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Can Covid-19 Induce Governments to Implement Tax Reforms in Developing Countries?*

Sanjeev Gupta[$] João Tovar Jalles[#]

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Abstract

We estimate that the short to medium-term fiscal impact of previous pandemics has been significant in 170 countries (including low-income countries) during the 2000-2018 period. The impact has varied, with pandemics affecting government expenditures more than revenues in advanced economies, while the converse applies to developing countries. Using a subset of 45 developing countries for which tax reform data are available, we find that past pandemics have propelled countries to implement tax reforms, particularly in corporate income taxes, excises and property taxation. Pandemics do not drive revenue administration reforms.

JEL: C33, C36, D63, E32, E62, H20
Keywords: fiscal policy; pandemics; local projection; impulse response functions; tax reforms; binary choice models

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1. Introduction

The Covid-19 pandemic has cost lives and disrupted economic activity worldwide. To prevent the spread of the virus, governments have imposed lockdowns with varying degrees of stringency. The general population has also sought to reduce exposure to the virus through voluntary social distancing. The result has been a dramatic contraction in economic activity in 2020 with global GDP estimated to have declined by 3.5 percent (IMF, 2021). The projected rebound in 2021 is not expected to restore the pre-crisis GDP in 2019 in advanced, emerging and developing economies until 2022. The global reduction in work hours in the second quarter of 2020 compared with the fourth quarter of 2019 was equivalent to 400 million full-time jobs; already 155 million full-time jobs were lost in the first quarter (ILO, 2020).

In an environment where most countries still face near zero interest rates (so monetary policy lacks effectiveness), fiscal policy has a crucial role in mitigating the pandemic´s overall economic impact and promoting a quick recovery. It can help save lives and shield the most-affected segments of the population. To counter income losses arising from the pandemic, countries have taken steps to help households and firms by implementing discretionary revenue and spending measures. In addition, they have provided liquidity support to the economy in the form of equity injections, asset purchases, loans, and credit guarantees. Together with lower projected output growth, these measures would reduce revenues in relation to GDP in 2020 and possibly beyond with important implications for public spending at a time when the overall spending has been scaled up. These developments are likely to result in larger budget deficits and rising debt-to-GDP ratios in the foreseeable future. Understanding empirically how public finances are affected is therefore important for policy makers notably once the unwinding of economic support measures begin and the "new-normal" is attained.

In this paper, we systematically study the short to medium-term fiscal impact of past pandemics in 170 countries, including low-income countries. We show that the fiscal impact is substantial in all countries. As low-income countries have limited fiscal space to accommodate the shock, we examine whether pandemic has created conditions for them to implement much-needed tax reforms to raise revenues over the longer term.[1] For this purpose, we rely on tax reform data from 45 emerging and low-income countries during 2000-2015.

This paper relates to two main strands of literature.

The first is the literature on the economic effects of pandemics. Studies of the macroeconomic impact of past pandemics and of other major diseases (such as SARS and HIV/AIDs) have typically quantified the resulting short-term loss in output and growth.[2,3] However, there is little consensus on economic consequences of pandemics. Results critically depend on the models used and on the availability of data (Bell and Lewis, 2004). A study by Brainerd and Siegler (2003), one of the few on the economic effects of the Spanish flu, suggested that the 1918/19 pandemic in the US actually increased growth in the 1920s. In contrast, Almond and Mazumber (2005) argued that the Spanish flu had long-term negative effects through its impact on fetal health. Using a theoretical model, Young (2004) argued that the AIDS epidemic in South Africa would increase net future per capita consumption, while Bell and Gersbach (2004) found strong negative effects. Jonung and Roeger (2006) estimated the macroeconomic effects of a pandemic using a quarterly macro-model constructed and calibrated for the EU-25 as a single economic entity. The recent literature on this topic, motivated by the Covid-19 pandemic, provides evidence of large and persistent effects on economic activity (see e.g. Atkeson, 2020; Barro et al., 2020; Eichenbaum et al., 2020). In fact, Ma et al. (2020) in an empirical analysis of the economic effects of past pandemics, found that real GDP is 2.6 percent lower on average across 210 countries in the year the outbreak is officially declared and remains 3 percent below pre-shock level five years later. Moreover, according to Jorda et al. (2020), significant macroeconomic after-effects of pandemics persist for decades, with real rates of return substantially depressed. Pandemics induce relative labor scarcity in some areas and/or a shift to greater precautionary savings.

[1] Note however that to support aggregate demand following crises, typically countries in the short-run cut taxes despite being mindful of the need for long term reforms. At the same time, countries also take measures to offset some of the adverse effects of pandemics on revenues and budget deficits.

[2] Even then, direct measures based on data from past episodes are not generally available (e.g. in the US, see Meltzer, Cox and Fukuda, 1999). An alternative would be to look at microeconomic outcomes for a given population in response to episodes for which high-quality administrative data are available (e.g. in Sweden Karlsson, Nilsson and Pichler, 2014). Absent such data, economic historians have to use more aggregated data at the regional or national level to study the relationship between pandemic incidence and economic outcomes (e.g., the 1918 flu epidemic across the US states, see Brainerd and Siegler, 2003).

[3] For a historic view of pandemics, see Kenny (2021).

The second strand of the literature is on the role of crises and recessions in affecting fiscal variables (European Commission (2009a). Financial crises have induced governments around the globe to take decisive action in terms of sustaining economic activity and preventing the meltdown of the financial sector. These actions had direct and indirect fiscal costs. Direct fiscal costs from actions from financial system rescue packages (such as capital injections, purchases of toxic assets, subsidies, payments of called upon guarantees) resulted in permanent decreases in government´s net worth (Such interventions result in higher public debt, which either show up as an increase in stock flow debt-deficit adjustments or as higher deficits (Attinasi et al., 2010; European Commission, 2009b). There also are indirect fiscal costs, i.e., due to the feedback loop from the crisis to economic activity. These involve lower revenues due to falling profits and asset prices, higher expenditure to counter the impact of the crisis, as well as interest rate and exchange rate effects due to market reactions (European Commission, 2009b). European Commission (2009b) building on fiscal reaction functions in the spirit of Gali and Perotti (2003) found that the bulk of the effect of crises on debt changes takes place during the first 2 years. Moreover, the impact of financial crises on debt was larger in emerging market economies than for the EU or other OECD countries. Building on a banking crises dataset by Laeven and Valencia (2008), several empirical studies have investigated the effect of crises on the debt-to-GDP ratio and GDP growth (Furceri and Zdzienicka, 2010, 2012; Reinhart and Rogoff, 2008, 2009, 2011). Furceri and Zdzienicka (2010) using a panel of 154 countries from 1980-2006 showed that banking crises are associated with a significant and long-lasting increase in government debt and that such increase is a positive function of higher initial indebtedness levels – so initial conditions matter. Employing different modelling techniques, Tagkalakis (2013) found significant econometric evidence that fiscal positions deteriorated during financial crises in 20 OECD countries over the 1990-2010 period. Several other studies investigated the direct fiscal implications of past banking system support schemes (Honoghan and Klingebiel, 2003), the determinants of fiscal recovery rates (European Commission, 2009b), as well as whether costly fiscal interventions reduced output loss (Claessens et al., 2005; Detragiache and Ho, 2010).[4]

[4] Claessens et al. (2005) explored the relationship between intervention policies and the economic and fiscal costs of crises. Costs were measured by the output loss relative to trend during the crisis episode. Detragiache and Ho (2010) found that crisis response strategies that commit more fiscal resources did not lower the economic costs of crises, and in some cases, they led to worse post crisis performance.

While the macroeconomic effects of pandemics have been studied, a deeper and more disaggregated assessment of their fiscal consequences is lacking. Past studies have focused on the fiscal costs of financial sector rescue packages. This paper looks in more detail on what happens to revenues and spending and not just the cost of rescue packages. Using a dataset put together by Ma et al. (2020), we first estimate the short to medium-term response of fiscal variables to major pandemic shocks.[5] As Ma et al. (2020) conclude, the impact of pandemic events on economic activity is likely to vary across episodes and countries´ initial conditions.

This paper finds that the short to medium-term fiscal impact of pandemics is significant in our sample of 170 countries (including low-income countries) during the 2000-2018 period. The impact varies, with pandemics affecting government expenditures more than revenues in advanced economies, while converse applies to developing countries, reflecting the size of automatic stabilizers in advanced economies. A deeper analysis of a subset of 45 developing countries for which tax reform data are available shows that past pandemics have propelled countries to implement tax reforms, particularly in corporate income taxes, excises and property taxation. Pandemics do not drive reforms in revenue administration.

The remainder of the paper is structured as follows. Section 2 presents the empirical strategy followed to study the dynamic response of fiscal variables to past pandemic shocks and lays out the strategy to examine whether these fueled tax reforms. Section 3 presents the data and key stylized facts. Section 4 discusses our empirical results while sensitivity and robustness checks are available in an online annex. Section 5 concludes and elaborates on the policy implications.

2. Econometric Methodology

a. Dynamic impact of Pandemics on Fiscal Outcomes

In order to estimate the response of fiscal variables to major pandemic shocks, we follow the local projection method proposed by Jordà (2005) to estimate impulse-response functions. This

[5] Historically, there were three influenza pandemics in the last century occurring in 1980 (A/H1N1), 1957 (A/H2N2) and 1968/69 (A/H3N2) (HPA, 2006). The most serious of these pandemics was A/H1N1 known as “Spanish flu”, which occurred in 1918/19 causing serious illness and a high number of deaths (20-40 million worldwide). The other two pandemics were less severe and had less impact on those in prime age with mortality occurring mainly amongst the elderly. Because these pandemics occurred at a time when data quality and coverage was poor, this paper focuses on the last 30 years to maximize country coverage.

approach has been advocated by Auerbach and Gorodnichenko (2013) and Romer and Romer (2019) as a flexible alternative, better suited to estimating a dynamic response—such as, in our context, interactions between pandemic shocks and macroeconomic and fiscal conditions. The baseline specification is:

$$y_{t+k,i} - y_{t-1,i} = \alpha_i + \tau_i + \beta_k pand_{i,t} + \theta X_{i,t} + \varepsilon_{i,t} \quad (1)$$

in which y is the dependent fiscal variable of interest; β_k denotes the (cumulative) response of the variable of interest in each k year after the pandemic shock; α_i, τ_i are country and time fixed effects respectively, included to take account for cross-country heterogeneity and global shocks; $pand_{i,t}$ denotes the pandemic shock from Ma et al. (2020).[6] $X_{i,t}$ is a set a of control variables including two lags of pandemic shocks, two lags of real GDP growth and two lags of the relevant fiscal dependent variable.

