. The VAT standard rate increased by 1 percentage point from 13 percent to 14 percent and the reduced rate increased by 0.5 percentage points from 6.5 percent to 7 percent.

The announced changes in the German VAT rate are coded as a major increase. Therefore, the VATRI assumes the value 2 for Germany for the year 1982.

United Kingdom 1991: The 1991 financial crisis in the United Kingdom entailed high-interest rates, falling house prices and a currency overvaluation. The crisis was preceded by the *Lawson Boom*, a period of high economic growth, falling unemployment and rising inflation. The boom was fueled by low interest rates, rising housing prices and cuts in the PIT, which gave rise to increased consumer wealth and spending. Economic growth was above the long run trend and initiated inflation tendencies. The financial crisis and the recession caused a reduction in tax revenues and increased social

welfare spending. In the spring of 1991 the public sector borrowing requirement was estimated to be 8 billion pound and a few months later, it was put at 19 billion pounds and projected to increase further (Grant, 2017). The Major government reacted by increasing the VAT standard rate from 15 percent to 17.5 percent.

The announced changes in the British VAT rate are classified as major increases. Therefore, the VATRI assumes the value 2 for the United Kingdom for the year 1991.

Turkey 1999: On 17 August 1999, the Izmit earthquake in northwestern Turkey killed approximately 17,000 people and left more than 250,000 people homeless (Marza, 2004). Izmit was the nearest major city affected, but the earthquake also caused considerable damage in Istanbul, about 70 kilometers away from the earthquake's epicenter (Barka, 1999). Another earthquake struck the Bolu area on 12 November 1999. The earthquakes had *"severe effects on economic activity"* (Bibbee et al., 2000). After official foreign funding, the remaining financing gap was estimated to be 2.1 billion USD. On 26 November 1999, the Turkish government announced an "earthquake package" of tax measures. It included *"a one-off tax on personal and corporate tax; real estate tax and motor vehicle tax paid in 1999; a special transactions tax; a special tax on each paper cheque; an increase in the remittances of surpluses generated by regulatory boards; a 25 percent increase in the tax on mobile telephone usage for 2000, and an increase in petroleum products consumption tax"* (Bibbee et al., 2000, p. 279). The total expected revenues from the earthquake package are 189 million USD in 1999 and 1.5 billion USD in 2000, offsetting large parts of the financing gap.

The announced changes in the Turkish VAT, PIT, CIT, EXE, and PRO rates are coded as major increases. Similarly, the announced changes in the Turkish PIT, SSC, and PRO bases are recorded as major increases. Therefore, the VATRI, PITRI, CITRI, EXERI, and PRORI and the PITBI, SSCBI, and PROBI assume the value 2 for Turkey for the year 1999.

Greece 2010: The Greek economy was heavily hit by the 2008/2009 international financial crisis and already saw its sovereign bond yields starkly increasing in 2009. After a decade of fast growth, the country fell into recession which would eventually suppress GDP by 23.9 percent between 2009 and 2013. The 2010 Economic Adjustment Programme initiated a period of strict international supervision. Government revenue

and expenditure were closely regulated by the "Troika".[11] Public finances required substantial consolidation due to a high public deficit. The first reform package included major VAT, PIT and CIT rate increases. The reform further substantially altered the PIT structure. It introduced four additional tax brackets (from five to nine) and increased the top tax rate from 40 percent to 45 percent for annual incomes over 100,000 EUR (Leventi and Picos, 2019).

The announced changes in the Greek VAT, PIT, and CIT rates are recorded as major increases. Therefore, the VATRI, PITRI, and CITRI assume a value of 2 for Greece for the year 2010.

Lessons from the case study evidence and hypotheses: The case studies reveal how a greater need for fiscal consolidation in late stages of national crises led governments to increase tax rates. Another reading of the results for some of the case studies is that economic crises sometimes initiate a "window of opportunity" for tax reforms, which would face political headwind in non-crisis years. This theory would suggest that national crises initiate reforms when they are necessary and politically infeasible prior to the occurrence of crises (see, e.g., Drazen and Grilli, 1990 and Drazen and Easterly, 2001 for similar arguments).

While the mechanisms are comparable across the cases explored in this section, a key takeaway is that governments reacted differently regarding the tax types that have been adjusted in response to crises. This observations underscores the need to model the entire tax system in empirical analyses, as focusing on individual tax types may result in false negatives, i.e. classifications of non-reform country-years that have, in fact, experienced tax reforms.

4 Empirical analysis: Tax reforms after crises

An important question is whether the results obtained by the comparison of means are robust when we condition on variables that may correlate with both the occurrence of national crises and tax reforms. We now investigate how national crises influence tax reforms using the full information provided in our dataset.

[11] The term "Troika" refers to a consortium of the European Commission, the European Central Bank and the International Monetary found that provided bailouts to several member states starting in 2010.

4.1 Empirical strategy

We estimate a Generalized Difference-in-Differences model of the following form (see, e.g. Imbens and Wooldridge, 2009 for methodological details)

$$\mathfrak{S}_{it}^{A} = \alpha + \gamma \mathbb{1}[t \geq C_{is}] + \mathbf{X}_{it}\boldsymbol{\theta} + \mathbf{A}_i + \mathbf{B}_t + \varepsilon_{it}, \tag{3}$$

where $\hat{\gamma}$ is the estimated effect of crisis C_{is} occurring at time s on tax reforms $\mathfrak{S}_{it}^{A}$ over the crisis-influenced years (see section 2.3 for a discussion of the years influenced by crises and our temporal coding scheme). Countries differ in a systematic manner in geographic, institutional, and cultural features, and these differences may well be correlated with both fiscal preferences (Camobreco, 1998; Pujol and Weber, 2003), tax morale (Alm and Torgler, 2006) and the ex ante vulnerability to crises (Shi et al., 2015). We account for time-invariant heterogeneity across countries by conditioning on fixed country effects $\mathbf{A}_i$. Taxation was subject to major trends during the past six decades (Fuest et al., 2021). We absorb cross-national trends in taxation by period fixed effects $\mathbf{B}_t$. These effects also account for cross-national contagion effects of crises as observed during the Financial Crisis of 2007-08 or the 2020-21 Coronavirus Pandemic. In extended specifications of our model, we account for selection on observables, adding time-varying confounders that are potentially correlated simultaneously with crises and tax reforms via the matrix $\mathbf{X}_{it}$. The idiosyncratic error term ε_{it} absorbs any time-variant unobservables on the country level.

