POLICY CORNER

Calamities, Debt, and Growth in Developing Countries

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Abstract

Public debt in developing economies rose at a fast clip during 2020–2021, at least partly due to the onset of the global COVID-19 pandemic. Nobel laureate Paul Krugman opined in early 2021 that "fighting covid is like fighting a war." This paper empirically examines trends in debt and economic growth around the onset of three types of calamities, namely natural disasters, armed conflicts, and external debt distress in developing countries. The estimations provide quantitative estimates of differences in GDP growth and debt trends in economies suffering episodes of calamities relative to the trends observed in economies not experiencing calamities. The paper finds that debt and growth evolve quite differently depending on the type of calamity. With the empirical evidence in hand, the authors argue that debt-financed reconstruction efforts after natural disasters, and thus plausibly in the aftermath of the pandemic, can help accelerate growth after such disasters with lower debt burden than in the aftermath of episodes of armed conflict without necessarily incurring the economic costs associated with episodes of debt restructuring. However, the implied upward trajectory of the debt to GDP ratio in developing economies is not trivial, even after post-disaster growth upticks, which raises concerns about long-term debt sustainability after episodes of reconstruction after natural disasters. If so, the time for orderly preemptive debt restructuring might be approaching quickly since recoveries after debt defaults tend to be more costly.

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1 Introduction

"Fighting Covid is like fighting a war." Paul Krugman, *New York Times*, February 7, 2021.

At the time of writing, the COVID-19 pandemic was still ravaging the world. If fighting the health and economic impacts of the pandemic is like fighting a war, as argued by Krugman, what does this imply for the accumulation of sovereign debt in developing countries? Governments are in fact accumulating debt to make up for lost revenues and respond to the pandemic with social protection and public health programs. As a result, the global average general government debt rose from 84% of GDP in 2019 to 99% in 2020. In emerging market economies, average general government debt rose from 52 of GDP in 2019 to 64% in 2020 (IMF, 2021).

While rising debt might be less risky for advanced countries, developing countries face tensions between the short-run gains and the potential long-run costs of debt-financed public spending. What should governments' do amidst an economic calamity? Use debt to finance the economic recovery or should they allow their economies to tank without additional fiscal support because of fears about debt sustainability? This paper shows that answers to these questions are not simple; it depends on the type of calamity. When hit by a natural disaster, which we argue is more similar to an epidemic than episodes of war, the evidence presented herein is more optimistic about the possibility of raising growth after the onset of such calamities. But debt and debt over GDP both tend to rise in the aftermath, raising both hope and concerns because the debt burden rises but to a lesser extent than under episodes of war or debt distress.

On the one hand, public debt can alleviate short-run financial constraints, allowing governments to increase or maintain public consumption and investment. On the other hand, there are costs associated with public debt accumulation. The costs tend to be smaller for the developed world, as they face lower borrowing costs. Advanced countries are also less "debt intolerant," a term coined by Reinhart et al. (2003), so they can continue to borrow at relatively higher public debt levels. Developing countries face relatively high borrowing costs. If the payoff in terms of GDP (or fiscal multiplier) of fiscal spending is not sufficiently high, the borrowing will add to future debt burden.

Therefore, this current pandemic calamity raises an important empirical issue: How do public debt and growth evolve during calamities in developing economies? Yet, despite the issue's importance, the literature is scant and incomplete at best. This paper is an effort to fill the gap. It examines how debt and economic growth evolve before, during, and after the onset of three types of calamities, namely natural disasters, conflicts, and external debt distress, in developing countries. At the time of writing, we could not find any published work documenting the trends in growth and debt around episodes of calamities.

The evidence reported herein indicates that central government debt (or "public debt" for brevity) tends to rise to finance economic recovery during and after large natural disasters in developing countries. During the three years following a large natural disaster, growth in public debt is significantly higher than in countries that did not experience a disaster—the counterfactual scenario. Real GDP growth collapses in the year of a natural disaster but after that picks up faster than growth in no-disaster countries. This finding provides an important empirical regularity that public debt does accumulate after disasters and is likely to do so after this pandemic, possibly to support economic recovery.

In contrast, the evolution of debt and growth is different around armed conflicts. Public debt increases after the onset of armed conflicts. Still, economic growth does not pick up after the onset of war, which suggests that government spending during conflicts might not be used to support economic growth.

Finally, the paper finds that highly indebted developing countries experience lower growth than economies that do not enter into episodes of debt distress *before* the onset of debt distress episodes. Debt distress episodes are defined in this paper as those with external debt restructurings.[1] Debt restructuring is a process wherein a country experiencing financial distress and liquidity problems refinances its existing external debt obligations to gain more flexibility in the short term and make its debt load more manageable overall. There are two types of debt restructurings— preemptive and post-default. In preemptive restructurings, a country decides to restructure its external debt before it misses any payments. In a post-default restructuring, a country is forced to enter into debt negotiations because it has missed payments (that is, defaulted). The evidence reported here shows that both types of restructurings are costly in terms of output growth, but preemptive restructurings are less costly than defaults. Before they restructure, debtor countries experience slower growth than countries that do not restructure. This empirical finding applies to both preemptive and post-default restructurings. However, after the first year of restructuring, growth starts to recover during preemptive restructurings but remains depressed during post-default restructurings. This finding is consistent with a (more descriptive) finding in Asonuma and Trebesch (2016). In addition, debt growth is significantly lower in both preemptive and post-default restructurings compared to the countries that did not restructure. The findings offer some guidance to governments amid the rising trend of debt over GDP post-disaster. They suggest that if a country must engage in debt restructurings, it might be better to do so preemptively.