Equation (1) is estimated using OLS.[7] [8] Pandemic shocks are treated as exogenous events as they cannot be anticipated nor correlated with past changes in economic activity. In large scale epidemics, effects will be felt across whole economies, or across wider regions, for two reasons: either because the infection itself is widespread or because trade and market integration eventually propagate the economic shock across borders.

b. Do pandemic events trigger structural tax reforms?

A structural tax reform (*STR*) for country *i* at time *t* takes the value one as identified in the narrative database—the next section provides details on data. All other non-reform years take the value zero.[9] Based on this binary characterization, our main exercise consists of estimating logistic

[6] All pandemic shocks featured in our analysis are country-wide shocks.
[7] Another advantage of the local projection method compared to vector autoregression (autoregressive distributed lag) specifications is that the computation of confidence bands does not require Monte Carlo simulations or asymptotic approximations. One limitation, however, is that confidence bands at longer horizons tend to be wider than those estimated in vector autoregression specifications.
[8] Impulse response functions (IRFs) are then obtained by plotting the estimated β_k for k= 0,1,..5 with 90 (68) percent confidence bands computed using the standard deviations associated with the estimated coefficients β_k—based on robust standard errors clustered at the country level.
[9] The database also includes what we call "tax reversals", that is, reforms that reduce revenue collection. Note that the database considers large tax revenue changes in the aggregate but also identifies tax reforms by sub-category. Some

regressions to assess the likelihood of a tax reform by testing specifically the pandemic channel, while controlling for other variables identified in the literature affecting the implementation of reforms.[10] In particular, we estimate the following reduced-form model:[11]

$$\text{Prob}(\text{STR} = 1|X) = \Phi(\lambda_i + pand'\boldsymbol{\alpha} + X'\boldsymbol{\beta}) \qquad (2)$$

where $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$ are vectors of the parameters to be estimated, $pand$ is the pandemic shock, X is a vector of exogenous control variables, and $\Phi(\cdot)$is the logistic function.[12] λ_i denote country fixed effects to capture unobserved heterogeneity and different initial conditions or underlying structural characteristics. Our list of control variables includes: real GDP growth, inflation rate, trade openness and the unemployment rate. Such structural forces have also been put forward as influencing the reform momentum. For instance, small open economies may be more amenable to reform due to greater exposure to competitive pressures and international policy diffusion (see e.g. Belloc and Nicita, 2011). The structural model associated with (2) can be written as:

$$\text{STR} = \lambda_i + \boldsymbol{\alpha} pand_{it} + \boldsymbol{\beta} X_{it} + \varepsilon_{it} \qquad (3)$$

The STR variable can take the value one if there is a reform in any area of taxation, including revenue administration.[13]

$STR_{\text{it}} = 1$ if $STR^{*}_{\text{it}} > 0,$ and 0 otherwise.

with i = 1, …, N; t = 1, …, T; λ_i captures the unobserved individual effects; and ε_{it} is an error term.

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of the reforms using tax specific instruments may be revenue decreasing. These are identified in Akitoby et al. (2020) Appendix table 4. Overall, their database identifies 163 reforms associated with positive revenue changes against 36 reforms associated with negative revenue changes, that is, the latter corresponds to 18 percent of the total 199 major tax reforms. Given the low proportion of "tax reversals" in the total universe of observations, we decided to drop them.

[10] This is akin to the methodology proposed by Aoyagi and Ganelli (2015), who considered – looking at another issue, namely inclusive growth - the direct impact of a fixed block of structural determinants, coupled with a set of controls.

[11] For details on this binary choice model see, for example, Greene (2012, Ch. 17).

[12] We should note that, as probit models do not render themselves well to the fixed-effects treatment due to the incidental parameter problem (Wooldridge, 2002, Ch. 15, p. 484), we estimate a logit model with fixed-effects.

[13] Eight categories are considered and detailed in the next section, namely reforms in the area of: personal income tax, corporate income tax, general goods and service tax, value added tax, excises, trade taxes, property taxes and revenue administration.

3. Data

Our empirical analysis consists – as explained above –of two related but separate steps. The first makes use of a heterogeneous unbalanced sample of 170 countries from 2000-2018. The key regressor in the study of fiscal consequences of pandemics is taken from the dataset on pandemics/epidemics put together by Ma et al. (2020); this dataset starts in 2000 and covers SARS in 2003; H1N1 in 2009; MERS in 2012; Ebola in 2014; and Zika in 2016. Among the five events, the most widespread one is H1N1 (Swine Flu Influenza). We constructed a dummy variable, the pandemic event or shock, which takes the value 1 when the World Health Organization declares a pandemic for the country and zero otherwise. The list of countries that are affected by each event is given in Table 1 below.

Table 1. List of Pandemic and Epidemic Episodes

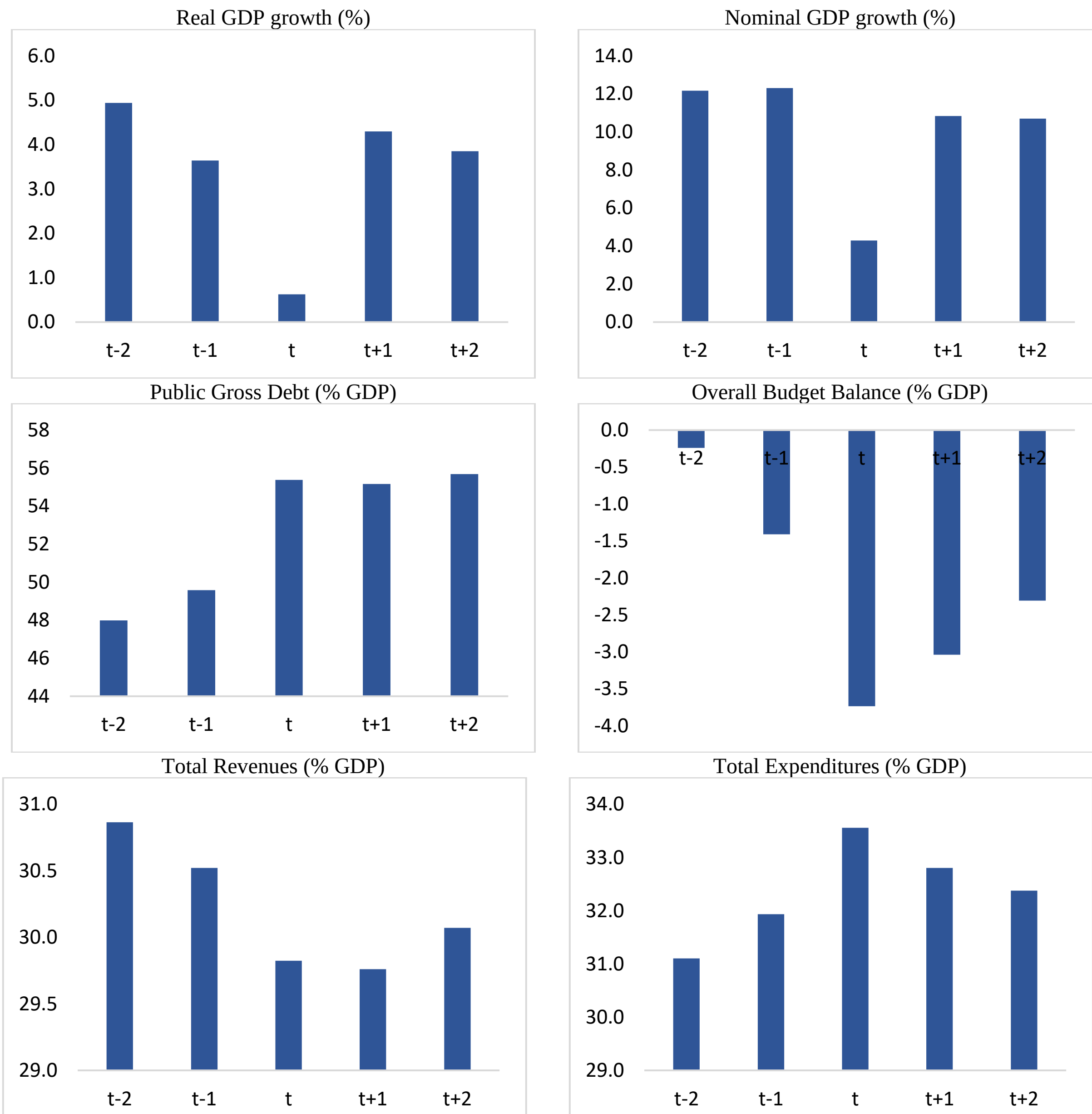
Starting year	**Event Name**	**Affected Countries**	**Number of countries**
2003	SARS	AUS, CAN, CHE, CHN, DEU, ESP, FRA, GBR, HKG, IDN, IND, IRL, ITA, KOR, MNG, MYS, NZL, PHL, ROU, RUS, SGP, SWE, THA, TWN, USA, VNM, ZAF	27
2009	N1H1	AFG, AGO, ALB, ARG, ARM, AUS, AUT, BDI, BEL, BGD, BGR, BHS, BIH, BLR, BLZ, BOL, BRA, BRB, BTN, BWA, CAN, CHE, CHL, CHN,CIV, CMR, COD, COG, COL, CPV, CRI, CYP, CZE, DEU, DJI, DMA, DNK, DOM, DZA, ECU, EGY, ESP, EST, ETH, FIN, FJI, FRA, FSM, GAB, GBR, GEO, GHA, GRC, GTM, HND, HRV, HTI, HUN, IDN, IND, IRL, IRN, IRQ, ISL, ISR, ITA, JAM, JOR, JPN, KAZ, KEN, KHM, KNA, KOR, LAO, LBN, LCA, LKA, LSO, LTU, LUX, LVA, MAR, MDA,MDG, MDV, MEX, MKD, MLI, MLT, MNE, MNG, MOZ, MUS, MWI, MYS, NAM, NGA, NIC, NLD, NOR, NPL, NZL, PAK,PAN, PER, PHL, PLW, PNG, POL, PRI, PRT, PRY, QAT, ROU, RUS, RWA, SAU, SDN, SGP, SLB, SLV, STP, SVK, SVN, SWE, SWZ, SYC, TCD, THA, TJK, TON, TUN, TUR, TUV, TZA, UGA, UKR, URY, USA, VEN, VNM, VUT, WSM, YEM, ZAF, ZMB, ZWE	148
2012	MERS	AUT, CHN, DEU, EGY, FRA, GBR, GRC, IRN, ITA, JOR, KOR, LBN, MYS, NLD, PHL, QAT, SAU, THA, TUN, TUR, USA, YEM	22
2014	Ebola	ESP, GBR, ITA, LBR, USA	5
2016	Zika	ARG, BOL, BRA, CAN, CHL, COL, CRI, DOM, ECU, HND, LCA, PAN, PER, PRI, PRY, SLV, URY, USA	18
		Total Pandemic and Epidemic Events	220