Identification: The key identifying assumption requires that absent of the treatment, countries with and without national crises would have followed similar trends in the post-crisis period (see, e.g., Kahn-Lang and Lang, 2020 for a discussion). This assumption would be fulfilled in case the intervention is randomly assigned, in which case $\hat{\gamma}$ identifies the effect of national crises on tax reforms. Some national crises may, however, be influenced by tax policies, which is why the treatment of national crises, particularly of economic crises, is potentially endogenous. The focus on the announcement date of tax reforms alleviates the concern of reversed causation, ruling out anticipation effects that may initiate or contribute to economic downturns. Financial crises have been shown to be more difficult to predict than economic crises. Some researchers hence employ empirical settings similar to ours to estimate the causal effects of financial crises on economic outcome variables (see, e.g., Romer and Romer, 2017). The possibilities to influence natural disasters by human intervention are usu-

ally highly restricted. Hence, conditioning on the ex ante risk of natural disasters via fixed constants for countries, the literature usually treats large sudden natural disasters as exogenous events (see, e.g., Cavallo et al., 2013 for a discussion). However, post-crisis tax reforms may nevertheless be mitigated, amplified or even initiated by other variables that are influenced by crises. To the extent that these variables are time-invariant, we absorb them by our country-level fixed effects. To the extent that selection depends on observed factors, we include them in our matrix of control variables. When there is selection on time-varying unobservables, however, the parameter estimate $\hat{\gamma}$ may be biased. To assess the degree of confounding by unobserved factors necessary relative to the information in the model in order to eliminate the estimated effects, we employ the test constructed by Oster (2019).

As a complementary strategy to asses the plausibility of the identifying assumption of equation (3), we conduct an event study analysis where we inspect whether treated and non-treated countries have developed in parallel prior to the occurrence of national crises. While this does not necessarily mean that treated and non-treated countries would have followed similar trends absent of the crises, diverging pre-crisis trends would render the identifying assumption unlikely.

4.2 Baseline results

Table 1 shows the baseline results for the overall tax system index (Panel A), and also provides results for tax rates (Panel B) and tax bases (Panel C). We present estimates of equation (3) for the three types of crises (natural disasters, financial crises, and economic crises) and a combined measure that jointly considers all types of crises (labeled "All crises"). We also report estimates that consider the intensity of economic crises, i.e. the growth rate during an economic crisis (multiplied by -1).

The estimates reported in Table (1) uncover large tendencies for fiscal consolidation in response to crises. The main result is that in all model specifications, the index value for both tax rates and tax bases is higher after national crises, suggesting that governments, on average, increased taxes in response to crises. The parameter estimates of the crisis variables are statistically significant at the 5% level for natural disasters (2.10), financial crises ($t = 2.35$), and strong economic crises ($t = 2.59$). Examining tax policy measures, we observe that governments respond to financial crises and strong economic crises particularly by increasing tax rates (Panel B) and to natural disasters by broadening tax bases (Panel C).

Table 1 TAX POLICIES AFTER NATIONAL CRISES—BASELINE-RESULTS

Dependent variables: *Aggregate Tax Reform Indicators*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: Aggregate Tax System Indicator				
Post-Crisis	0.0415 (0.027)	0.0838** (0.040)	0.0949** (0.040)	0.0212 (0.034)	0.311** (0.120)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0733	0.0736	0.0791	0.0699	0.0787
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: Aggregate Tax Rate Indicator				
Post-Crisis	0.0469 (0.038)	0.0839 (0.059)	0.128** (0.061)	0.0168 (0.049)	0.446** (0.180)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0885	0.0880	0.0962	0.0857	0.0968
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: Aggregate Tax Base Indicator				
Post-Crisis	0.0361 (0.027)	0.0836** (0.040)	0.0596 (0.043)	0.0256 (0.033)	0.176 (0.104)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0598	0.0605	0.0602	0.0586	0.0597
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax system indicator, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

4.3 Selection on observables

Our baseline results may be driven by omitted variables that are correlated simultaneously with national crises and tax policies. In Table (A-1) we re-estimate our baseline models including variables that potentially confound the relationship between crises and tax reforms. Given the heterogeneity of countries in our sample, an obvious source of confounding variation may come from the development level of countries. When tax systems change over the course of development, we might expect different tax reactions between advanced and emerging market economies. To address the influence of the development level, we include the logarithm of real per capita GDP, taken from the Penn World Tables 9.1 (an update of Feenstra et al., 2015), into the model. Tax reforms and especially the type of tax reforms may depend on the distribution of incomes. We hence also add the Gini coefficient of pre-tax incomes, which we obtain from the Standardized World Income Inequality Databse (SWIID) (see Solt, 2020). Another driver of tax reforms may be political institutions. Profound tax reforms may be politically more difficult in democracies, particularly in late stages of national crises when the electorate is negative towards tax increases. To account for political institutions, we include the continuous machine learning algorithm developed by Gründler and Krieger (2016, 2021). Finally, a large body of literature examines the relationship between globalization, welfare systems and taxation (Schulze and Ursprung, 1999; Potrafke, 2015; Jha and Gozgor, 2019). We account for the impact of globalization on welfare systems via the KOF Globalisation Index (compiled by Dreher, 2006 and Gygli et al., 2019).

When including the additional control variables, the number of observations declines due to data availability. Hence, we first re-estimate our baseline model but find no sign for sample selection. In the second step, we re-estimate all models of the baseline results including the additional set of controls. Inferences do not change when we account for factors that may simultaneously correlate with crises and tax reforms. In particular, the parameter estimates remain in the same ballpark as those obtained in our baseline model.

4.4 The role of public debt

When countries enter an economic crisis with high levels of debt, irrespective of whether or not the debt has contributed to or even caused the crisis, one could expect that

pressure to increase taxes soon after the crisis is higher. Previous research has discussed the role of public debt for economic crises, also in the context of the global financial crisis 2007-08 and the following European debt crisis (e.g. Tagkalakis, 2013; Alesina and Giavazzi, 2013). This research shows that public and private debt booms have been robust predictors for the outbreak of financial crises in industrialized countries between 1870 and 2008 (Schularick and Taylor, 2012). Conditioning on the ex ante vulnerability to natural disasters, we would not assume that public debt influences the occurrence of natural disasters, but the level of public debt may nevertheless affect the pressure to reform tax systems after natural disasters.

To examine the effect of national crises on tax reforms conditional on the pre-crisis level of public debt, we augment equation (3) as follows