Our paper is relevant for the COVID-19 literature because the paper examines and differentiates the evolution of debt and growth around three types of calamities. First, the COVID-19 pandemic shares many traits with large natural disasters in fundamental ways relevant to understanding analytically how public debt and economic growth interact. Both pandemics and natural disasters are rare and unexpected occurrences at least with respect to their timing, and neither is directly caused by economic policies. Both result in economic contractions because people cannot work and conduct normal economic activity due to physical destruction or

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[1] This paper uses debt distress and debt restructurings interchangeably.

safety concerns. Krugman (2021) was perhaps the first to use the disaster and war metaphor to discuss the economics of the pandemic. In fact, pandemics and epidemics were included in natural disaster databases (such as the International Disaster Database (EM-DAT) that we use in this paper). The COVID-19 pandemic was also declared by the U.S. Federal Emergency Management Agency (FEMA) as a disaster on March 13, 2020 (FEMA, 2020). Therefore, examining debt and output growth around natural disasters can help policy-makers and economists understand how debt-financed fiscal expenditures help the recovery from the pandemic. The evidence reported here indicates that public debt and output growth tend to rise faster after natural disasters than in economies without disasters, thus illustrating how debt-financed fiscal expansions can help economic reconstruction in the aftermath of disasters.

Certainly, some aspects of the pandemic differ from a natural disaster. A natural disaster is generally local, whereas a pandemic is global. Certain types of natural disasters, such as earthquakes, are more short-lived, while the pandemic's duration is uncertain. New variants make the pandemic longer than anticipated, even in countries with high vaccination rates. Nevertheless, the differences do not weaken the similarities of the pandemic and a natural disaster for the purpose of analyzing growth and debt dynamics. Both pandemics and natural disasters can have detrimental effects on growth during the emergency state, depress both supply and demand, and require substantial resources to mitigate the negative consequences for economic activity during and immediately after the episode.

Second, our paper also helps shed light on how debt and growth change around debt distress episodes, which many countries will inevitably enter after the pandemic, given large debt accumulation. We find that preemptive debt restructurings are less economically costly than post-default restructurings, which offers empirical evidence consistent with the idea that preemptive restructurings of public debt are plausibly superior to waiting until default is inevitable.

The rest of this paper is organized as follows. Section 2 provides a brief review of related literature. Section 3 presents data and the econometric model specifications. Section 4 contains the results, and Section 5 concludes.

2 Related Literature

In recognition of the importance of and challenges posed by calamities, a recent volume of the *IMF Economic Review* published papers on the pandemic and extreme events. The main gist of the edited volume is aptly summarized by Boz and Tesar (2022) in an article titled "Living in the Extreme: Economics of Pandemics, Climate Change and Tail Risks." The collection of papers included in this edited volume comes closest in subject matter to this paper, with the lecture by Reinhart (2022), "From Health Crisis to Financial Distress," being the closest relative of this paper. Yet, the existing literature offers incomplete evidence at best about the evolution of debt and growth around calamities. Jordà et al. (2022) find that the real rates of return after pandemisc were depressed for decades after pandemics, in stark contrast to what happens after wars. Gatti et al. (2021) provide a brief discussion about the evolution in a broad policy

discussion on public debt in the Middle East and North Africa (MENA). Fomby et al. (2013) analyze the growth aftermath of natural disasters, but the authors did not discuss the role of public debt.

The literature on the detrimental effects of armed conflicts on output is rich and quite consistent. Collier (1999) distinguishes four common routes by which armed conflicts can hurt the economy. Conflicts destroy physical and human capital, disrupt internal social dynamics, cause countries to divert public funds from activities that enhance output, contribute to dissaving, which leads to economic deterioration. The magnitude of the impact of conflict on output is also estimated in the literature. Collier finds that the annual growth rate during civil wars is 2.2 percentage points lower than in the counterfactual scenario without wars. Growth during the five years that follow a one-year conflict is about 2.1 percentage points lower than what would have occurred had the war never happened. Armed conflict can also generate significant collateral damage to the output of neighboring economies. These negative spillover effects tend to amplify as the intensity of conflict increases (Murdoch and Sandler 2002, 2004).

Nevertheless, the literature on the relationship between armed conflict and public debt is thin. Lederman and Rojas (2018) study the evolution of fiscal expenditure, public debt, and inflation around the onset of armed conflicts, but the authors did not examine output growth. The authors found that public debt in conflict-afflicted economies tends to be higher than in non-conflict economies before the onset of conflicts, begins to rise further before the conflict begins and stays high afterward. Their findings are consistent with our findings that public debt growth rises after the onset of armed conflicts.

The literature about growth around debt distress episodes is rich, especially the literature on sovereign defaults. For example, Borensztein and Panizza (2009) found that the output costs of sovereign defaults are high. Moreover, defaulting on debt can cause long-run damage to financial systems (Reinhart et al. 2003). More recently, Asonuma and Trebesch (2016) distinguish between preemptive versus post-default restructurings and show that preemptive restructurings are associated with lower output losses than post-default restructurings. Nevertheless, the authors only provide descriptive statistics to support this argument.

At the time of writing, this paper is the first to showcase econometric evidence regarding the evolution of public debt and growth around episodes of calamities, aiming to understand how debt and growth interact. It employs a difference-in-difference econometric framework with country and year fixed effects, which control for common global shocks affecting both the treatment and control country groups. The difference-in-difference framework yields descriptive empirics comparing growth and debt-growth trends between the countries experiencing calamities and those that do not. The data and the empirical framework are described further in the next section.

3 Data and Empirical Model Specifications

3.1 Data

Four main sets of data are used for this paper.

(a)   Data on natural disasters

   Data for natural disasters are from the International Disaster Database (EM-DAT). The pool of natural disasters included in EM-DAT fulfills at least one of the following outcomes in an affected country: 10 or more people dead, or 100 or more people affected, a declaration of a state of emergency, or a call for international assistance. Between 1900 and 2020, the world had 15,563 natural disasters, of which 1492 were epidemics, making them the fourth most common natural disaster (see Fig. 1).[2]

   Since the interest is in analyzing macroeconomic trends in developing countries, all developed countries (identified by the World Bank's Historical Income Classification in 1987) are excluded from the analysis. If a country was created after 1987, its classification is based on the income classification of the year of its creation.

