A Panel VARX Analysis of Debt and Natural Disasters in SIDs

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Abstract

This paper investigates whether there is statistical evidence to support a negative impact from natural disasters on SIDS' debt to GDP ratios. We study the difference between SIDS and non-SIDS in an effort to gauge whether size matters. This approach differs somewhat from the traditional literature, which has focused primarily on differences in development, educational attainment and institutional development, when assessing the impact of disasters. Using a PVARX specification, our results suggests that debt to GDP ratios increase in SIDS following storms and floods, and in contrast to Acevedo (2014), that the change in debt ratios are statistically significant. We also conclude that floods lead to faster debt accumulation than storms, and that debt increases less in non-SIDS, mainly because of their stronger macroeconomic fundamentals. The latter is observed when examining the significance of natural disaster intensity and the covariance between debt to GDP ratios, fiscal policy, growth and aid. Aid relief is found to play a significant mitigating role.

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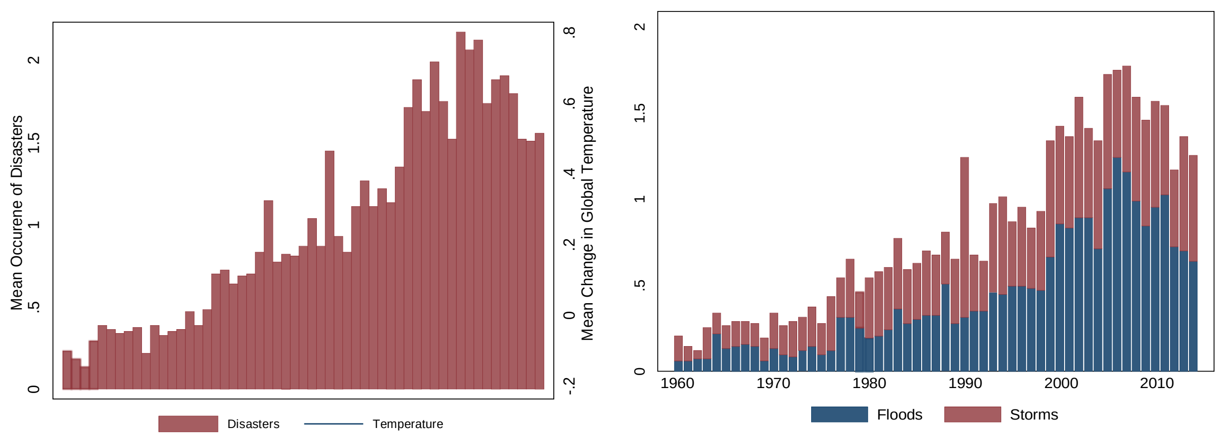
1 Introduction

In line with the steady rise in average global temperatures, the occurrence of natural disasters has increased dramatically. This change in climatic patterns has been particularly evident in Caribbean and Pacific SIDS, where Storms and floods are more frequent, and where disaster related costs now account for a higher proportion of gross GDP (see Guha-Sapir et al.).

Figure 1: Change in Average Global Temperature and the Frequency of Natural Disasters



Between 1994 and 2014, they were 168 disasters recorded in SIDS [2], the damage from which totalled U.S 3.9 billion dollars, or approximately 1.6 percent of SIDS' GDP. In contrast, over this same period, the damage from natural disasters impacting 62 non-SIDS was estimated at less than 1 percent of GDP, despite these countries experiencing a significantly larger number of disasters per country (See Appendix A). These stylized facts alone suggest a differential impact from disasters on SIDS versus non-SIDS.

Empirical studies on the topic confirm this hypothesis. Specifically, a majority of authors (for example, Noy and Nualsri (2011); Raddatz (2009); Rasmussen et al. (2004)) agree that disasters affect developing countries disproportionately, and that events of this nature often

[2] Based on our sample of 21 SIDS

have a negative macroeconomic impact, including on fiscal performance.

Our adjacent hypothesis is that there is likely to be a statistically significant and positive impact of natural disasters on debt - a huge development challenge for several small island countries. At present, more than half of SIDS hold debt to GDP ratios well above the IMF's 60 percent threshold, and quite a number of SIDS have undergone debt restructurings, many of which occurred in the past decade.