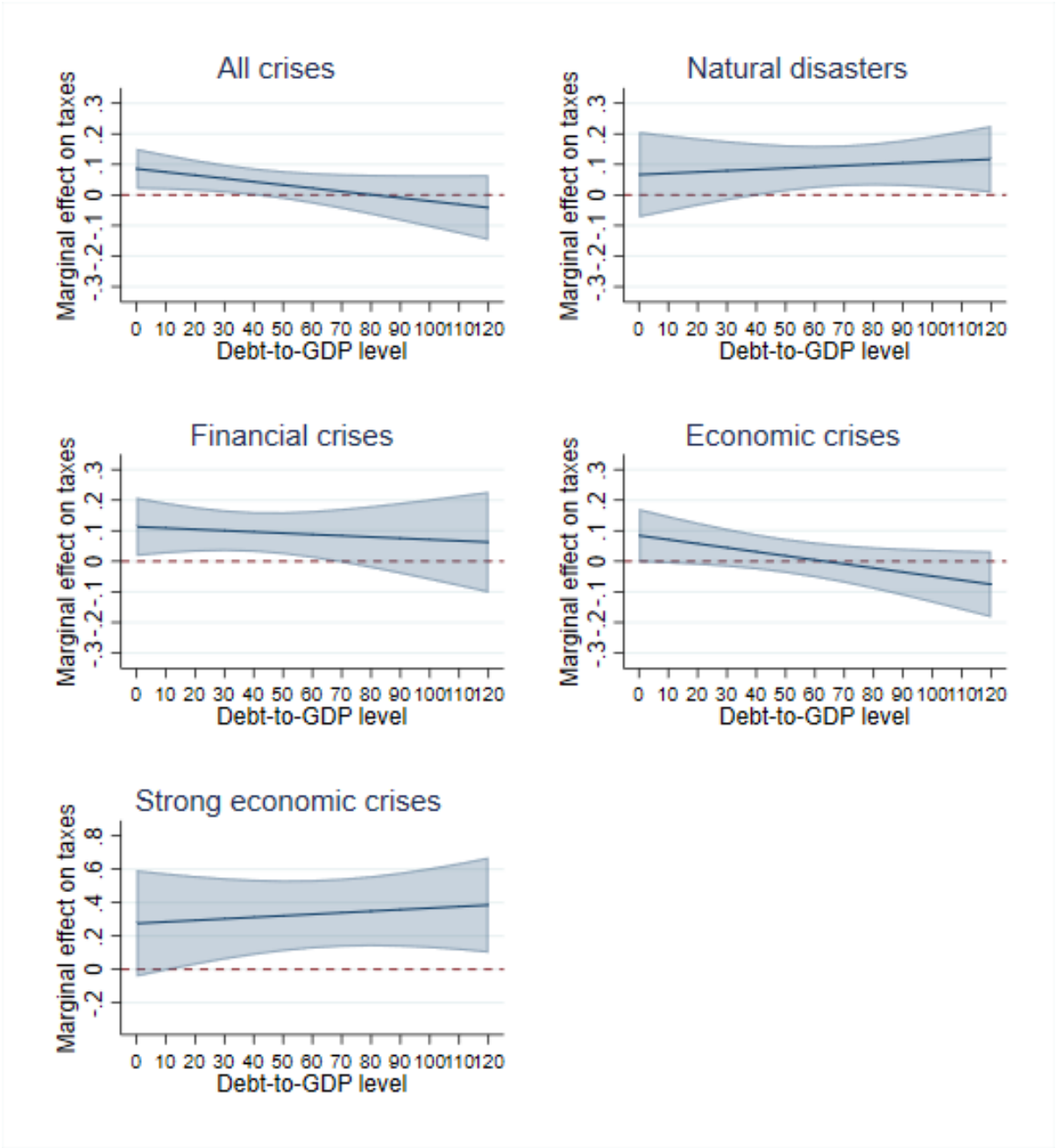
$$\mathfrak{S}_{it}^{A} = \alpha + \gamma \mathbb{1}[t \geq C_{is}] + \rho D_{it-1} + \omega(\mathbb{1}[t \geq C_{is}] \times D_{it-1}) + \mathbf{A}_i + \mathbf{B}_t + \varepsilon_{it}, \qquad (4)$$

where D_{it-1} denotes the pre-crisis level of public debt relative to GDP, and the estimated parameter $\hat{\omega}$ reports the effect of national crises on tax reforms conditional on the debt level before the crisis.

Figure (4) shows the results of equation (4) for all types of crises. For the aggregate crises measure, we observe that a higher initial debt-to-GDP level paradoxically reduces post-crisis tax increases. However, the conditional effects differ regarding the type of crises. The marginal effect of financial crises on tax reforms is positive but lacks statistical significance if the initial debt-to-GDP level is high. For natural disasters and strong economic crises, we observe the opposite pattern, i.e. an increasing tendency to raise taxes after crises when the initial debt-to-GDP level was higher. A possible explanation for this pattern is that recoveries from economic crises, in particular financial crises, are weaker and last longer if public debt before the crisis is already high (Schularick and Taylor, 2012). In these cases governments may hesitate to raise taxes too early.

Figures (B-5) and (B-6) in the appendix report complementary analyses for tax rates and tax bases. The results are in line with the overall reaction of tax policies to crises, but they also reveal significant differences regarding the political reaction to financial crises. While tax rates tend to increase after financial crises with higher levels of debt-to-GDP, tax bases are narrowed after financial crises when the pre-crisis level of indebtedness is high.

Figure 5 EFFECTS OF NATIONAL CRISES ON TAX REFORMS CONDITIONAL ON PRE-CRISIS DEBT-TO-GDP LEVELS



Notes: The figure shows the marginal effect of national crises on tax reforms relative to the pre-crisis level of debt-to-GDP, empirically estimating equation (4). The figure uses the aggregate tax reform index to measure post-crisis tax reforms. Data on debt levels relative to GDP is collected from the International Monetary Funds (IMF). The dashed red line represents a marginal effect of 0, the blue areas reflect 90% confidence intervals.

4.5 Selection on unobservables

Threats to the validity of our estimates may also come from the potential of a bias resulting from selection on unobservables. We cannot account for such factors in our model, but we can test for the degree of selection on unobservables relative to the information provided by the variables included in the model that is necessary to explain away the results. Oster (2019) provides a test for such validation exercises.

The Oster test can be implemented in two versions. The first version computes bias-adjusted treatment effects under a specific assumption about the importance of unobserved factors relative to observed factors that are included in the model (the so called "δ factor in the methodology of Oster, 2019). As a second version, the test can be implemented to estimate the degree of proportionality δ, i.e. the degree to which selection on unobservables must be larger compared to selection on the variables included in the model. We obtain $\delta = 3.73$ for natural disasters, $\delta = 1.41$ for financial crises and $\delta = -22.34$ for strong economic crises. These values mean that the influence of omitted variables needs to be between 1.41 and 22.34 times more important than the variables in our models (including fixed effects for countries and years and the observed variables we included as controls) to bring the effect of national crises to zero. Given that these estimates (greatly) exceed the threshold rule-of-thumbs level of $\delta = 1$, the results suggest that it is unlikely that our findings are explained by selection on unobservables and suggest a causal interpretation of the impact of crises on tax reforms (see also Buggle and Nafziger, 2021 for a discussion on the causal interpretation of $\delta > 1$).

4.6 Event study analysis

An important assumption underlying our estimates is that there are no systematic differential trends in taxation prior to the occurrence of crises (*"parallel trends assumption"*). We conduct a flexible event study to asses the plausibility of this assumption. The event study design reveals two pieces of information that are not observable in the single-coefficient difference-in-differences model. First, the key identifying assumption of equation (3) requires that tax policies in countries with and without treatment would have followed similar post-crisis trends absent of the treatment. This assumption cannot directly be assessed, but the event study allows us to investigate whether tax policies in treated and non-treated countries have developed in parallel prior to

national crises. Parallel pre-trends would signal a high likelihood that the idenifying assumption of the model is fulfilled. Second, the event study delivers information about the temporal dimension of the treatment effects. In our baseline specification, we assume that national crises exert effects in the year of the treatment and the year after the treatment. The event study allows for a closer inspection of the temporal nature of the treatment and potential dynamics after the first post-crisis year.