   Not all disasters generate damages large enough to change macroeconomic dynamics, however. Therefore, to filter events with large macroeconomic effects, our econometric analysis focuses on natural disasters that generated damages equivalent to at least 1% of the country's GDP that year, based on the total estimated damages

Fig. 1 Natural disasters 1900–2020. *Note*: Authors' calculations based on EM-DAT database. (Color figure online)

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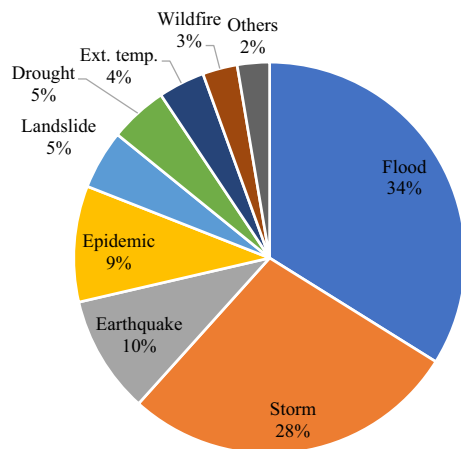
[2] According to the EM-DAT database, from the 691 catastrophes registered for the Middle East and North Africa region between 1900 and 2020, the most common natural disasters are floods (323 episodes, 46.7% of the total), earthquakes (167 episodes, 24.2%), storms (72 episodes, 10.4%), and epidemics (39 episodes, 5.6%).

reported by EM-DAT[3]. The final sample covers 282 severe natural disasters between 1960 and 2019 in 86 developing countries. They include floods, earthquakes, droughts, storms, landslides, volcanic activity, extreme temperature, and wildfires. Unfortunately, the data on large disasters do not include episodes of epidemics, nor does it include the years of the COVID-19 pandemic that started in late 2019 and early 2020 for most countries.

(b) Data on armed conflicts

This paper uses the UCDP/PRIO Armed Conflict data set (version 20.1) that covers conflicts between 1963 and 2019. Given that the main goal is to study the relationship between growth and debt growth around the start of conflicts in general, all extra-systemic, interstate, internal, and internationalized internal armed conflicts affecting developing countries reported by the database are included in the estimation samples. Conflicts between two or more states are assigned to the developing countries involved in such conflicts. A conflict is defined as "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in a calendar year." The sample covers 107 armed conflicts between 1963 and 2019 in 61 developing countries.

(c) Data on debt restructurings

Data on debt restructurings are based on Asonuma and Trebesch (2016), which provide information on the occurrence and duration of 204 restructurings globally between 1978 and 2019, 197 of which have been completed. The cases are further differentiated into two categories: preemptive restructurings and post-default restructurings. In preemptive restructurings, governments renegotiate with lenders while they are still current on their loan payments. In post-default restructurings, governments unilaterally default and then renegotiate their debt. After limiting the sample to developing countries, we obtain 100 complete episodes of post-default restructurings and 65 completed episodes of preemptive restructurings. Many countries have multiple restructurings.

(d) Growth and debt data

Data for output growth are annual growth in real GDP from the World Bank's *World Development Indicators* from 1960 until 2019. Data for public debt are Central Government Debt from the IMF's *Global Debt Database* (GDD), which is the most comprehensive database of public debt from 1960 to 2019. Data for external

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[3] According to EM-DAT, this is the value of all damages and economic losses directly or indirectly related to the disaster.

debt are from the IMF's *World Economic Outlook* (October 2020) between 1980 until 2019.

3.2 Model Specification

This paper applies the difference-in-difference framework with country and year fixed effects to investigate the evolution of debt and growth around episodes of calamities. This method estimates the association of a treatment (the onset of a calamity, such as a natural disaster, an armed conflict, or a debt restructuring episode) to an outcome (GDP growth and public debt accumulation). The framework compares the average change of these variables for the treatment group (economies affected by a calamity) with the average change for the control group (non-affected economies).

The econometric model specification that aims to identify these potential effects is the following difference-in-difference estimator:

$$y_{c,t} = c_0 + \mu_c + \mu_t + \beta_n D_n + \theta Calamities_{c,t} + \epsilon_{c,t} \tag{1}$$

The subscripts c and t denote countries and years, respectively. $y_{c,t}$ represents the macroeconomic variable of interest (GDP growth, annual percent; debt growth, annual percent). The inclusion of country fixed effects (μ_c) along with time fixed effects (μ_t) implies that we will be comparing within-country macroeconomic trends of affected and non-affected economies during each year in the sample.

D_n is a dummy variable that identifies the nth year from the onset (year 0) of a calamity. The subscript n denotes the duration of each episode covering seven years around the onset of a calamity. Therefore, n ranges from -3 to $+3$. For example, $n = -3$ implies 3 years before the onset of the calamity (be it a natural disaster, conflict or debt distress). c_0 represents the constant term, and $\epsilon_{c,t}$ is the error term. β_n are the coefficients of interest to be estimated, which we allow to vary over the course of calamity episodes. Again, n ranges from -3 to $+3$. This setup implies that we are tracing pre-calamity trends and post-onset trends, which allows for inferences about whether the differential trends, if any, predate the onset of a calamity. Additional controls in the regression include $Calamities_{c,t}$ which is a control for the number of calamities during the previous six years, in case calamities are overlapping. Robust standard errors are clustered at the country level.[4]

Again, it is useful to note that the estimated coefficients D_n do not represent the causal effects of calamities on public debt accumulation or output growth. Some calamities, such as debt restructurings or conflicts, might not be exogenous. They can arise from the poor performance of the economy and national institutional characteristics. The estimated coefficients D_n only capture the *differential* dynamics of public debt and output growth around the onset of calamities between the treatment

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[4] It is noteworthy that a widely used indicator of a country's debt burden is the ratio of public debt divided by GDP. Our general model specification allows inferences with respect to the evolution of this ratio by comparing the relevant coefficient estimates of the models for growth of GDP and growth of public debt.

group (economies affected by calamities) and the control group (non-affected economies). Hence, it might be prudent to interpret them as associations, although further below we discuss the implications of endogenous probabilities of facing a calamity, particularly episodes of debt distress.

4 Results

This section examines the dynamics of growth and public debt accumulation around natural disasters, armed conflicts, and debt restructurings.

4.1 Output and Public Debt Growth around Natural Disasters

First, we present the dynamics of public debt and economic growth around large natural disasters (generating damages of at least 1% of their GDP) relative to the contemporaneous control group of non-affected countries for public debt and GDP growth. Figure 2, panel A, shows the estimated effects three years before and three years after the year of natural disasters.