Source: based on Ma et al. (2020)

Other macroeconomic and fiscal variables come from the IMF´s World Economic Outlook (WEO) database. Specifically, in addition to real GDP, the following fiscal variables are analyzed as main dependent variables: public gross debt, total government revenues, total government expenditures, overall budget balance, public consumption expenditure, public investment expenditure, social spending, direct taxes, indirect taxes and non-tax revenue (all expressed in percent of GDP).

Figure 2 plots the evolution of key macro and fiscal aggregates before, during and after the pandemic shock. This unconditional association shows that economic growth goes down while debt goes up and the overall balance deteriorates as a result of both a fall in revenues and an increase in expenditure. These movements are somewhat persistent over time.

Figure 2. Evolution of fiscal variables around Pandemics



Note: x-axis in years; t=0 is the year of the pandemic shock.

In the second empirical exercise, due to data availability, we focus on the sample of a smaller group of 45 developing countries. We use a new "narrative" database of major tax reforms implemented in 45 developing economies (23 emerging and 22 low-income) during the 2000-2015 period (Akitoby et al., 2020). An important novelty and strength of this database is the precise timing and nature of key legislative tax actions that took place over the 15-year period under scrutiny. Figure 3 provides the number of years of tax reforms identified in the sample and illustrates the heterogeneity of reforms efforts by type. Excise reforms have been more frequently implemented. In general, fewer major reforms have been implemented in the areas of property taxes. Reforms in tax administration have been more the rule than the exception, acompanying a specific tax policy measure. Out of 119 years of tax reforms, only 17 correspondend to tax policy measures not acompanied by improvements in revenue administration.

Figure 3. Number of country-years with tax revenue reforms by type

(45 developing economies, 2000-2015)

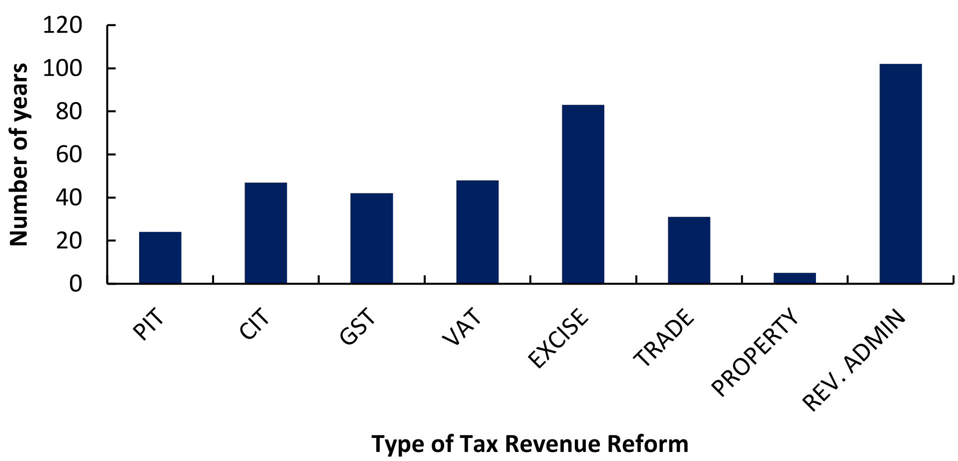
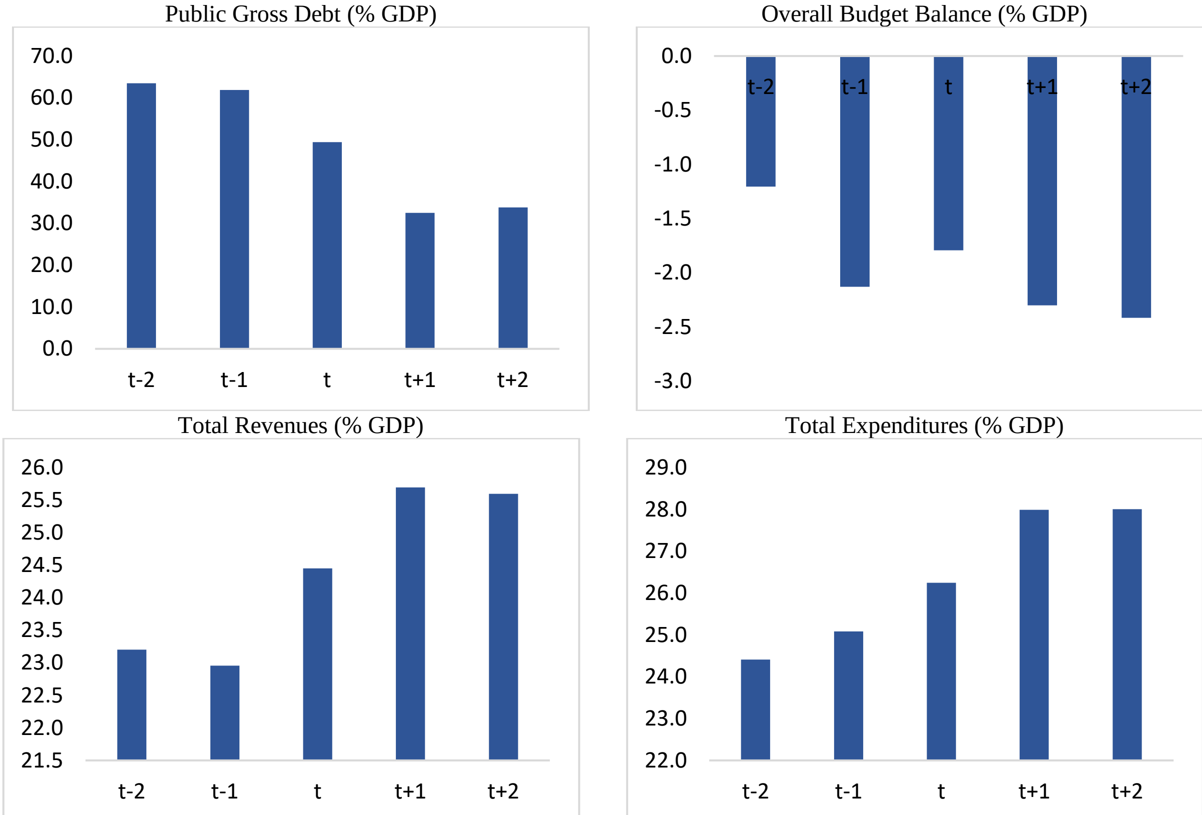


Figure 4 plots the evolution of key fiscal aggregates before, during and after the tax reform event. This unconditional association shows that government's overall balance improves in the year of the reform as a result of an increase in revenues suggesting that these reforms were effective revenue-enhancing structural changes.

Figure 4. Evolution of fiscal variables around tax reforms



Note: x-axis in years; t=0 is the year of the tax reform event.

Control variables used in equation 3 enter with a one-year lag to minimize reverse causation issues. The inclusion of real GDP growth, inflation rate, trade openness and the unemployment rate as explanatory variables is motivated by a model selection analysis conducted by Duval et al. (2020) exploring key correlates driving reforms (cf. footnote1). They also relate to the fiscal policy literature (for recent review studies see Bergh and Henrekson, 2011 and Halkos and Paizanos, 2015). The appendix presents a table with summary statistics of the explanatory variables used in the regressions.