Table 1: Gross Debt to GDP Ratios and Debt Restructuring in SIDS (1995-2014)

Country	Gross Debt (2014)	Debt Restructurings
Antigua & Barbuda	98.23	1
The Bahamas	60.89	0
Barbados	100.73	0
Cabo Verde	114.00	0
Comoros	24.50	0
Dominica	76.37	1
Fiji	50.4	0
Grenada	100.47	1
Guinea-Bissau	54.28	0
Jamaica	135.69	2
Lesotho	47.78	0
Mauritius	56.17	0
Papua	35.58	0
Seychelles	65.32	1
Singapore	98.57	0
St. Lucia	79.38	0
St. Vincent and the Grenadines	76.65	0
Suriname	26.94	0
Trinidad and Tobago	39.25	0
Vanuatu	19.46	0

Source: World Bank Database

To our knowledge, only Acevedo (2014) has attempted to investigate the relationship between natural disasters and debt empirically, and we note that he does not find a statistically significant result. In this regard, we digress from the traditional literature and test the significance of disaster impact by size of country, rather than by income or level of development. Our justification rests on the fact that small countries are inherently more susceptible to disaster shocks, particularly because of their comparatively tiny land masses, and monocrop economies.

A disaster shock to a small land mass has a much greater probability of affecting the national population and gross domestic product. Further, most SIDS are dependent on one or two sectors, including: tourism, commodity exports and mineral production, all of which are indefensible against shocks from natural disasters. The important to our prior, however, is the fact that disasters in small countries often generate large and unexpected re-construction costs, which in some cases have to be financed by debt, especially in the absence of sufficient aid or primary resources.

To investigate the impact of disasters, we use a Panel Vector Auto-regression (PVARX) analysis with GMM/IV estimators and dynamic response functions. In addition, we explore whether they are indirect effects from disasters by way of analyzing impulse response functions (IRFs). IRFs help us to trace the covariance and dynamic response of variables important to debt accumulation, namely: the growth rate, primary balance and flows of net ODA.

We continue in the next section with a brief review of previous work done on this topic, and we then proceed to describing the PVARX model. In Section 4 we provide details on our data sources and describe important transformations. Results are discussed in the following section and then we conclude.

2 Review of Literature

Substantial research has been done on the macroeconomic implications of natural disasters. However, very few research papers have focused specifically on the direct impact of natural disasters on debt.

Studies suggest that the relative costs from natural disasters are much higher in developing than in advanced economies, and that Small island states are particularly vulnerable. Rasmussen et al. (2004) finds that the countries of the Eastern Caribbean stand out as among the most disaster-prone in the world. There is support for this view from work conducted by Sosa and Cashin (2009) who highlight the susceptibility of the Eastern Caribbean to disasters shocks. Using country-specific VAR models, they find that external shocks explain more than half of macroeconomic fluctuations in the region, and that domestic business cycles are especially vulnerable to changes in climatic conditions. They conclude, however, that negative effects from disasters in this region are short rather than long lasting.

On the contrary,Raddatz (2009) uncovers a long-run relationship between natural disasters and output when using panel time-series techniques. According to his study, a climate related disaster reduces real GDP per capita by at least 0.6 percent, with droughts having the largest average impact of approximately 1 percent of GDP per capita. Similar to Ramussen and Sosa and Cashin, he also finds that small states are more vulnerable than other countries, particularly to windstorms. Further, that aid plays a mitigating role, and hence, a country's level of external debt would not necessarily be statistically related to the output impact from disasters.

Because of the multi-country nature of this work, the chosen approach has usually been panel data and in a lot of cases, panel data combined with vector auto-regressive techniques. This is not surprising given several data limitations and the fact that there are no specific theoretical models that provide an explanation of the macroeconomic impact of disasters. One of the most comprehensive pieces of work using the Panel data VAR approach, is a paper by Fomby et al. (2009) who argue that the impact of some natural disasters can in fact be beneficial, at least when they are of moderate intensity, but that severe disasters never have a positive impact.

Authors have also sought to shed light on what determines the extent of natural disaster damage. These papers tend to have the objective of helping countries find appropriate mitigating policy options. Toya and Skidmore (2007) find that income (including aid) is not the only important factor in reducing deaths and damages due to disasters. Other factors such as higher educational attainment, greater openness, more complete financial systems, and smaller government can also lead to fewer losses. Conversely, Noy (2009) argues that countries with an increased ability to mobilize resources for reconstruction are better able to withstand an initial disaster shock, and to prevent further spillovers to the macro-economy.

The studies that have looked at the fiscal implications of disasters have found significant negative impacts on fiscal variables. Benson and Clay's (2004) analysis suggests that natural disasters cause significant budgetary pressures, with both short-term and long-term implications for economic growth and development. Additionally, that the primary fiscal response to disasters is a reallocation of resources. Benson and Clay also find that disasters have little impact on trends in flows of aid, a result in direct contradiction to that reported by Raddatz.