Assessing the effects of lags and leads to the occurrence of national crises, our event study is specified as follows

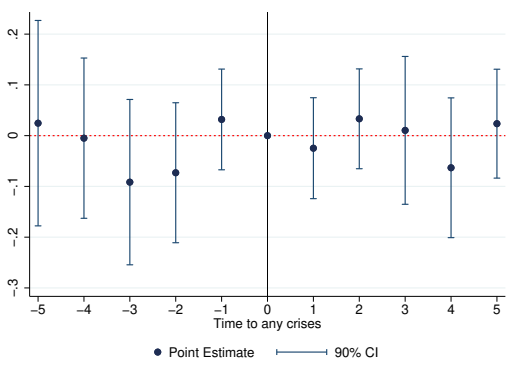
$$\mathfrak{S}_{it}^{A} = \alpha + \sum_{j=2}^{J} \beta_j(\mathbb{1}[t = C_{it}^{0} - j]) + \sum_{k=1}^{K} \gamma_k(\mathbb{1}[t = C_{it}^{0} + k]) + \mathbf{A}_i + \mathbf{B}_t + \varepsilon_{it}, \qquad (5)$$

where C_{it}^{0} denotes the year in which the national crisis occurred (opposed to the definition of crisis-influenced years used for the baseline model). We specify a time window of five years before and after the occurrence of national crises and present estimates in Figure (6). The figure shows dynamics for all crises (Figure 6a), and the three types of crises for which Table (1) found significant effects (natural disasters, financial crises and strong economic crises, Figures 6c–6d).

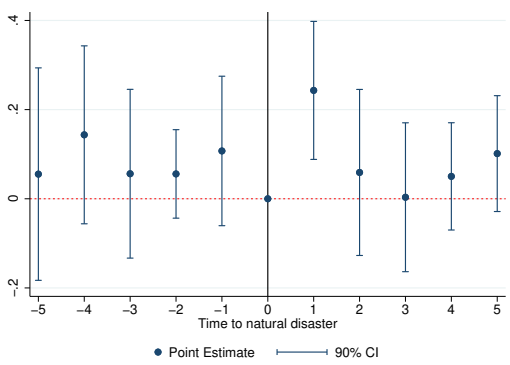
For all treatments, Figure (6) suggests parallel trends of countries with and without treatment prior to the occurrence of national crises. This result suggests that there is no violation of the parallel trends assumption. Given that there is no statistically significant parameter estimate in pre-crisis years, we might also not expect that our benchmark results are distorted by anticipation effects.

The treatment effects shown for financial crises, natural disasters, and strong economic crises manifest in the first year after the crises. There is no further dynamic effect of crises on tax policies in later years. The parameter estimates suggest that policymakers tend to adjust tax policies quite quickly when crises occur. Given this immediate reaction, tax policies in reaction to crsies do not seem to be procyclical. We find no effect for our aggregate crisis measure (Figure 6a). This zero effect is driven by regular economic crises. Consistent with our benchmark estimates, we find no treatment effect if we consider all economic crises. Importantly, however, the parallel trends assumption is fulfilled also when we consider the full set of economic recessions (not reported).

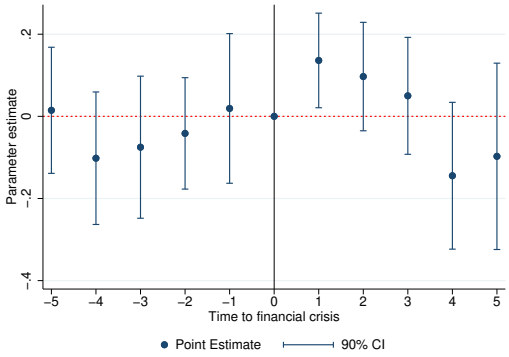
Figure 6 EVENT-STUDY ANALYSIS, NATIONAL CRISES AND TAX RATES



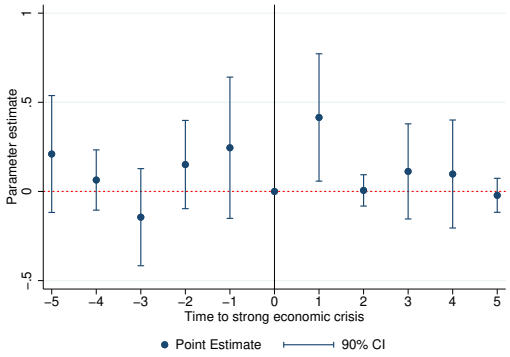
(a) All crises



(b) Natural disasters



(c) Financial crises



(d) Severe economic crises

Notes: The figure plots the coefficients from event study analysis on the relationship between national crises and the overall tax rate indicator for a window spanning from five years prior to a national crisis to five years after a national crisis. The figure considers the three types of crises for which table Table (1) reports statistically significant post-crisis tax reforms: financial crises (Figure 6c), natural disasters (Figure 6b) and severe national crises (Figure 6d). For comparison, we also show the results for all crises (Figure 6a).

4.7 Cross-validation: Alternative taxation data

A threat to the identification of our results is that the estimated parameters may be driven by the coding scheme employed to compile the tax reform index of Fuest et al. (2021). To cross-validate our results, we next employ alternative tax data from Alesina et al. (2020). This data includes detailed fiscal consolidation plans and the impact these plans have on the economy. Data is available for 16 countries for the period 1978–2014 and distinguishes between consolidation via taxes and spending. A downside is that detailed information for tax rates and tax bases is not available. Also, the number of included tax types is limited and the sample size is smaller compared to the Fuest et al. (2021) data.

We re-estimate the baseline model of Table (1) using data on consolidation via taxes compiled by Alesina et al. (2020). The results, reported in Table (A-2) in the appendix, are remarkably close to the baseline estimates, even though the sample of countries and years is considerably smaller. We find a strong increase of tax-based consolidation efforts after financial crises ($t = 3.16$) and strong economic recessions ($t = 3.21$). We also find a positive association with the aggregate crisis index ($t = 1.70$).

4.8 Heterogeneity across tax types

A pending question is whether the post-crisis increases in taxes is driven by individual types of taxes. A key advantage of the tax reform indices compiled by Fuest et al. (2021) is that they allow for a fine-grained distinction between six types of taxes. In the next step, we relate national crises to the tax reform indices of individual tax types. The results are shown in Tables A-3 to A-8 in the appendix. We observe substantial heterogeneity in post-crisis tax reforms across tax types, but also observe clear patterns of tax reforms depending on the type of crises. After financial crises, governments particularly increase corporate income taxes and value added taxes. After natural disasters and strong economic crises, we mainly observe an increase in personal income taxes. For corporate and personal income taxes, the results are startling, because there are distinct negative trends in taxation of both corporate and personal incomes observable over the past five to six decades (see Fuest et al., 2021).

The results also suggest that crises do not affect property taxation at all, and they suggest that there is even a *negative* effect of some national crises on the tax bases for excises (but not on tax rates).

Need for fine-grained tax indicators: Taken together, our results reflect a considerable degree of heterogeneity in post-crisis tax reforms of governments. Focusing on single tax types or analyzing tax rates or tax bases only would not be sufficient to uncover differential tax policies after crises.

5 Conclusions

National crises force incumbents to implement fiscal policies that tackle the economic downturns. Deficit spending during recessions, however, often results in higher debt-to-GDP levels once the peak of the crisis is over. Governments that want to bring back public debt to the pre-crisis level face two options: Either cutting spending or increasing taxes. The empirical literature has shown that both variants of consolidation trigger differential effects on GDP growth, with tax increases being more detrimental to growth than spending cuts (see Alesina et al., 2020 for an overview). Hence, the type of fiscal consolidation matters for the post-crisis recovery. Due to a lack of cross-nationally comparable data, however, there has been no study yet investigating in detail how tax policies were changed after crises.