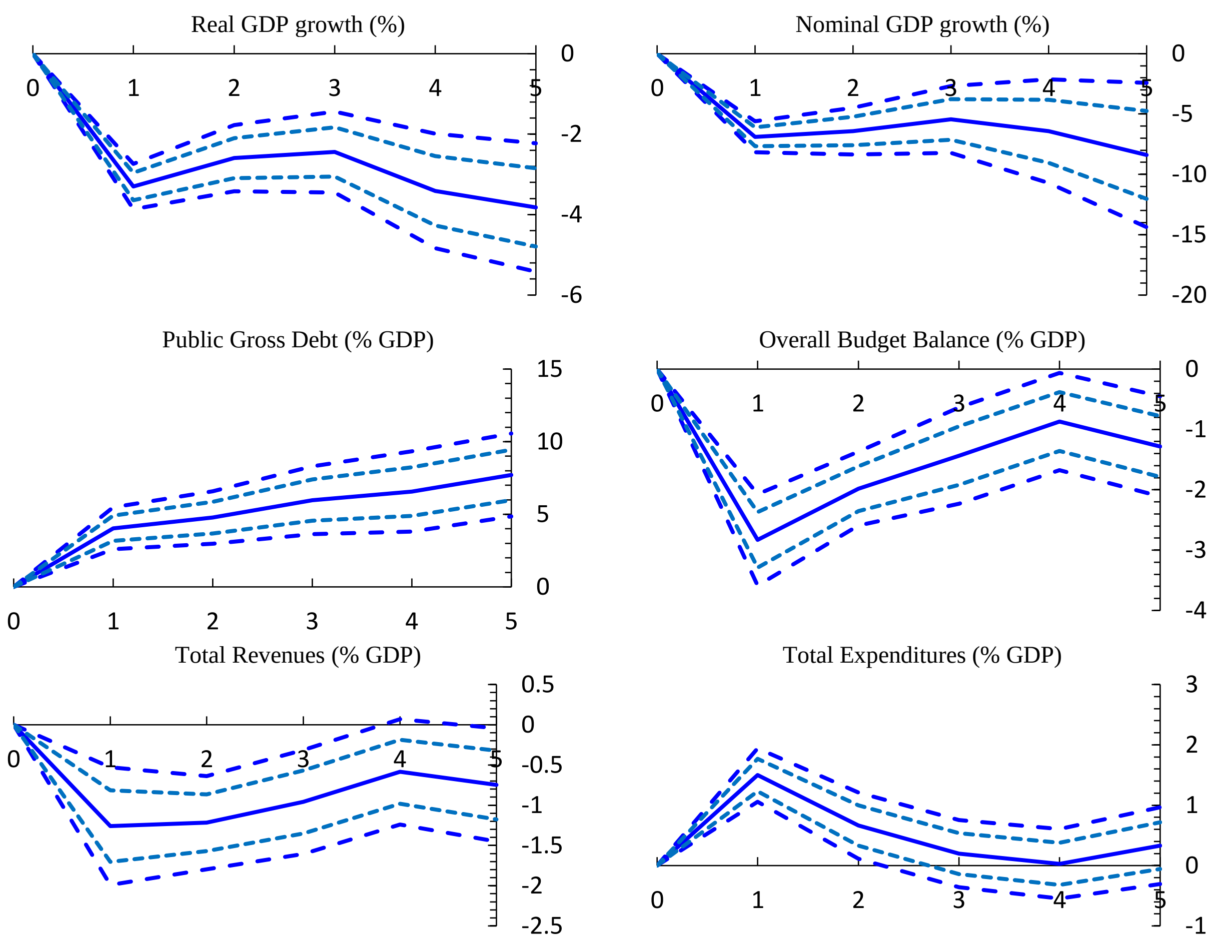
4. Empirical Results

A. Fiscal Consequences of Pandemics

Figure 5 shows the results of estimating equation (1) for alternative fiscal dependent variables. Both the 90 and 68 percent confidence bands are shown together with the fiscal response.

Public debt rises close to 4 percentage points of GDP in the first year after the pandemic event and reaching a cumulative of close to 8 percentage points of GDP after 5 years, meaning that the pandemic impact is non-negligible and long-lasting. At the same time, the budget balance deteriorates immediately reaching a deficit of 2.4 percent of GDP but improves subsequently until it stabilizes at a level worse than before the pandemic at about -1.3 percent of GDP. This deterioration in the fiscal position reflects a combined effect of fall in revenues and an increase in expenditure of about 1 percent of GDP. The effect on expenditure dissipates from the third year onwards, while for revenues it takes about five years for the negative impact to become statistically not different from zero.

Figure 5. Impact of Pandemics on Macro and Fiscal Variables, all countries (% GDP)



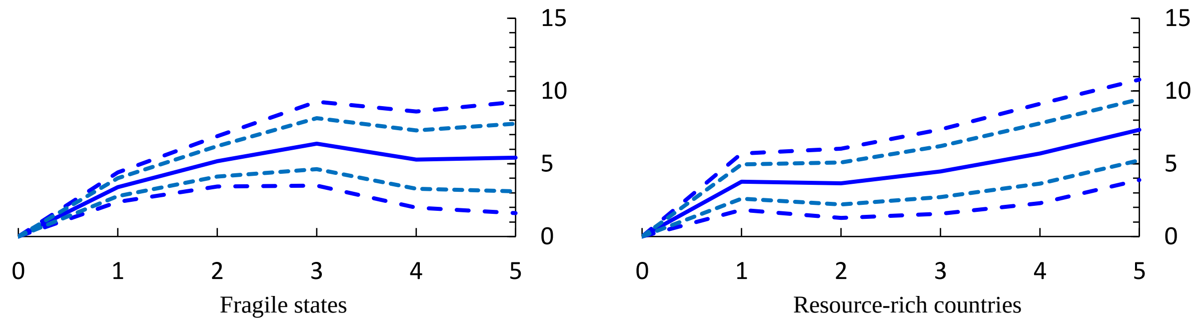
Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. The graph shows the response and both the 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

Splitting the sample of 170 countries between advanced and developing economies and performing sensitivity with respect to country characteristics (such as being a fragile state or a resource-rich economy) yields results shown in Figures 6a-d.[14] Analyses of two key groups of low-income countries, resource-rich and fragile states (countries defined by the World Bank as having less good policy performance or institutions) is important because:

- in fragile states crises typically create a revenue shortfall for only some countries, because others already have very low revenue levels to start with. Moreover, in many countries fiscal deterioration results from ensuing spending increases.
- resource-rich countries typically suffer a massive fiscal deterioration because of the fall in global oil and commodity prices, but also due to spending increases.[15]

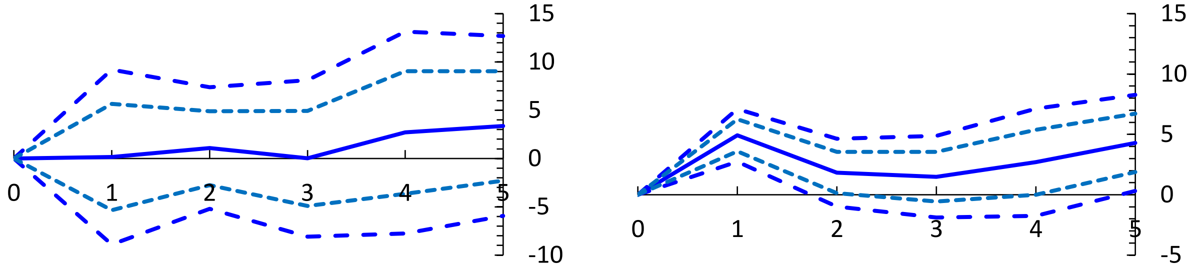
We observe that pandemics´ effect on debt ratios is relatively small in the sub-sample of fragile states and begins to rise after tapering off in the initial years in resource-rich countries. That said, the negative toll pandemics have on the budget is long-lasting in the case of developing countries, explained largely by a significant fall in revenues. This contrasts with advanced economies where revenues are not affected as much but expenditures increase owing to the natural operation of automatic stabilizers which are larger in this group of countries.

Figure 6.a Impact of Pandemics on Public Gross Debt by Group of countries (% GDP)



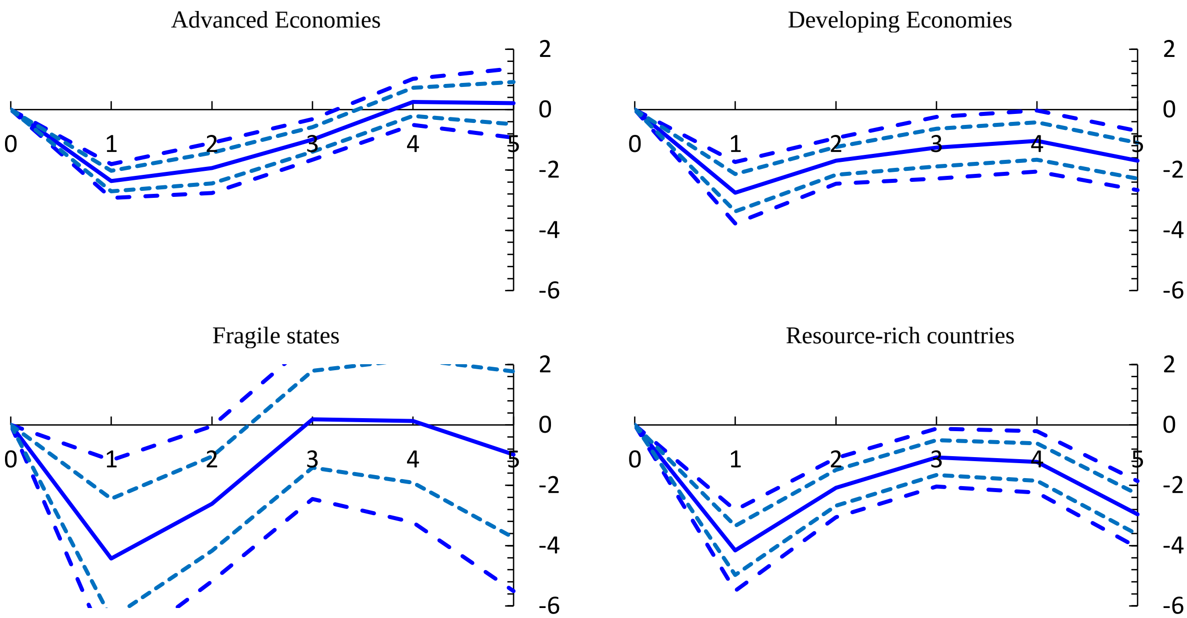
[14] We separately estimated the impact of pandemics on sub-Saharan Africa. Results reported in Appendix Figure A1 show that pandemics worsen the overall fiscal balance more than for the entire sample mainly because of a much larger decline in region's revenues.