GDP growth is higher post-disaster in developing countries affected by large natural disasters than in countries that did not experience them. In the year of the disaster (D_0), GDP growth in affected economies is significantly lower than the control group (1.3 percentage points lower). But GDP growth is 0.9 and 0.8 percentage points higher in the first and second years after the onset of a large natural disaster in affected counties relative to non-affected countries. In sum, although large natural disasters cause a strong economic contraction in the year they occur, GDP tends to bounce back the three years following the event, reaching a rate of output growth almost one percentage point higher than in non-affected economies.

Public debt growth significantly increases more in developing countries affected by large natural disasters than in countries that did not experience such natural disasters, as shown in Fig. 2, panel B. From the first year to the third year after the onset of a natural disaster, public debt growth in affected economies is 2.3–3.6 percentage points higher than in unaffected economies. This finding provides an important empirical regularity that public debt does accumulate after disasters and is likely to do so after this pandemic, possibly to support economic recovery.

Does the fact that growth recovers relatively fast after natural disasters imply that the debt burden falls? The evidence illustrated in Fig. 2 implies that this is not the case. By comparing the estimated coefficients in Panel B that correspond to the differential evolution of public debt after the onset of a disaster with the coefficients in Panel A that correspond to the differential evolution of growth, we can clearly see that the estimated coefficient on debt after the onset of a disaster is much larger. In fact, at the peak of growth, the coefficient is less than one, while the coefficients on public debt range between 2 and 4%. Thus, debt over GDP rises despite the acceleration in growth.
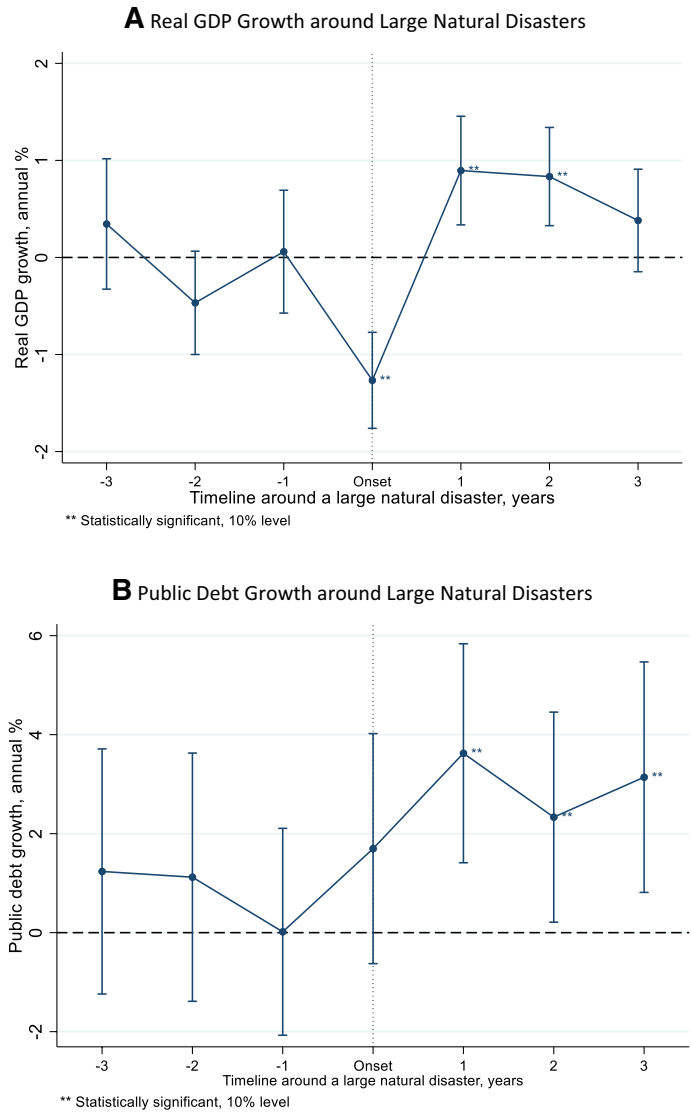
A Real GDP Growth around Large Natural Disasters

** Statistically significant, 10% level

B Public Debt Growth around Large Natural Disasters

** Statistically significant, 10% level

Fig. 2 Output and public debt growth around large natural disasters. *Note*: The figure displays real GDP growth and central government debt growth before, during, and after severe natural disasters relative to the baseline of no severe disasters. Severe natural disasters generate damages equivalent to at least 1% of GDP. The final sample covers 282 severe natural disasters between 1960 and 2019 in 86 developing countries. The disasters include floods, earthquakes, droughts, storms, landslides, volcanic activities, extreme temperatures, and wildfires. The econometric framework follows a difference-in-difference approach, with country and year fixed effects. Bars show 90% confidence interval. **Indicates statistical significance at 10% level, based on robust standard errors
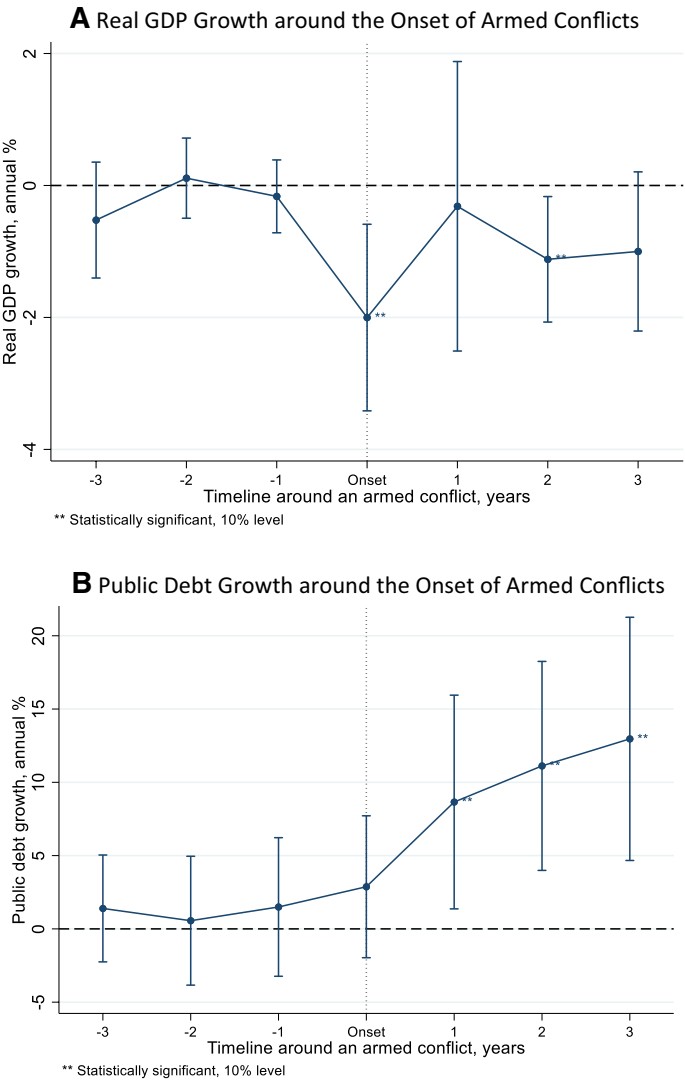
A Real GDP Growth around the Onset of Armed Conflicts