The main message of our paper, one that consistently arises across various model specifications, is that crises are often followed by an increase in taxes. This result has political implications because tax increases in the aftermath of national crises are likely to slow the pace of economic recovery. From a fiscal policy perspective, the tendency of governments to increase taxes in late stages of economic crises also raises the question of whether there is a procyclicality bias in fiscal policy which systematically undermines economic recoveries after crises. Investigating this issue and the reasons for this bias if it exists is an avenue for future research.

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Appendix A: Supplementary Tables

Table A-1 TAX POLICIES AFTER NATIONAL CRISES—ACCOUNTING FOR SELECTION ON OBSERVABLES

Dependent variables: *Aggregate Tax Reform Indicators*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: Aggregate Tax System Indicator				
Post-Crisis	0.0272	0.0846**	0.0981**	-0.0002	0.408***
	(0.0290)	(0.040)	(0.041)	(0.033)	(0.134)
Observations	861	861	861	861	861
Countries	21	21	21	21	21
R-Squared	0.0839	0.0868	0.0933	0.0822	0.0981
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
	Panel B: Aggregate Tax Rate Indicator				
Post-Crisis	0.3040	0.0945	0.1420**	-0.0129	0.5970***
	(0.037)	(0.056)	(0.061)	(0.049)	(0.185)
Observations	861	861	861	861	861
Countries	21	21	21	21	21
R-Squared	0.0939	0.0961	0.106	0.0928	0.113
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
	Panel C: Aggregate Tax Base Indicator				
Post-Crisis	0.024,	0.0747*	0.0539	0.0125	0.218*
	(0.033)	(0.042)	(0.045)	(0.039)	(0.124)
Observations	861	861	861	861	861
Countries	21	21	21	21	21
R-Squared	0.0598	0.0605	0.0602	0.0586	0.0597
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). The table accounts for potential selection on unobservables, including an array of additional control variables (the level of GDP, the distribution of pre-tax incomdes, political institutions, and globalization). Panel A presents results for the overall tax indicator for corporate income taxes, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-2 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR THE TAX CONSOLIDATION DATA IN ALESINA ET AL. (2020)

Dependent variables: *Total tax-based impact of consolidation plans*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
Post-Crisis	0.105 (0.062)	-0.035 (0.106)	0.280*** (0.089)	0.043 (0.070)	0.948*** (0.295)
Observations	481	481	481	481	481
Countries	13	13	13	13	13
R-Squared	0.184	0.175	0.201	0.176	0.190
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Data on the total consolidation impact of tax policies is collected from Alesina et al. (2020). Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (4.7) for a brief description of the dataset compiled by the authors. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-3 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR CORPORATE INCOME TAXES (CIT)

Dependent variables: *Tax Reform Indicators for CIT*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: CIT Tax System Indicator				
Post-Crisis	0.0650 (0.070)	0.198 (0.151)	0.325** (0.129)	-0.047 (0.083)	0.279 (0.536)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0816	0.0824	0.0875	0.0813	0.0814
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: CIT Tax Rate Indicator				
Post-Crisis	0.127 (0.095)	0.188 (0.135)	0.367** (0.134)	0.0235 (0.107)	0.210 (0.438)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0988	0.0981	0.104	0.0971	0.0973
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: CIT Tax Base Indicator				
Post-Crisis	0.0026 (0.118)	0.208 (0.244)	0.283 (0.214)	-0.118 (0.135)	0.210 (0.438)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0574	0.0580	0.0592	0.0579	0.0973
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax system indicator for corporate income taxes, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for corporate income taxes have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-4 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR PERSONAL INCOME TAXES (PIT)

Dependent variables: *Tax Reform Indicators for PIT*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: PIT Tax System Indicator				
Post-Crisis	0.155 (0.128)	0.131 (0.218)	0.231 (0.172)	0.127 (0.130)	0.828* (0.400)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0644	0.0627	0.0644	0.0633	0.0647
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: PIT Tax Rate Indicator				
Post-Crisis	0.114 (0.105)	0.448*** (0.151)	0.191 (0.183)	-0.062 (0.127)	1.179** (0.501)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0845	0.0884	0.0849	0.0835	0.0886
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: CIT Tax Base Indicator				
Post-Crisis	0.197 (0.197)	-0.186 (0.335)	0.270 (0.233)	0.315* (0.160)	1.180** (0.502)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0527	0.0517	0.0525	0.0541	0.0886
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax indicator for personal income taxes, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for personal income taxes have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-5 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR VALUE ADDED TAXES (VAT)

Dependent variables: *Tax Reform Indicators for VAT*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: VAT Tax Indicator				
Post-Crisis	0.0958*	0.100	0.161**	0.072	0.392
	(0.053)	(0.103)	(0.073)	(0.064)	(0.277)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0497	0.0470	0.0509	0.0476	0.0485
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: VAT Tax Rate Indicator				
Post-Crisis	0.071	0.128	0.182	0.0437	0.800
	(0.085)	(0.203)	(0.110)	(0.126)	(0.468)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0468	0.0467	0.0487	0.0461	0.0505
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: VAT Tax Base Indicator				
Post-Crisis	0.121**	0.0729	0.139**	0.101	0.803
	(0.046)	(0.0686)	(0.061)	(0.060)	(0.468)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0439	0.0388	0.0417	0.0413	0.0505
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax indicator for value added and sales taxes, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for value added and sales taxes have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-6 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR EXCISES (EXE)

Dependent variables: *Tax Reform Indicators for EXE*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: EXE Tax Indicator				
Post-Crisis	0.0135 (0.046)	0.043 (0.074)	0.0725 (0.076)	0.0365 (0.049)	0.306 (0.264)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0535	0.0537	0.0553	0.0542	0.0563
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: EXE Tax Rate Indicator				
Post-Crisis	0.0756 (0.079)	0.0569 (0.143)	0.192 (0.141)	0.125 (0.097)	0.711 (0.525)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0571	0.0559	0.0599	0.0586	0.0608
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: EXE Tax Base Indicator				
Post-Crisis	-0.047** (0.026)	0.0284 (0.038)	-0.047 (0.037)	-0.0517* (0.025)	0.711 (0.525)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0448	0.0417	0.0429	0.0443	0.0608
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax indicator for excises, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for excises have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-7 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR PROPERTY TAXES (PRO)

Dependent variables: *Tax Reform Indicators for PRO*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: PRO Tax Indicator				
Post-Crisis	-0.0001 (0.026)	0.063 (0.040)	0.0462 (0.037)	-0.0153 (0.041)	0.453 (0.274)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0439	0.0454	0.0453	0.0442	0.0558
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: PRO Tax Rate Indicator				
Post-Crisis	-0.008 (0.029)	-0.001 (0.045)	0.025 (0.047)	-0.001 (0.034)	0.565 (0.387)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0440	0.0439	0.0443	0.0439	0.0611
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: PRO Tax Base Indicator				
Post-Crisis	0.008 (0.040)	0.127** (0.046)	0.067 (0.046)	-0.0294 (0.062)	0.565 (0.380)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0454	0.0478	0.0466	0.0458	0.0611
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax indicator for property taxes, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for property taxes have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