[15] For evidence on the impact of the last global financial crisis on the budgets of low-income countries, see Kyrili and Martin (2010).



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. The graph shows the response and both the 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

Figure 6.b Impact of Pandemics on Overall Budget Balance by Group of countries (% GDP)



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2017. The graph shows the response and both the 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

Figure 6.c Impact of Pandemics on Total Revenues by Group of countries (% GDP)

Advanced Economies

Developing Economies

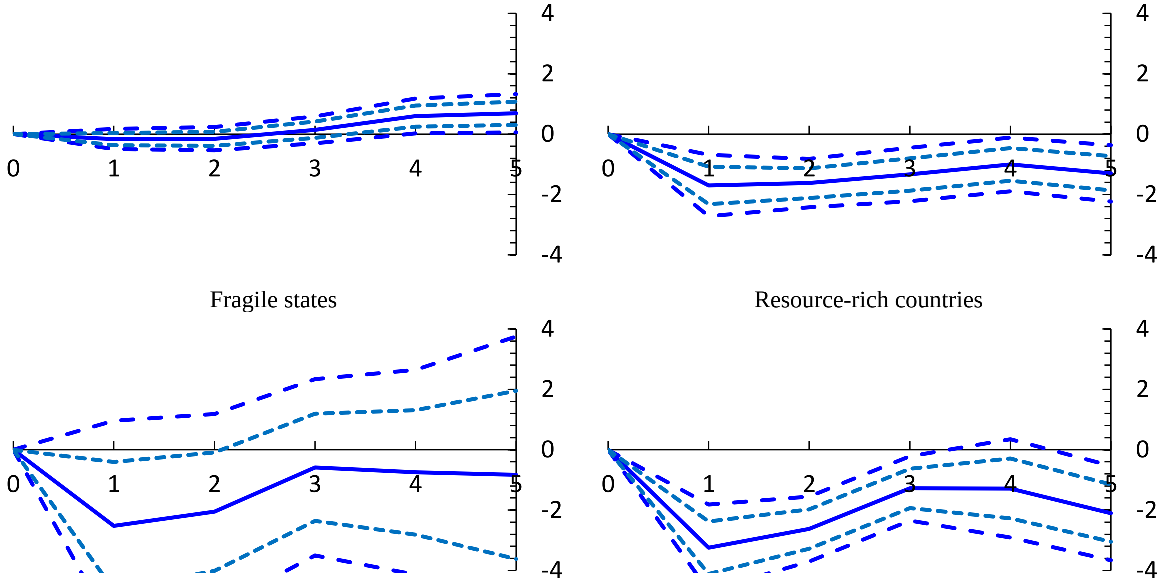


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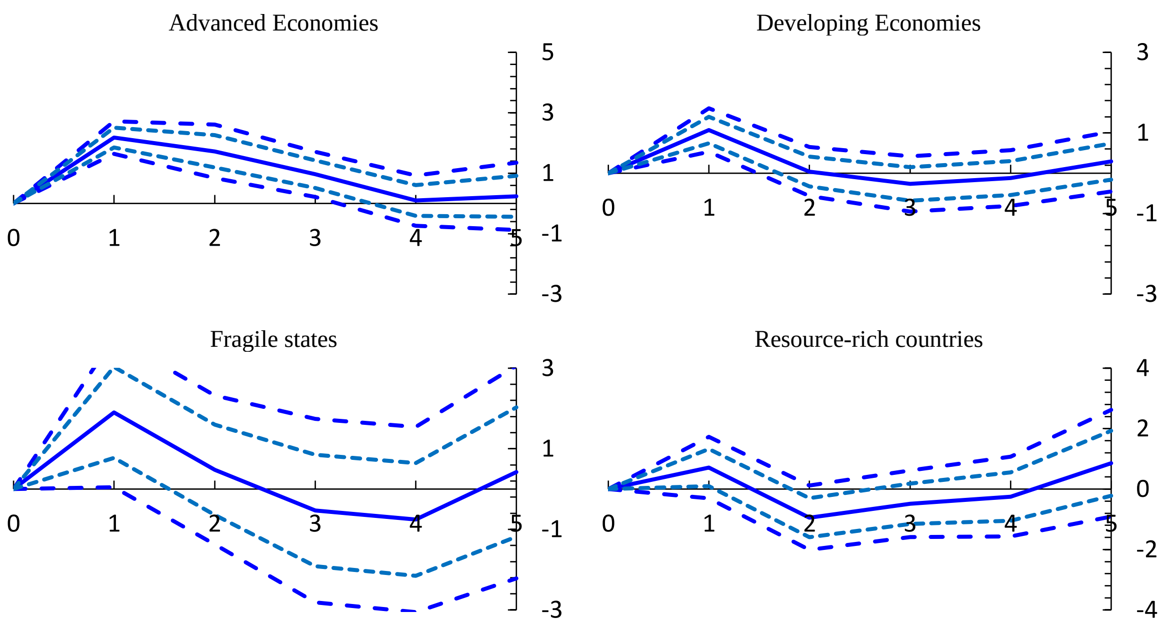
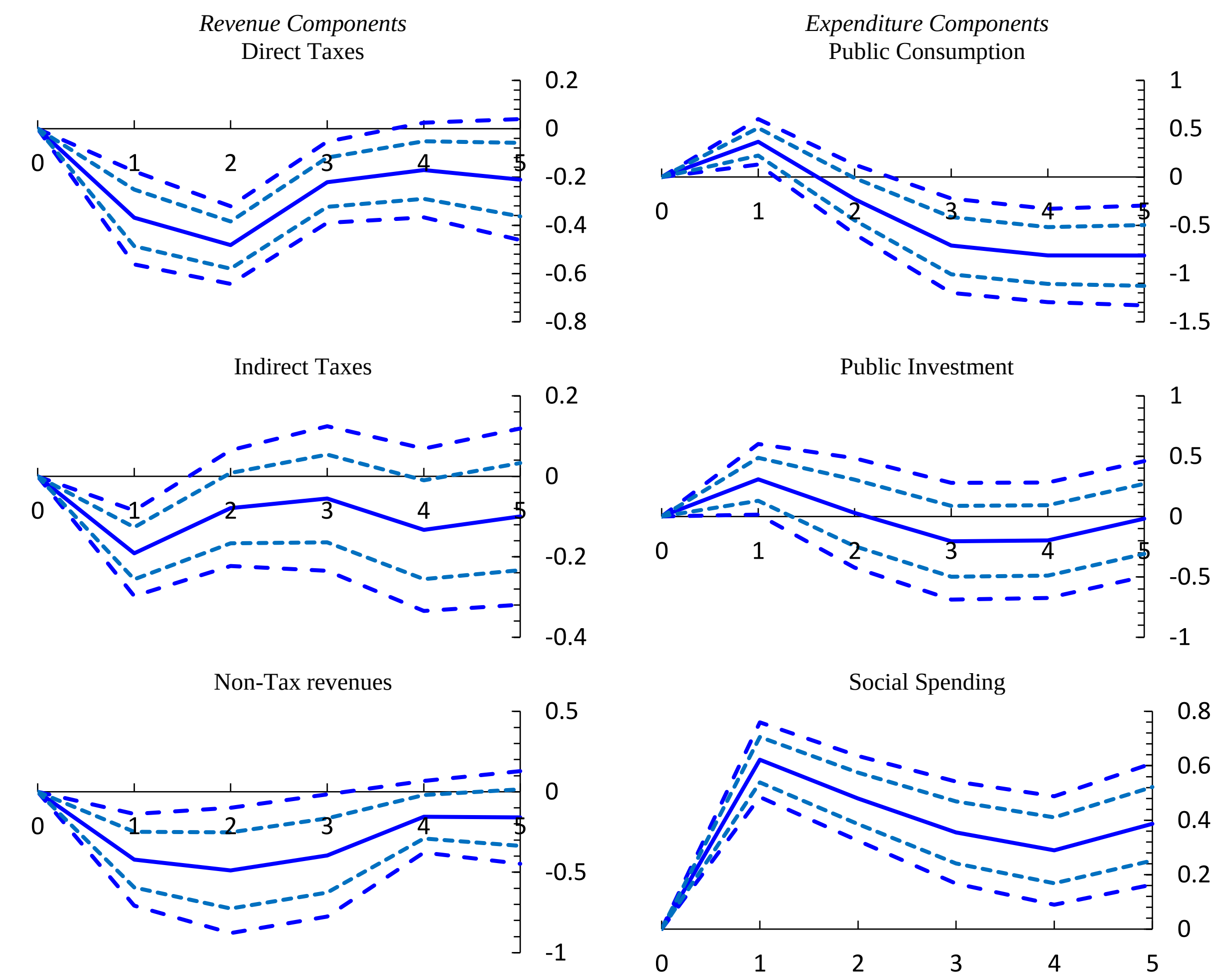
Figure 6.d Impact of Pandemics on Total Expenditures by Group of countries (% GDP)



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. The graph shows the response and both the 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

A relevant question is whether the effect on the budget is being driven by a particular component of revenues and expenditure. In this regard, we decompose revenues into direct taxes, indirect taxes and non-tax revenues and expenditures into public consumption, public investment and social spending (all expressed in percent of GDP). Looking at Figure 7 – for the entire sample - we observe that the fall in revenue is mostly driven by a drop in direct taxes followed by a decline in non-tax revenues (such as grants). Expenditure increase in turn is mostly the result of the operation of automatic stabilizers, that is, the jump in social spending.