** Statistically significant, 10% level

B Public Debt Growth around the Onset of Armed Conflicts

** Statistically significant, 10% level

Fig. 3 Output and public debt growth around the onset of armed conflicts. *Note*: The figure displays the evolution of real GDP growth and central government debt growth in conflict countries relative to non-conflict economies before, during, and after armed conflicts. $t=0$ indicates the onset of armed conflicts. The econometric framework follows a difference-in-difference approach, with country and year fixed effects. The sample covers 107 armed conflicts between 1963 and 2019 in 61 developing countries. Bars show 90% confidence interval. **Indicates statistical significance at 10% confidence interval based on robust standard errors

4.2 Output and Public Debt Growth around Armed Conflicts

Econometric results suggest that growth does not on average significantly increase after a conflict's onset, as illustrated in Fig. 3, panel A. At the onset of conflict (year

0), economic growth is significantly lower in conflict economies compared to non-conflict economies—2 percentage points lower. Nevertheless, three years after the start of conflicts, growth did not significantly pick up compared to non-conflict economies. If anything, economies with conflicts continued to see relative contraction for at least three years after the onset of conflicts, ranging from 0.3 to 1.1 percentage points lower than non-conflict economies. The contraction is statistically significant at D_{+2}.

On the other hand, growth in public debt is significantly higher for conflict economies than non-conflict economies three years after the onset of conflict as shown in Fig. 3, panel B. The difference is 8.6 to 13 percentage points and rises over time. These findings suggest that developing economies experiencing conflicts probably finance the increasing government expenditures by relying on public debt, particularly after the conflict starts. However, the debt financing does not appear to help growth, perhaps because the finance is devoted to activities related to military dimensions of armed conflicts.

4.3 Output and External Debt Growth Around Episodes of Debt Restructuring

Next, we analyze the growth dynamics in output and external debt around episodes of debt distress. Figure 4 shows the relative dynamics of external debt and output growth in developing countries with debt restructurings compared to countries without them. Economic growth for developing countries with debt distress is lower than for developing countries with no debt distress *before* restructuring episodes. This is clear evidence that the propensity to enter into an episode of debt restructuring is an endogenous outcome of low growth. One year before the start of the restructurings (D_{-1}), output growth is 2.3 percentage points lower, and the difference is statistically significant. Two and three years before such an event, on average, the growth rate of the treatment is also lower than in the control group, although these estimates are not statistically different from zero.

After the start of a debt restructuring, growth for affected countries continues to be significantly lower than countries without debt restructurings until three years after the onset of the restructuring. For example, one year after the start of restructurings (D_{+1}), output growth of developing countries with debt restructurings is 2.6 percentage points lower than developing countries with no debt restructurings. Two years after the beginning of the episode, on average, the growth rate of affected countries remains about 1.7 percentage points below that of the control group, but this estimate is not statistically significant. Overall, these findings suggest a large output cost of debt distress; further below we provide estimates aiming to attenuate the endogeneity bias that might be afflicting these estimates.

The results indicate that external debt growth is slower as the restructuring starts (compared to countries with no debt restructuring). At D_{+1} and D_{+2}, external debt growth in developing economies with debt restructurings is 14–26 percentage points lower than that in developing countries with no debt restructurings. The differences are statistically significant. This finding could reflect the exclusion of restructuring countries from international debt markets and/or the reduction in debt granted by creditors during the restructuring negotiations.
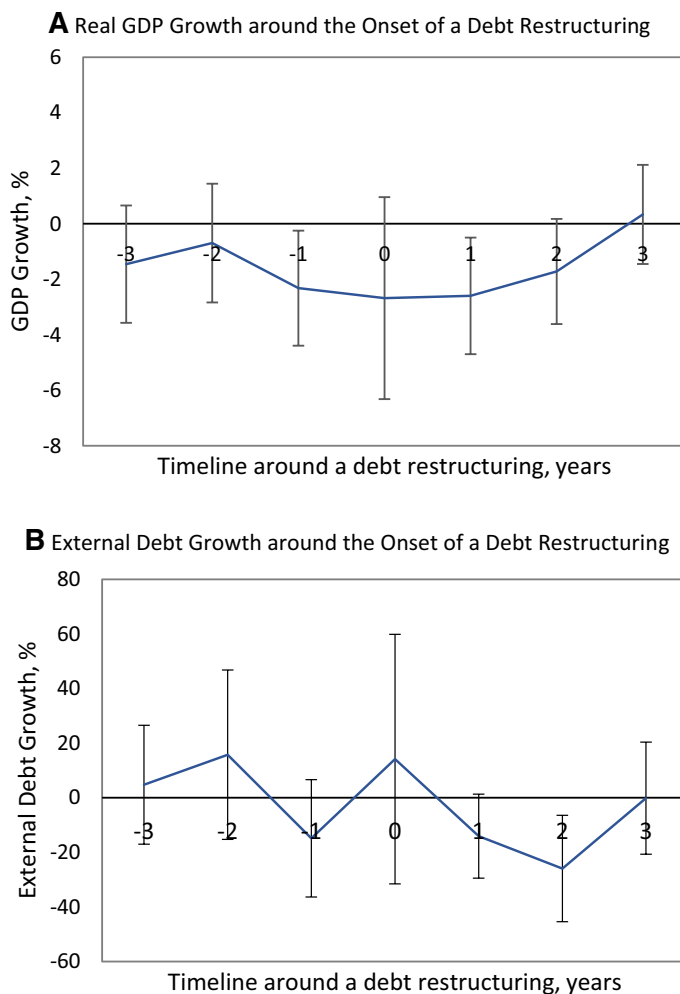
A Real GDP Growth around the Onset of a Debt Restructuring