Table A-8 TAX POLICIES AFTER NATIONAL CRISES—RESULTS FOR SOCIAL SECURITY CONTRIBUTIONS (SSC)

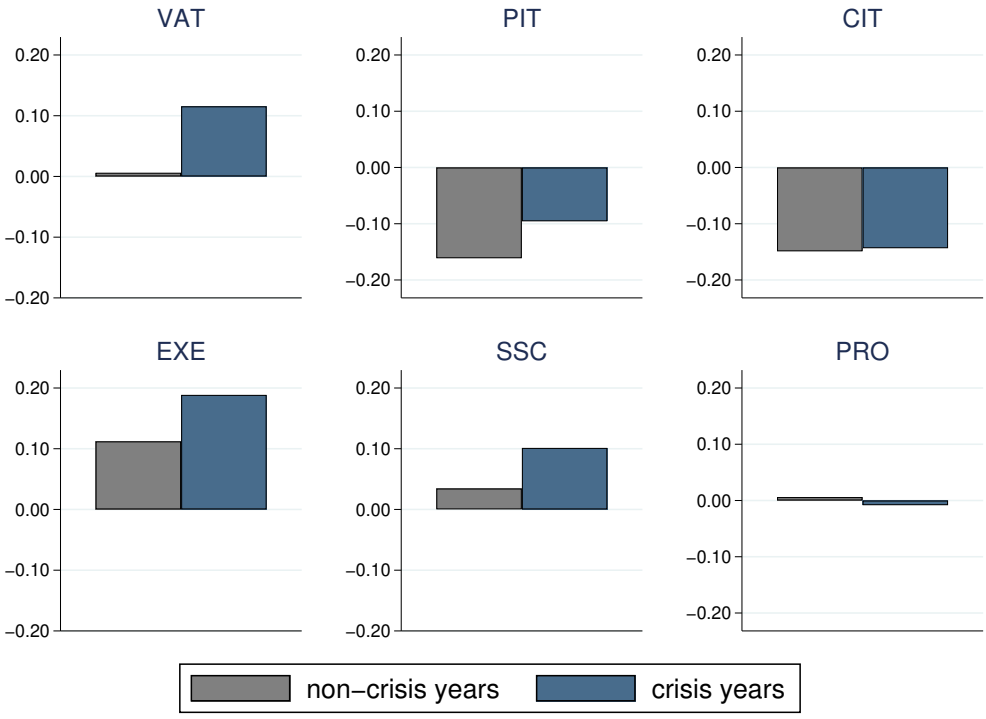
Dependent variables: *Tax Reform Indicators for SSC*					
	(I) All Crises (Dummy)	(II) Natural disasters (Dummy)	(III) Financial crises (Dummy)	(IV) Economic crises (Dummy)	(V) Economic crises (Intensity)
	Panel A: SSC Tax Indicator				
Post-Crisis	0.0764 (0.047)	-0.0145 (0.069)	0.0926 (0.063)	0.0650 (0.047)	0.267 (0.172)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0421	0.0381	0.0408	0.0403	0.0400
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel B: SSC Tax Rate Indicator				
Post-Crisis	0.125** (0.057)	0.0677 (0.078)	0.121 (0.088)	0.0939 (0.069)	0.244 (0.224)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0532	0.0492	0.0507	0.0507	0.0495
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
	Panel C: SSC Tax Base Indicator				
Post-Crisis	0.0274 (0.061)	-0.0967 (0.080)	0.0645 (0.073)	0.0362 (0.054)	0.244 (0.220)
Observations	1,136	1,136	1,136	1,136	1,136
Countries	22	22	22	22	22
R-Squared	0.0452	0.0460	0.0457	0.0453	0.0495
Country-FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The table shows estimates for tax reforms after national crises, estimating the generalized difference-in-difference models of equation (3). Panel A presents results for the overall tax indicator for social security contributions, the subsequent columns show how tax rates (Panel B) and tax bases (Panel C) for social security contributions have responded to national crises. Standard errors robust to arbitrary heteroskedasticity are reported in parentheses. All specifications include fixed effects for countries and years. See Section (2.1) for details on the construction of the aggregate indicators for tax rates and tax bases, which reflect the overall change in a country's tax system. See Section (2.2) for details on the composition of the variables capturing crisis-influenced years for the types of crises.