Figure 7. Impact of Pandemics on Revenue and Expenditure Components, all countries (% GDP)



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. The graph shows the response and both the 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

B. Do Pandemics propel Tax Reforms?

Table 2 reports estimation of baseline equation 3. We observe that pandemics increase the likelihood of tax reforms happening – the effect is positive and statistically significant when all 45 countries are considered. Results suggest that crisis situations present an opportunity for a country to implement tax reforms. The statistical effect is lost—while maintaining the correct sign--when countries are further subdivided into two groups of emerging market and low-income economies, possibly due to smallness of sample size (see specifications 2 through 5 in Table 2). Regarding controls, the more developed a country is, the more likely it is to implement tax reforms as reflected in statistical significance of real GDP variable, although the pandemic variable is significant in the small sample of fragile states with relatively low real GDP. In contrast, countries characterized by high inflation tend to implement fewer tax reforms possibly due to the availability of seigniorage and heightened economic volatility that makes the outcome of a given reform more uncertain. A country more open to trade seems to be associated with a higher likelihood of tax reforms taking place (consistent with the findings by Belloc and Nicita, 2011). We tried income distribution and corruption variables as controls as well. The former is included to determine whether tax reforms are perceived as benefiting the rich. The latter tests whether perception of high levels of corruption is a deterrent to reforming tax systems. Both variables turned out to be statistically insignificant. As their inclusion greatly reduced the number of observations, in what follows next these controls are not included.

Table 2: Determinants of structural tax reforms, baseline model

Specification	(1)	(2)	(3)	(4)	(5)	(6)
Sample	all	EME	LIC	exc. fragile	only fragile	exc. resource rich
Real GDP	0.036	0.086*	0.014	0.061	-0.087	-0.001
	(0.036)	(0.049)	(0.056)	(0.045)	(0.085)	(0.043)
Inflation rate	-2.496***	-6.734***	-1.247	-1.895	5.328**	-0.084
	(0.842)	(2.015)	(0.864)	(1.581)	(2.540)	(1.343)
Trade openness	0.006***	-0.003	0.011***	0.001	0.004	0.000
	(0.002)	(0.004)	(0.003)	(0.004)	(0.005)	(0.003)
Unemployment rate	-0.150	-0.621**	-0.070	-0.020	-0.086	-0.047
	(0.104)	(0.291)	(0.140)	(0.141)	(0.287)	(0.129)
Pandemic shock	0.807**	0.619	0.843	0.232	1.274*	0.307
	(0.357)	(0.467)	(0.580)	(0.420)	(0.783)	(0.384)
Observations	785	394	391	413	137	476
Pseudo-R2	0.041	0.087	0.041	0.008	0.060	0.001

Note: All models are estimated by logit. Dependent variable is the structural tax reform binary variable. Standard errors are reported in parenthesis. Country fixed effects estimated but omitted. The constant term is not reported for parsimony. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

The previous table did not distinguish tax reforms between tax policy and revenue administration. In Table 3, we remedy this and study the likelihood of reforms of different taxes/measures. For this purpose, we re-run specification (3) in Table 2 for alternative binary-type dependent variables. We find that pandemics seem to trigger reforms in CIT, excises and property taxes. Also, VAT and excise reforms are more likely when inflation is lower as one would expect.

Table 3: Determinants of structural tax reforms, by tax category

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable (tax reform)	PIT	CIT	GST	VAT	Excises	Trade	Property	Revenue Administration.
Real GDP	0.093	0.035	0.043	0.031	0.067	-0.309***	0.246*	0.077**
	(0.062)	(0.058)	(0.074)	(0.051)	(0.047)	(0.091)	(0.134)	(0.038)
Inflation rate	-0.946	-1.726*	-2.105*	-2.034**	-1.676**	-1.726	-2.678*	-2.141***
	(0.884)	(1.049)	(1.273)	(0.967)	(0.843)	(1.321)	(1.473)	(0.820)
Trade openness	0.017***	0.012***	0.014***	0.004	0.005	-0.011	0.002	0.008***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.008)	(0.008)	(0.002)
Unemployment rate	0.402**	0.512**	-0.086	0.056	0.152	0.272	0.303	-0.181*
	(0.200)	(0.200)	(0.219)	(0.149)	(0.137)	(0.328)	(0.333)	(0.108)
Pandemic shock	-0.847	0.847*	0.382	0.362	0.730*	1.086*	0.000	0.519
	(1.031)	(0.516)	(0.760)	(0.501)	(0.421)	(0.664)	(0.000)	(0.383)
Observations	785	785	785	785	785	785	750	785
Pseudo-R2	0.092	0.079	0.066	0.020	0.025	0.097	0.047	0.043

Note: All models are estimated by logit. Dependent variables identified in the second row. Standard errors are reported in parenthesis. Country fixed effects estimated but omitted. The constant term is not reported for parsimony. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

Revenue administration reforms typically cover multiple areas. We re-did the previous exercise by zooming into the 8 specific areas of revenue administration for which we have information. Coefficient estimates attached to the pandemic variable in Table 4 come out statistically insignificant. It appears pandemic events boost the possibility of certain tax policy reforms but not that of revenue administration.

Table 4: Determinants of revenue administration reforms

Specification Dependent variable (Rev.Adm. area/reform)	(1) Management & HR	(2) Large taxpayers' office	(3) IT system	(4) Registration & filing	(5) Audit & verification	(6) Management payment obligations	(7) Improving compliance	(8) Customs clearance
Real GDP	0.012	0.080	-0.037	-0.057	0.003	-0.018	-0.074	-0.095*
	(0.046)	(0.053)	(0.045)	(0.047)	(0.043)	(0.053)	(0.056)	(0.054)
Inflation rate	-0.360	-2.046	-2.505	-2.350	0.045	-0.972	-5.183**	0.117
	(1.446)	(1.998)	(1.805)	(1.895)	(1.319)	(1.854)	(2.535)	(1.629)
Trade openness	0.004	0.003	0.002	0.007**	0.006**	0.005	-0.010**	0.004
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Unemployment rate	-0.238*	0.081	0.029	-0.325**	-0.102	-0.385**	-0.138	-0.663***
	(0.130)	(0.152)	(0.139)	(0.138)	(0.125)	(0.150)	(0.161)	(0.153)
Pandemic shock	0.280	0.061	-0.138	0.006	-0.118	0.391	-0.192	-0.157
	(0.425)	(0.504)	(0.467)	(0.474)	(0.440)	(0.480)	(0.553)	(0.575)
Observations	550	550	550	550	550	550	550	550
Pseudo-R2	0.011	0.008	0.010	0.029	0.010	0.023	0.030	0.050

Note: All models are estimated by logit. Dependent variables identified in the second row. Standard errors are reported in parenthesis. Country fixed effects estimated but omitted. The constant term is not reported for parsimony. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

C. Sensitivity and Robustness

We have carried out several robustness checks of the previous findings —see the Online Annex for detailed description and discussion.

Regarding the first empirical exercise, first, we re-estimated equation (1) excluding country fixed effects (Tuelings and Zubanov, 2010). Then, we included country-specific time trends as additional controls (see Figure A2 in the Online Annex). Results are similar to, and not statistically different from the baseline results. Given the possible concern that results may suffer from omitted variable bias we expanded the set of controls to include growth expectations and observed that results were in line with the ones presented in Figure 4 (see Figure A3 in the Online Annex). We also explored whether business cycle conditions at the time of the pandemic affect fiscal outcomes. Results available in Figure A4 in the Online Appendix suggest that the response of key fiscal aggregates to pandemics does not vary significantly with prevailing business conditions.

Further, we re-estimated equation (3) using 4 alternative estimators: Ordinary Least Squares, probit, ordered logit and the rare events relogit model. Results available in Table A1 in the Online Annex confirm the positive and significant coefficient estimate of pandemic shocks, meaning that such events increase the likelihood of tax reforms in the sample of developing countries under scrutiny.

5. Conclusion and Policy Implications

Results presented in this paper indicate that the fiscal landscape of countries is likely to alter as a result of the COVID19 pandemic, although there is a great deal of uncertainty about its likely impact on economic variables. We believe that this paper´s findings provide a lower bound to what the current pandemic is likely to inflict on countries. While all country groups would see a rising debt and widening of budget deficits, the revenue position of developing countries (and sub-Saharan Africa in particular) would worsen more than that of advanced economies‒an effect that is likely to persist. This outcome has important implications for low-income countries where average tax-to-GDP ratio is around 15 percent, and in many instances lower than the level necessary to achieve a significant acceleration in growth and development (Mullins, Gupta and Liu, 2020). The COVID-19 pandemic will significantly affect the tax bases of these countries for several years (Gupta and Liu, 2020). This means that policymakers in these countries should reconsider their revenue-raising strategy in favor of an approach that embraces a comprehensive reform package, including policies that have encountered political opposition in the past.

The paper showed that the fiscal effect varies, with pandemics affecting government expenditures more than revenues in advanced economies, while the converse applies to developing countries. The two sources of revenues that are affected the most are direct taxes and non-tax revenues. The former plays a bigger role in advanced and the latter in developing economies. An analysis of a subset of 45 developing economies for which tax reform data are available suggests that past pandemics have pushed countries to implement tax reforms, particularly in corporate income taxes, excises and property taxation. Unfortunately, pandemics do not drive developing countries to implement revenue administration reforms.