B External Debt Growth around the Onset of a Debt Restructuring

Fig. 4 Output and external debt growth around the onset of debt restructurings. *Note*: This figure displays real GDP growth and external debt growth before, during, and after the onset of debt restructurings, relative to the baseline of no debt restructurings. The econometric framework difference-in-difference approach; $t = 0$: onset of a restructuring. $t = -3, -2, -1$ indicate the years before restructurings; $t = 1$, 2, 3 indicate the years after a restructuring starts. To control for overlapping events, we have added frequency indicators in all regressions. For each of the seven years on the timeline, there are three different counts: (1) how many windows of three years before a restructuring overlap with that specific year; (2) how many events start on the same year; and (3) how many windows of three years after a restructuring overlap with that specific year. Bars show 90% confidence interval based on robust standard errors. Results on central government debt, not just external debt, are available upon request

Note, however, that in the analyses of natural disasters and conflicts, the choice of debt is central government's debt. Here, the choice of debt is external debt because
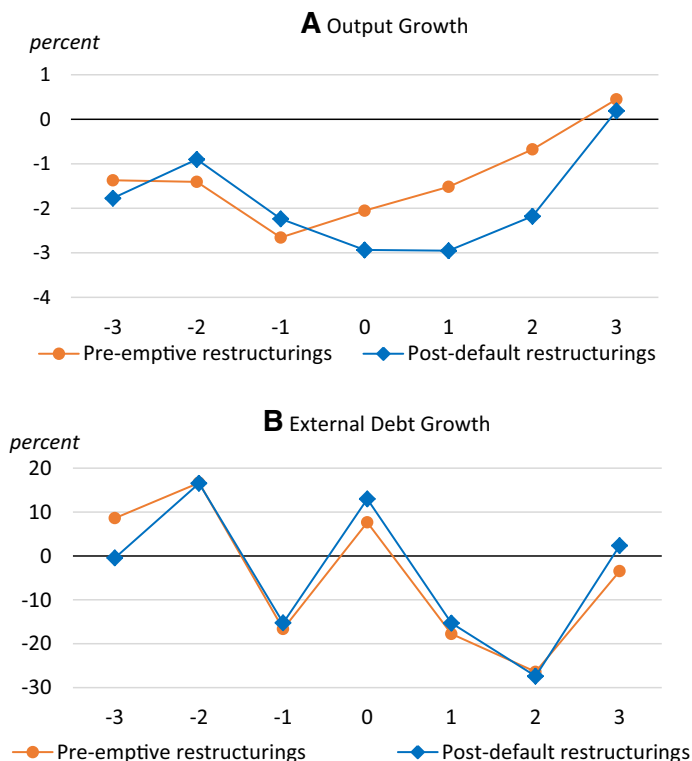
A Output Growth

B External Debt Growth

Fig. 5 Comparing preemptive with post-default restructurings. *Note*: The figure displays real GDP growth and external debt growth before, during, and after preemptive or post-default debt restructurings relative to the baseline of no debt restructurings. The econometric framework follows a difference-in-difference approach. $t=0$: onset of a restructuring. $t=-3, -2, -1$ indicate the years before restructurings; $t=1, 2, 3$ indicate the years after a restructuring starts. (Color figure online)

debt restructurings aim at resolving distress in external debt payments.[5] However, on the onset of a debt restructuring episode, governments may rely on other sources of debt, namely domestic debt, which would also be reflected in the central government debt. Additional results that are not presented here, however, show that central government debt also declines during a debt restructuring, but the difference is not statistically significant compared to the control group.

While any debt restructuring is associated with economic costs, preemptive restructurings appear to be less so on average than post-default debt restructuring. The corresponding results are shown in Fig. 5. Recall that there are two types of debt restructurings—preemptive and post-default. In preemptive restructurings, a country decides to restructure its external debt before it misses any payments. In a

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[5] Asonuma and Trebesch (2016) use external debt in their analysis of different type of debt distress episodes, showing that preemptive or post-default restructurings may affect differently access to international credit markets.

post-default restructuring, a country is forced to enter debt negotiations because it has missed payments (that is, defaulted). An important result not previously reported in the existing literature is that growth in affected economies relative to unaffected economies by post-default episodes during years $t+1$ through $t+3$ is negative, large in magnitude, and statistically different from zero, whereas the estimates for growth under episodes of preemptive debt restructurings are also negative, but smaller in magnitude, although they are not statistically different from zero at conventional levels.

Panel A shows that before debtor countries restructure, regardless of the type of restructurings, they experience slower growth than countries that do not restructure. However, after the first year of restructuring, growth starts to recover for countries with preemptive restructurings but remains depressed for countries with post-default restructurings. In fact, output growth of developing countries with preemptive restructurings is 1.5 and 0.6 percentage points lower than output growth of developing countries without restructurings, although the differences are not statistically significant. At the same time, one and two years after restructurings, the output growth of developing countries with post-default restructurings is 2.9 and 2.1 percentage points lower than the output growth of developing countries without restructurings. The differences are statistically significant. It is noteworthy that these results obtained with the difference-in-difference estimator are consistent with Asonuma and Trebesch's (2016) descriptive findings.

Panel B of Fig. 5 shows little difference in external debt growth between the two types of restructurings. This finding, combined with differential growth effects between preemptive and post-defaults restructurings, suggests that if countries have to enter debt restructuring negotiations, it might be better to do so preemptively. This is because it brings smaller output costs and has similar effects on debt growth compared to countries that restructure after they default.