*** Significant at the 1 percent level,
** Significant at the 5 percent level,
* Significant at the 10 percent level

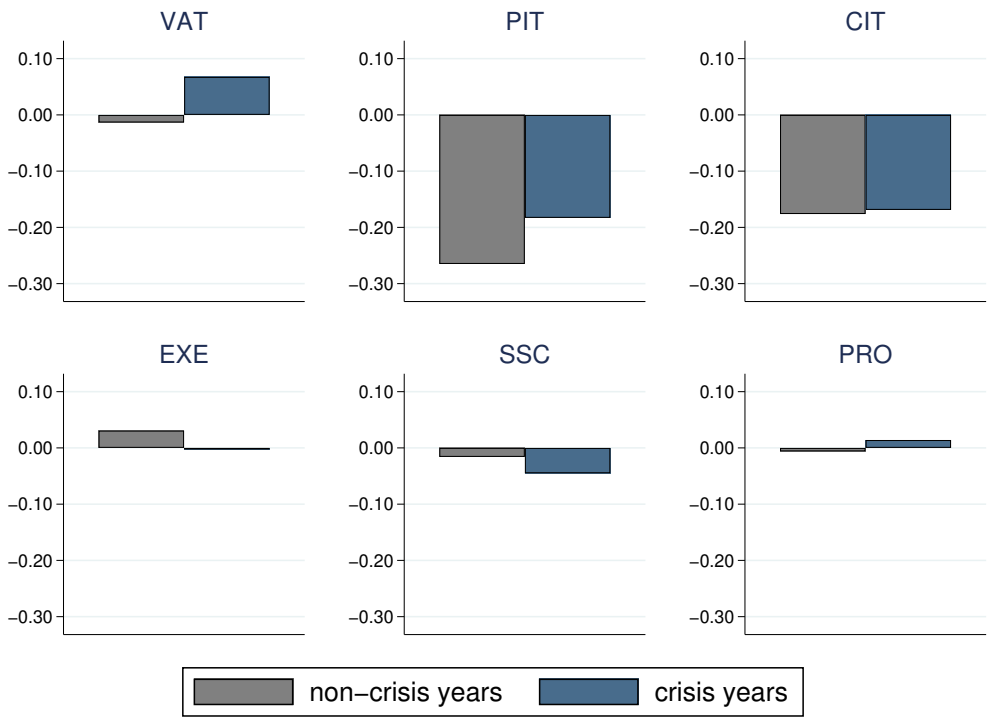
Appendix B: Supplementary Figures

Figure B-1 AVERAGE TAX RATE CHANGES BY TAX TYPES, 1962–2014



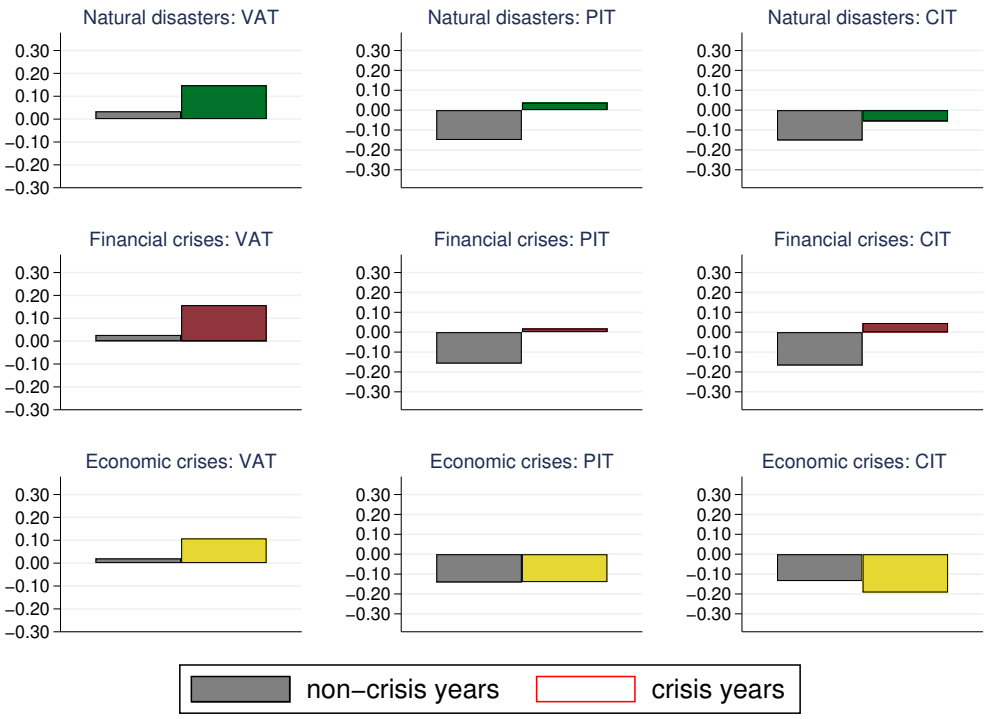
Notes: The figure shows the average change in our tax rate sub-indices for individual tax types, distinguishing between crisis years and non-crisis years and including all countries in our sample. "Crisis years" include t and $t+1$ when a crisis occurs in t. The sub-indices include for individual tax types range from -2 to +2 (see Section 2.1 for a detailed description of the indicators) and include: Value-added taxes (VAT), personal income taxes (PIT), corporate income taxes (CIT), social security contributions (SSC), excises (EXE), and property taxes (PRO).

Figure B-2 AVERAGE TAX BASE CHANGES BY TAX TYPES, 1962–2014



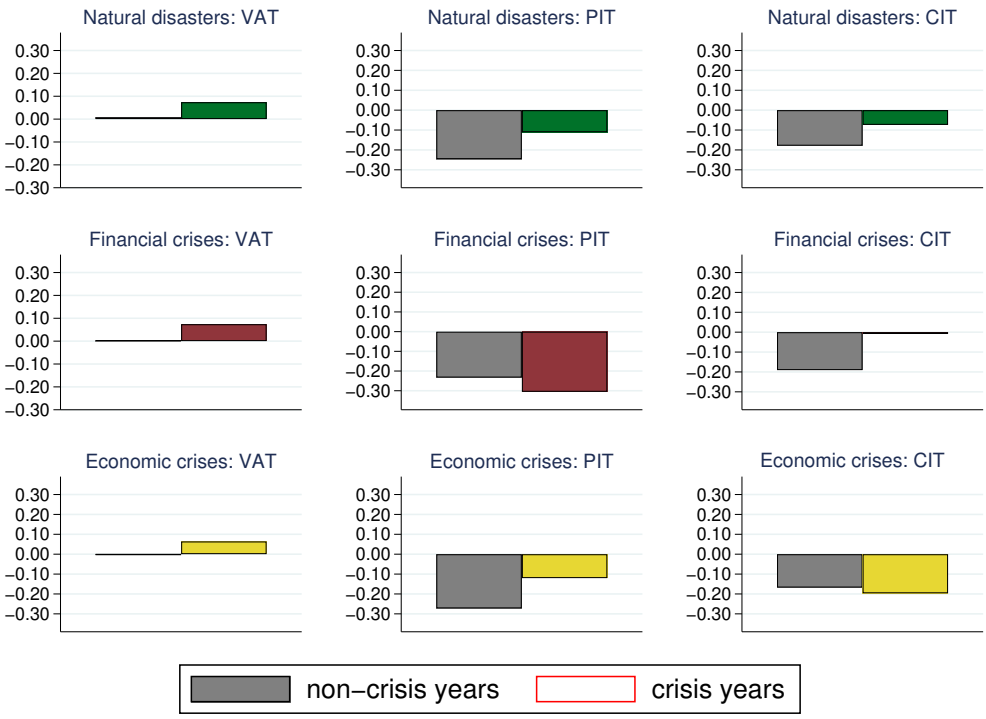
Notes: The figure shows the average change in our tax base sub-indices for individual tax types, distinguishing between crisis years and non-crisis years and including all countries in our sample. "Crisis years" include t and $t+1$ when a crisis occurs in t. The sub-indices include for individual tax types range from -2 to +2 (see Section 2.1 for a detailed description of the indicators) and include: Value-added taxes (VAT), personal income taxes (PIT), corporate income taxes (CIT), social security contributions (SSC), excises (EXE), and property taxes (PRO).