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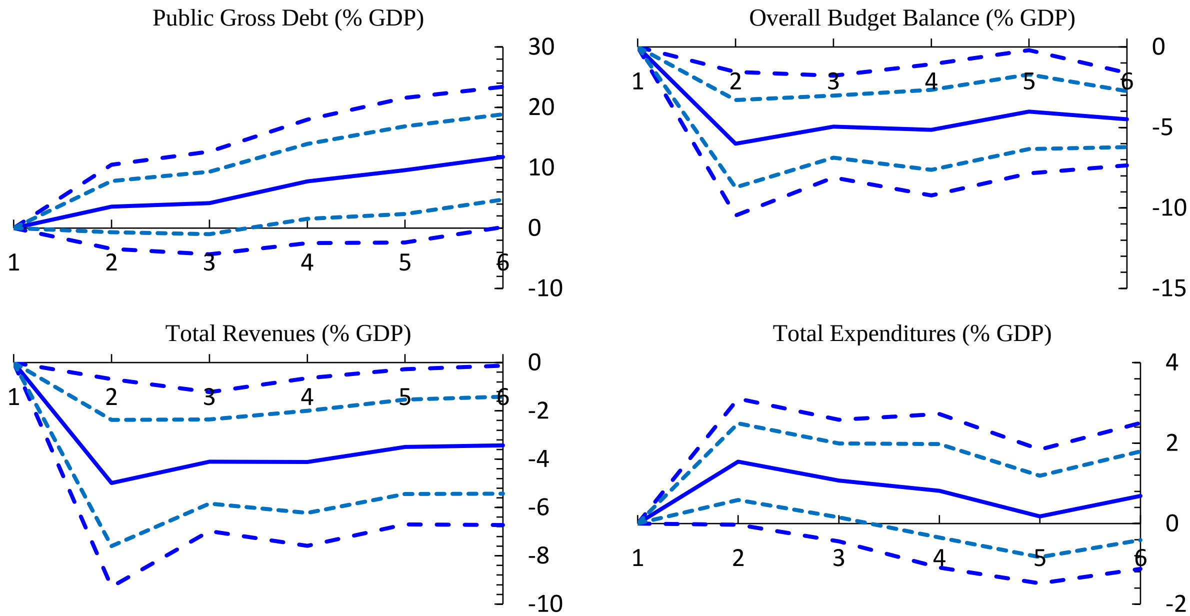
APPENDIX

Table A1. Summary Statistics

Variable	observations	Mean	Standard deviation	minimum	maximum
IRF analysis					
Public Debt	3143	55.32	39.14	0.07	495.20
Overall balance	3496	-.19	5.022	-39.03	125.13
Government revenues	3576	28.57	12.76	0.036	164.05
Government expenditures	3511	31.041	12.77	3.78	104.46
Binary Models Analysis					
Real GDP (log)	1165	5.10	3.01	-0.809	10.90
CPI (log)	1165	4.65	2.16	-7.58	17.84
Trade openness (% GDP)	1109	84.02	41.34	19.68	321.63
Unemployment (log)	1008	1.94	0.84	-2.30	3.62
Pandemic shock	882	0.043	0.203	0	1

Figure A1. Impact of Pandemics on Fiscal Variables, SSA (% GDP)



Note: Impulse response functions are estimated using a sample of sub-Saharan African countries over the period 1980-2018. The graph shows the response at both 90 and 68 percent confidence bands. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

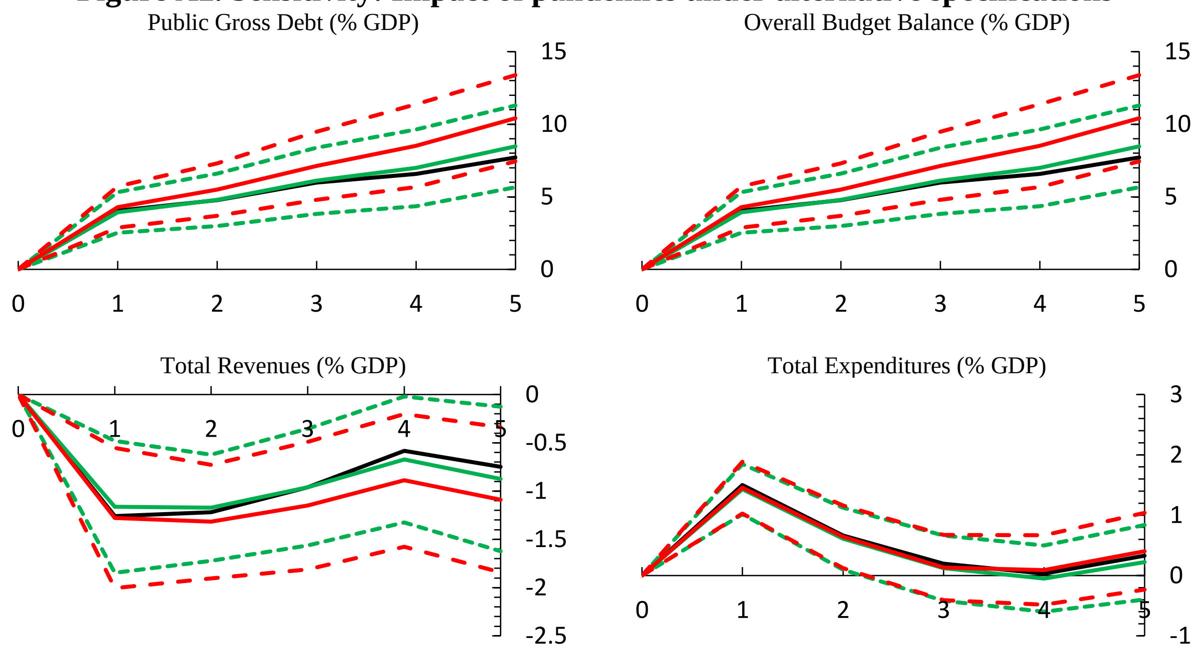
ONLINE ANNEX

Sensitivity and Robustness checks

A possible bias from estimating equation (1) using country-fixed effects is that the error term may have a non-zero expected value, due to the interaction of fixed effects and country-specific developments (Tuelings and Zubanov, 2010). This would lead to a bias of the estimates that is a function of *k*. To address this issue, equation (1) was re-estimated by excluding country fixed effects from the analysis. Results in Figure A1 (green lines) suggest that this bias is negligible.

To try and estimate the causal impact of pandemics on fiscal outcomes, it is important to control for previous trends in dynamics of the fiscal variables. The baseline specification attempts to do this by controlling for up to two lags in the dependent variable.[16] To further mitigate this concern, we re-estimate equation (1) by including country-specific time trends as additional control variables. Results in Figure A1 (red lines) keep the main thrust of our previous findings.

Figure A2. Sensitivity: Impact of pandemics under alternative specifications



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. Black solid line corresponds to the baseline result in Figure 4. Green lines denote the exercise dropping country fixed effects. Red lines denote the exercise adding country time trends. The graph shows the response and the 90 confidence bands for the two exercises conducted. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

Another possible concern regarding the analysis is that the results may suffer from omitted variable bias, as fiscal policies may be carried out because of concerns regarding future evolution of economic activity. To address this issue, we control for the expected values in *t-1* of future real GDP growth over periods *t* to *t+k*—that is, the time horizon over which the impulse response functions are

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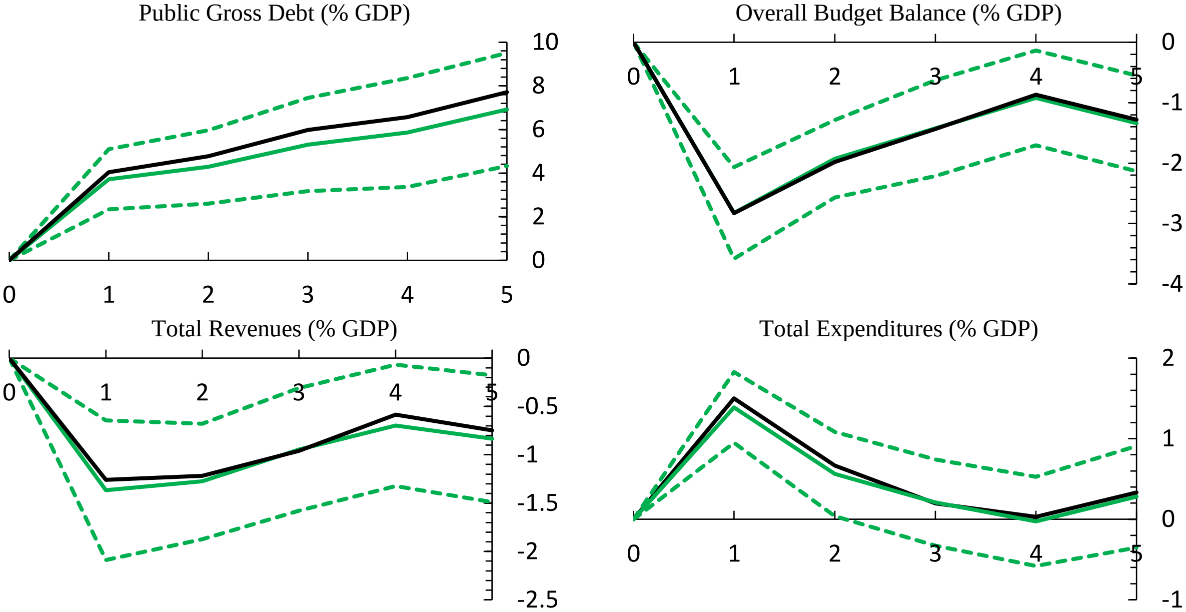
[16] Similar results are obtained when using alternative lag parametrizations. Results for zero, one and three lags (not shown) confirm that previous findings are not sensitive to the choice of the number of lags.

computed. These are taken from the fall issue of the IMF WEO for year *t-1*. Figure A2 shows the results from considering growth expectations in our baseline specification. We observe that these are in line with those presented in Figure 4.