Further, it is noteworthy that under both types of episodes of debt restructuring, growth remains below that of the control group, while external debt growth falls relative to the control group. However, a cursory inspection of the difference between the growth and debt coefficients indicates that the ratio of external debt falls as a share of GDP despite the fall in growth relative to the control group, because the relative decline in external debt growth falls by a larger extent.

Furthermore, by comparing the previous results on episodes of armed conflict and natural disasters, the expected evolution of debt over GDP is notably higher after the onset of armed conflict than in the aftermath of natural disasters. In the case of debt restructurings, as mentioned above, the debt ratio falls in the aftermath, while GDP growth falls because the fall in the stock of debt is larger than the fall in growth. Hence, episodes of natural disasters seem to provide more hopeful evidence about the prospects for debt sustainability in the aftermath of such episodes than after the onset of wars or debt restructurings, both of which imply large costs for the real economy. In addition, economies emerging from natural disasters are expected to face rising debt relative to GDP, which implies that debt vulnerabilities might continue to rise. This trend cannot continue unabated indefinitely; if the pace of growth remains below the growth rate of public debt years after the natural disaster, it might be prudent policy to consider an orderly preemptive debt restructuring,

rather than wait for an outright default that is likely to be more costly in terms of forgone growth.

5 Robustness Checks: Endogenous Propensity to Experience Debt Distress

In the previous section, we noted that the estimated coefficients on calamities do not necessarily capture causal effects due to potential endogeneity, especially for episodes associated with debt restructuring. In other words, unlike natural disasters, debt restructurings are not random events. They are usually the consequence of debt build up or, especially given the results discussed above, weak growth.

To mitigate the potential bias in the estimates of the impact of debt restructuring, we follow Jordà and Taylor (2016).[6] In a first step, the estimation approach consists of estimating the propensity score of an event (debt restructuring in this case) against observable characteristics. Here, as with the difference-in-difference estimations, we use three lags of GDP growth and external debt growth, which are the outcome indicators of interest. In a second step, the sample bias is corrected using the inverse of the estimated propensity score obtained in the first stage. Such adjustment generates counterfactuals where debt restructuring episodes occur quasi-randomly, contrary to the real world where those events are caused by some common features.

In the first step, we apply a country fixed effects estimation on the probability of a debt restructuring. Specifically, we use a Logit estimator with country and year fixed effects, along with a three-year distributed lag of both the GDP growth rate and the external debt growth rates, as the explanatory variables. This is our "saturated" Logit specification, borrowing the terminology from Jordà and Taylor (2016). Table 1 reports the results.

Table 1 reports the estimated Logit coefficients, as well as the net effect of the distributed lags of GDP growth and growth of external debt. The first column shows the results for all episodes of debt restructuring. The lagged growth rates have negative signs, with a significant net effect of -0.069, thus indicating that higher growth during the previous three years of one percentage point is associated with a fall in the probability of facing a restructuring of about 6.9%. In contrast, the net effect of external debt growth for three years has negligible impact on the probability of entering an episode of debt restructuring. The results on growth are even stronger for the case of preemptive restructurings. The net effect of growing by 1% is associated with a significant decline in the probability of a preemptive restructuring of about 24.4%. In contrast, neither GDP growth nor external debt growth has a significant impact on the probability of a post-default debt restructuring. These results are consistent with the previously discussed results from the difference-in-difference estimations where it was evident that sub-par GDP growth was associated with the advent of episodes of debt restructuring. In addition, these results suggest that

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[6] We gratefully acknowledge an anonymous referee for suggesting this approach.

Table 1 Logit estimates of the propensity to experience an episode of debt restructuring

Variables	(1)	(2)	(3)
	Episode: restructuring	Episode: preemptive	Episode: default
L. Δgdp	−0.029	−0.103*	−0.032
	[0.025]	[0.053]	[0.037]
L2. Δgdp	−0.027	−0.118**	0.010
	[0.024]	[0.056]	[0.038]
L3. Δgdp	−0.013	−0.023	−0.014
	[0.024]	[0.047]	[0.038]
L. Δdebt	−0.004	−0.017	0.001
	[0.008]	[0.016]	[0.009]
L2. Δdebt	−0.007	0.007	−0.007
	[0.008]	[0.017]	[0.011]
L3. Δdebt	0.007	0.024*	0.004
	[0.007]	[0.014]	[0.009]
Net effect of lagged GDP growth	−0.069	−0.244	−0.036
$Prob$(L. Δgdp + L2. Δgdp + L3. Δgdp = 0)	0.065	0.004	0.526
Net effect of lagged external debt growth	−0.004	+0.014	−0.002
$Prob$(L. Δdebt + L2. Δdebt+ L3. Δdebt =0)	0.759	0.506	0.883
Year and country fixed effects	Yes	Yes	Yes
Observations	1748	718	1012
Countries	51	23	30
Episodes	165	65	100
Log likelihood	−231.67	−70.45	−103.57

The table reports Logit coefficients on 3-year lags of GDP and external debt growth prior to the onset of an episode of debt restructuring. The second column shows the results for episodes of preemptive debt restructurings; the third shows the results for episodes of post-default restructurings. Samples are restricted to countries with at least one episode. The net effects are equal to the sum of the relevant coefficients. The table reports the probability of the null that the sum of the relevant coefficients is equal to zero. The specifications include country and year fixed effects. Standard errors are in brackets

***$p<0.01$; **$p<0.05$; *$p<0.1$

the endogeneity of the risk of entering such an episode is particularly important for episodes of preemptive restructuring.