Figure B-3 AVERAGE CHANGES OF VAT, PIT, AND CIT RATES BY TYPES OF CRISES, 1962–2014



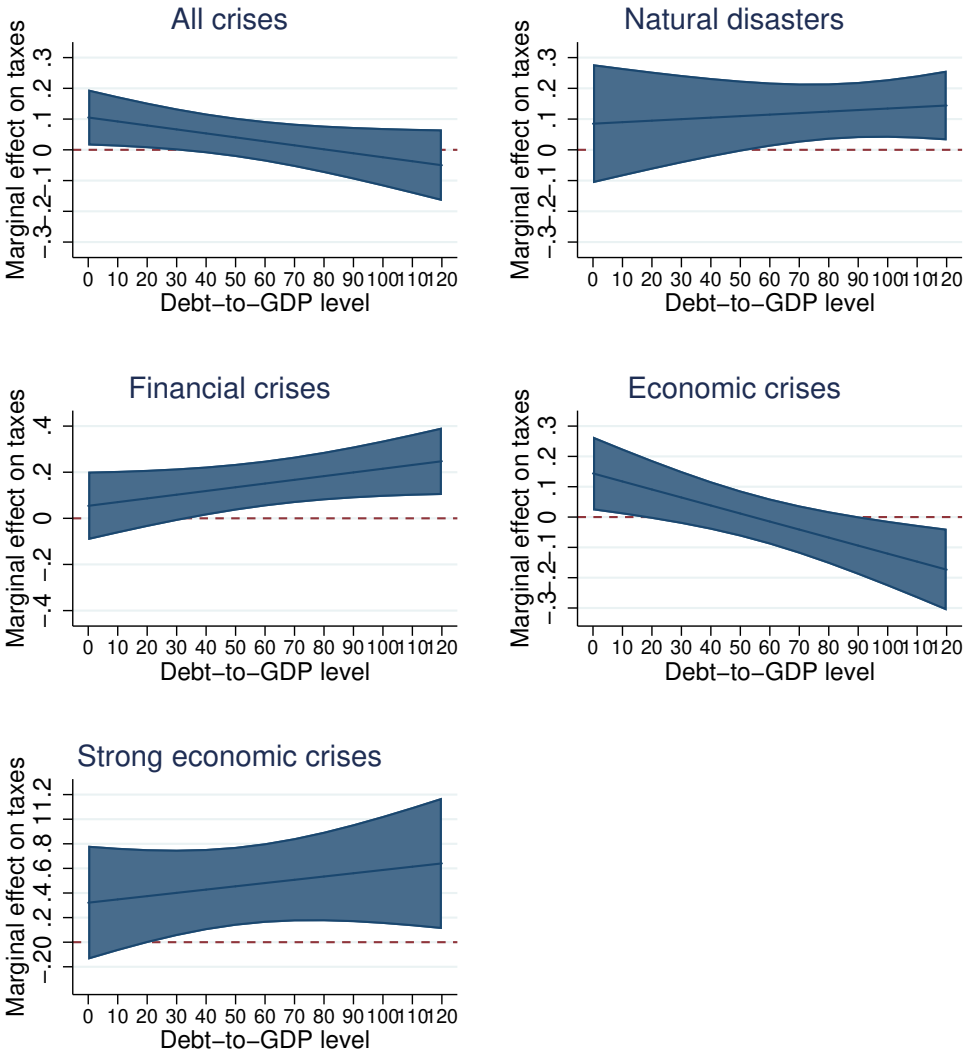
Notes: The figure shows the average change in our tax rate sub-indices for Value-added taxes (VAT), personal income taxes (PIT), and corporate income taxes (CIT), distinguishing between crisis years and non-crisis years by types of crises. The figure includes all countries in our sample. "Crisis years" include t and $t+1$ when a crisis occurs in t. The sub-indices include for individual tax types range from -2 to +2 (see Section 2.1 for a detailed description of the indicators).

Figure B-4 AVERAGE CHANGES OF VAT, PIT, AND CIT BASES BY TYPES OF CRISES, 1962–2014



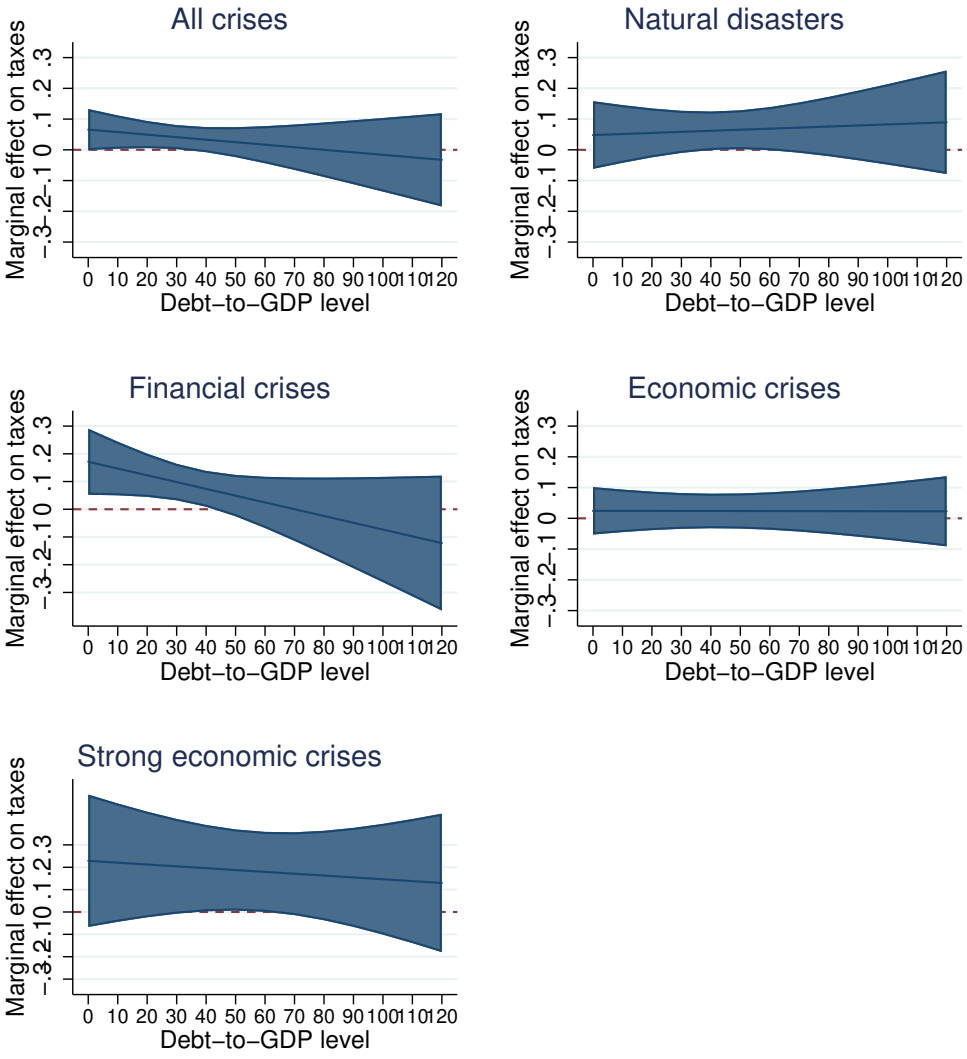
Notes: The figure shows the average change in our tax base sub-indices for Value-added taxes (VAT), personal income taxes (PIT), and corporate income taxes (CIT), distinguishing between crisis years and non-crisis years by types of crises. The figure includes all countries in our sample. "Crisis years" include t and $t+1$ when a crisis occurs in t. The sub-indices include for individual tax types range from -2 to +2 (see Section 2.1 for a detailed description of the indicators).

Figure B-5 EFFECTS OF NATIONAL CRISES ON TAX REFORMS CONDITIONAL ON PRE-CRISIS DEBT-TO-GDP LEVELS, TAX RATE INDICATOR



Notes: The figure shows the marginal effect of national crises on tax reforms relative to the pre-crisis level of debt-to-GDP, empirically estimating equation (4). The figure uses the aggregate tax reform index for tax rates to measure post-crisis tax reforms. Data on debt levels relative to GDP is collected from the International Monetary Funds (IMF). The dashed red line represents a marginal effect of 0, the blue areas reflect 90% confidence intervals.

Figure B-6 EFFECTS OF NATIONAL CRISES ON TAX REFORMS CONDITIONAL ON PRE-CRISIS DEBT-TO-GDP LEVELS, TAX BASE INDICATOR



Notes: The figure shows the marginal effect of national crises on tax reforms relative to the pre-crisis level of debt-to-GDP, empirically estimating equation (4). The figure uses the aggregate tax reform index for tax bases to measure post-crisis tax reforms. Data on debt levels relative to GDP is collected from the International Monetary Funds (IMF). The dashed red line represents a marginal effect of 0, the blue areas reflect 90% confidence intervals.