Figure A3. Additional Control: economic expectations



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. Black solid line corresponds to the baseline result in Figure 3. Green lines denote the exercise augmented with growth expectations. The graph shows the response and the 90 confidence bands for the two exercises conducted. The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

We also explored whether business cycle conditions at the time of the pandemic affect fiscal outcomes. That means the response is allowed to vary with the state of the economy:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \tau_i + \beta_k^L F(z_{i,t}) pand_{i,t} + \beta_k^H (1 - F(z_{i,t})) pand_{i,t} + \theta M_{i,t} + \varepsilon_{i,t} \qquad \text{(A1)}$$

with

$$F(z_{it}) = \frac{\exp(-\gamma z_{it})}{1+\exp(-\gamma z_{it})}, \quad \gamma > 0$$

in which z_{it} is an indicator of the state of the economy (the real GDP growth) normalized to have zero mean and unit variance.[17] The coefficients β_L^k and β_H^k capture the fiscal impact of pandemics at each horizon k in cases of extreme recessions ($F(z_{it}) \approx 1$ when z goes to minus infinity) and booms ($1 - F(z_{it}) \approx 1$ when z goes to plus infinity), respectively.[18] [19] Results in Figure A3 suggest

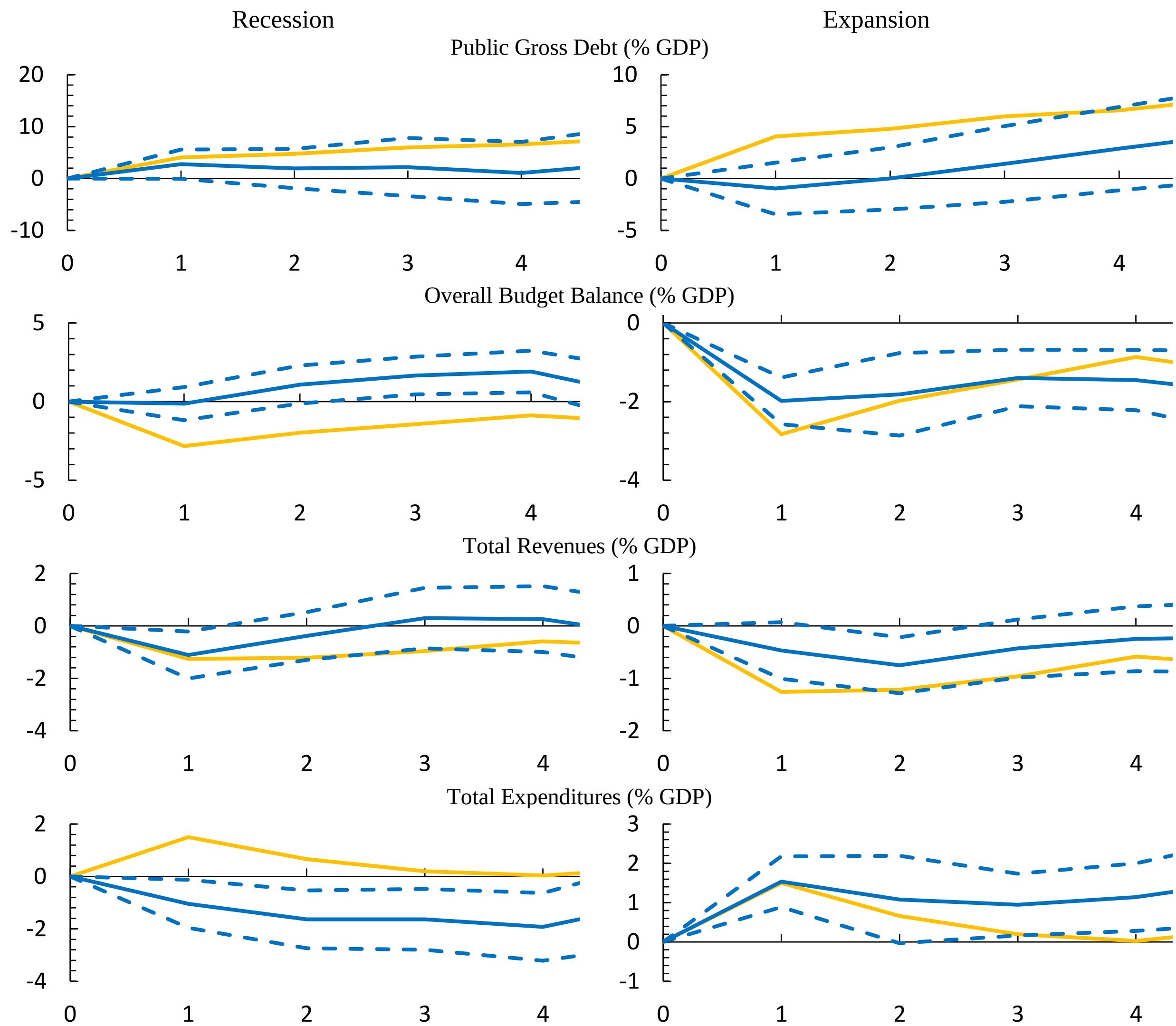
[17] The weights assigned to each regime vary between 0 and 1 according to the weighting function $F(.)$, so that $F(z_{it})$ can be interpreted as the probability of being in a given state of the economy.

[18] $F(z_{it})$=0.5 is the cutoff between weak and strong economic activity.

[19] We choose $\gamma = 1.5$, following Auerbach and Gorodnichenko (2012), so that the economy spends about 20 percent of the time in a recessionary regime—defined as $F(z_{it}) > 0.8$. Our results hardly change when using alternative values

that the response of key fiscal aggregates to pandemics does not vary significantly with prevailing business conditions. The two exceptions are the response of the overall fiscal balance, which becomes statistically insignificant in bad times (in contrast with a negative response in the baseline or unconditional specification); and that total expenditure actually falls in bad times (in contrast with a positive response in the baseline or unconditional specification).[20]

Figure A4. State Contingent Regression: Impact from Pandemics on Fiscal Outcomes over the Business Cycle



Note: Impulse response functions are estimated using a sample of 170 countries over the period 1980-2018. Yellow solid lines correspond to the baseline result in Figure 4. The graph shows the response and the 90 confidence bands.

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of the parameter γ, between 1 and 6. Auerbach and Gorodnichenko (2012, 2013) discuss the advantages of using the local projection approach to estimating non-linear effects.

[20] Results are also robust to re-estimating equation (4) more simply through a dummy variable that takes value 1 when the GDP growth rate of the country considered is below its sample average and zero otherwise (results available upon request).

The x-axis shows years (k) after pandemic events; t = 0 is the year of the pandemic event. Estimates based on equation 1. Standard errors in parentheses are clustered at the country level.

To test for the robustness of the results of the logistic regressions, we re-estimated the baseline model with a number of alternative estimators. First, we re-estimate the baseline specification resorting to an Ordinary Least Squares (OLS) approach. Second, we use a probit approach. Third, we employed an ordered logit model under the assumption that the larger the number of tax reforms the better in our context. Finally, we employ a rare events logit (or relogit) estimator. In a logistic regression, the Maximum Likelihood estimates are consistent but only asymptotically unbiased. The basic problem is having a number of units (structural tax reforms) in a panel that has no events. This means that the country-specific indicators corresponding to the all-zero countries perfectly predict the zeroes in the outcome variable (Gates, 2001; King, 2001).[21] The simplest way of dealing with this problem is decreasing the rareness of the event of interest: by lowering the threshold of what constitutes the event of interest or expanding the data selection period, for example, there is less need to correct for rareness. Alternatively, the King and Zeng's (2001) bias correction method, the relogit estimator, can be used.[22] The relogit estimator for dichotomous dependent variables provides a lower mean square error in the presence of rare events and can be defined as follows:

$$\text{Prob}(STR_{it} = 1|Z_{it}) = \Phi(Z'_{it}\vartheta) \Leftrightarrow \text{Prob}(STR_{it} = 1|S_{it}, X_{it}) = \Phi(\alpha_i + Pol_{it}'\boldsymbol{\eta} + X_{it}'\boldsymbol{\gamma}) \quad (1)$$

with $i = 1, \ldots, N$; $t = 1, \ldots, T$, where $\Phi(\cdot) = \frac{1}{1+e^{-(Z'_{it}\vartheta)}} = \frac{1}{1+e^{-(\alpha_i + Pol'_{it}\eta + X_{it}'\gamma)}}$, α, η, γ are the vectors of the parameters to be estimated, and $\Phi(\cdot)$is the logistic function.

The parameters can be estimated by maximum likelihood.[23] However, as pointed out by King and Zeng (1999a, 1999b, 2001), the estimates of $\Phi(\cdot)$ and $\Phi(\cdot) \cdot [1 - \Phi(\cdot)]$ among observations that include rare events (in our case, for which *STR = 1*) will be typically larger than those among observations that do not include rare events (i.e., for which *STR = 0*). Consequently, their contribution to the variance will be smaller, rendering additional 'rare' events more informative than additional 'frequent' events. Therefore, we follow King and Zeng (1999a, 1999b) and correct for the small sample and rare events biases and estimate a relogit model where the sampling design is random or conditional on Z_{it}.[24]

The regression results of these alternative estimators are reported in Table A1.

[21] This is a well-known phenomenon in the statistical literature (for an overview see Gao and Shen, 2007).
[22] King and Zeng (2001) describe rare events as "dozens to thousands of times fewer ones […] than zeroes".
[23] And the variance of the estimated coefficients can be expressed as $Var(\hat{\vartheta}) = (Z'VZ)^{-1}$, where $\boldsymbol{V}$ is a diagonal matrix, with diagonal entries equal to $\Phi(\cdot) \cdot [1 - \Phi(\cdot)]$. In the case of rare events, $\Phi(\cdot)$ will be generally small.
[24] We use the software package "relogit" provided by Tomz et al. (1999).

Table A1: Determinants of structural tax reforms: robustness to alternative estimators

Specification	(1)	(2)	(3)	(4)
Estimator	Probit	OLS	Relogit	Ordered Logit
Real GDP	0.023	0.006	0.036	0.192***
	(0.021)	(0.006)	(0.035)	(0.041)
Inflation rate	-1.462***	-0.105***	-2.328**	-0.436*
	(0.439)	(0.037)	(0.965)	(0.231)
Trade openness	0.004***	0.001***	0.006***	-0.002
	(0.001)	(0.000)	(0.002)	(0.003)
Unemployment rate	-0.091	-0.028	-0.149	0.153
	(0.062)	(0.019)	(0.101)	(0.106)
Pandemic shock	0.493**	0.188***	0.813**	1.009***
	(0.219)	(0.073)	(0.370)	(0.350)
Observations	785	785	785	785
R2	0.274	0.033		
Pseudo-R2	0.042			0.029

Note: estimator identified in the second row. Standard errors are reported in parenthesis. Country fixed effects estimated but omitted. The constant term is omitted for parsimony. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.