In the second step, we apply the local projection method by Jordà (2005) to estimate the subsequent output and debt growth after debt restructuring by assigning weights to the observations used in the regressions. The weights are the inverse of the predicted probability that the event takes place, based on the estimation in the first stage. Figure 6 plots the dynamics of growth and debt after mitigating the propensity-allocation bias. The analyses are limited to the sample encompassing all episodes of debt restructuring, because of the limited number of countries and episodes for which the allocation bias adjustment could be applied in the first stage—see sample characteristics at the bottom of Table 1 above.
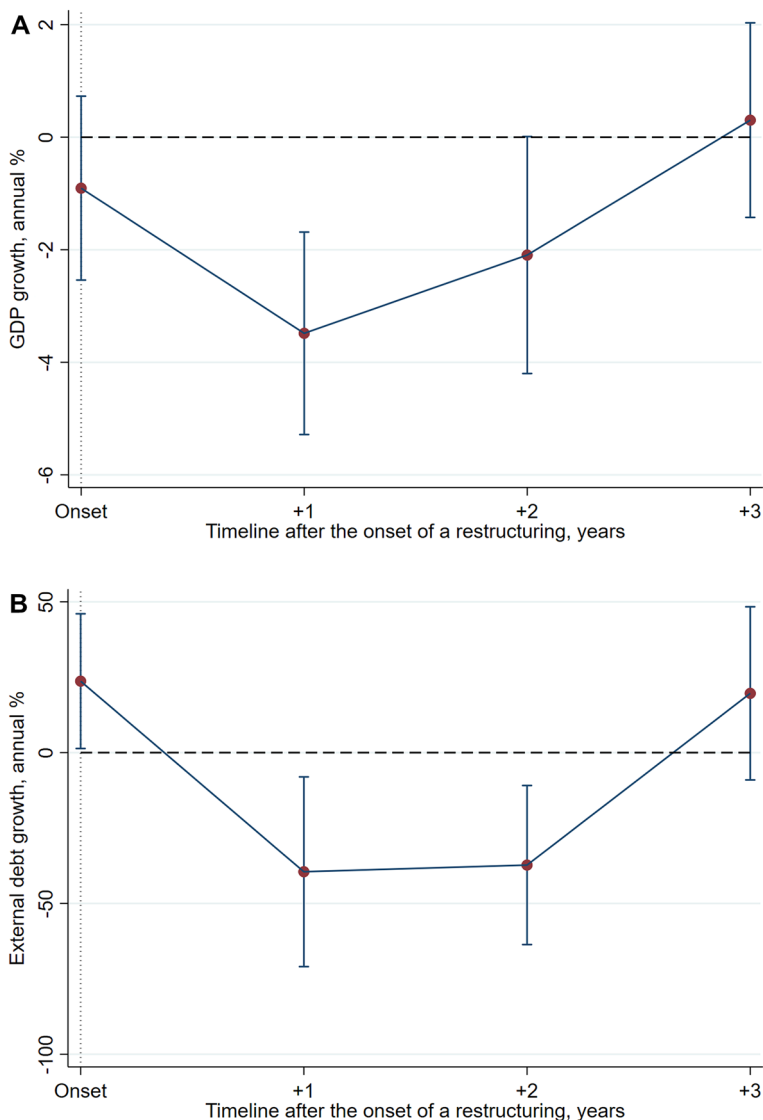
Fig. 6 Output and external debt growth after the onset of debt restructurings (with inverse probability weights). *Note*: This figure displays the impulse responses of real GDP growth and external debt growth after the onset of debt restructurings, relative to the baseline of no debt restructurings (with inverse probability weights). The econometric framework follows the local projection approach by Jordà (2005) with country and year fixed effects; $t=0$: onset of a restructuring. $t=-3, -2, -1$ indicate the years before restructurings; $t=1, 2, 3$ indicate the years after a restructuring starts. Bars show 90% confidence interval.

Panel A shows that growth drops relative to that of countries with similar pre-existing growth and debt trends but without a debt restructuring. These results are statistically stronger than the results reported in Fig. 4. One year after the

onset of the episode, GDP growth falls by 3.5 percentage points relative to the control group (versus -2.6 in Fig. 4, panel A); falls again in the second year by 2.1 (versus -1.7 in Fig. 4, panel A). Regarding growth in external debt, the fall is much greater in this sample after controlling for allocation bias than in Fig. 4. For example, in the first year after the onset, debt growth falls by 39.5 percentage points relative to the control group (versus -14.1 in Fig. 4, panel B) and falls by 37.3 in the second year post-onset (versus -25.9 in Fig. 4, panel B). Although these estimates appear too strong, they do lend credence to the idea that debt restructuring episodes are associated with both economic losses in terms of forgone GDP growth and notable reductions in the pace of external debt accumulation. These results, again, imply a downward trend in the external debt over GDP ratio after the onset of episodes of restructuring.

6 Conclusions

This paper is a first effort to systematically explore how growth and debt evolve around the onset of three types of calamities: natural disasters, armed conflicts, and episodes of debt distress. Moreover, the paper is relevant for the COVID-19 pandemic, as developing economies accumulated public debt during 2020–21 to cope with the pandemic.

The paper finds that debt and growth evolve quite differently depending on the type of calamity facing an economy. This finding carries important implications for economic management after the COVID-19 pandemic and more importantly for future calamities, including climate-related disasters.

The COVID-19 pandemic shares many traits with large natural disasters. Both pandemics and natural disasters are rare and largely unexpected shocks, and they are not directly caused by economic policies. Both result in economic contractions because people cannot work and conduct normal economic activity (due to physical destruction or safety concerns). Therefore, examining public debt and output growth around natural disasters can help understand how debt-financed fiscal expenditures can help the recovery from the pandemic.

The evidence presented above indicates that public debt and output growth tend to rise faster after natural disasters than in economies without disasters, thus illustrating how debt-financed fiscal expansions can help economic reconstruction. It is worth noting that the story might be different for high-income economies. Furthermore, on average, the expected path of the debt to GDP ratio is positive, because the growth of public debt after natural disasters strike tends to be higher than that of GDP growth. This realization should make us wary of post-Covid debt trends to the extent that the pandemic shares key characteristics with episodes of natural disasters that are unrelated to the previous debt and growth trends.

In contrast, episodes of debt distress characterized by the initiation of negotiations over debt restructuring are different in that economies entering such episodes tend to grow slower than countries that do not suffer debt distress prior to the

episode. Furthermore, episodes of preemptive debt restructuring are associated with higher growth relative to counterfactual than episodes of forced restructuring after debt defaults. This paper is the first to report the heterogeneity of relative trends across countries for these calamities. Hence to the extent that post-Covid debt over GDP trends continue on the upswing, it might be preferable to begin processes of orderly debt restructuring rather than wait until economies are forced to unilaterally default.

Declarations

Conflict of interest On behalf of all authors, I confirm that there are not conflicts of interest associated with this paper.

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