Melecky and Raddatz (2011) combine to investigate fiscal impacts by way of a panel vector autoregressive model and data for high and middle-income countries over 1975 to 2008. Their results are not entirely different. What is unique though is that they argue that natural disasters cause fiscal pressures through their effect on output, rather than directly, especially in lower-middle-income countries. Finally, they find that countries with more developed financial or insurance markets suffer less from disasters in terms of output declines.

Research by Noy and Nualsri (2011) links the fiscal impact to governments' policy behaviour. They find that in the aftermath of a disaster, developed countries adopt counter-cyclical policies, while developing countries adopt a more pro-cyclical stance. Scott-Joseph (2010) provides support for this conclusion. She empirically explores the effects of natural disasters expenditure on fiscal policy cyclicality, using a panel of ECCU states for the period 1980 to 2008. Her findings indicate that natural disasters create pressure for governments in the

ECCU to run pro-cyclical fiscal policies, and she identifies external public sector debt as the most important channel through which natural disasters expenditure affects fiscal cyclicality.

In perhaps the only piece of empirical research explicitly focusing on the impact of natural disasters on debt, Acevedo (2014) uses panel data and a vector autoregressive model with exogenous natural disasters shocks, to examine the effects of natural disasters on per capita GDP and the debt to GDP ratio. He finds that both storms and floods have a negative effect on growth, and that despite its statistical insignificance, debt increases with floods but not with storms. His evidence further suggests that there is weak support for debt relief's role in easing the negative effects of storms on debt.

3 Empirical Approach

We utilise the Panel VARX specification described in (1). The panel VARX is an extension of the basic panel VAR to allow for a linear relationship with a set of exogenous covariates (see Canova and Ciccarelli (2013)).

$$Y_t = A(l)_{i0} + A(l)_{i1} Y_{t-1} + F(l)_{ij} X_t + \mu_{it} \quad (1)$$

All variables in the vector Y_t are treated as endogenous, allowing us to uncover their joint dynamics. In addition, Y_t comprises a cross section dimension such that there exist y_{it} = $(y^I_{1t}, y^I_{2t}, \ldots\ldots y_{Nt})^I$, where $i = 1, 2 \ldots N$ indicates the number of cross sections, each of which possesses $t = 1, 2 \ldots T_i$ observations.

If we let G denote the number of endogenous variables (the debt to GDP ratio , real GDP growth, the primary balance and net ODA)), then vector Y_t takes on a G x 1 dimension in the panel VAR. The choice of variables comprising Y_t is motivated by our discussion of the literature.

Panel fixed effects are captured by the G x 1 vector $A(l)_{i0}$. Where l is a polynomial in the lag operator, with $A(l)_i = \sum_{i=0}^{N} A_i l^j$, for $j = 1, 2 \ldots \rho$ lags. The term $A(l)_{i1}$ is a G x N matrix of lagged coefficients, while $F(l)_{ij}$ is a G x M matrix of coefficients for the exogenous variables (natural disasters, financial crisis shocks and oil shocks) in the G x 1 vector X_t. Disturbances are labelled $\mu_{it} = (\mu_{1t}, \mu_{2t}, \ldots .\mu_{Nt})^I$, where μ is $\sim iid(0, \Sigma)$ and has dimension N x 1.

The model is estimated using the GMM/IV estimator. This estimator provides consistent estimates of the PVAR parameters even in panels with short time series, albeit normally with large N. The methodology provides three alternatives for removing bias, caused by $A(l)_{i0}$ and its correlation with the disturbance term. We opt for the forward orthogonal deviation approach, illustrated by the following equation:

$$m_{it} = (m_{it} - \overline{m}_{it}) \sqrt{T_{it}/(T_{it} + 1)} \tag{2}$$

Where m_{it} is an untransformed variable, respecifying the model in this form eliminates the time invariant characteristics. The mean $\overline{m}_{it}$ is derived from available future observations T_{it} rather than from past realisations of m_{it}. This specific estimator is preferred to the first differenced GMM/IV estimator primarily because of the relatively small N in our sample (see Abrigo et al. (2016)).

The GMM/IV estimator uses instrumentation to find the matrix of coefficients A that satisfies the sample moment conditions. It is given by:

$$A = \left(\overline{Y}^{*\prime} ZWZ^{\prime} \overline{Y}^{*}\right)^{-1} \left(\overline{Y}^{*\prime} ZWZ^{\prime} Y^{*}\right) \tag{3}$$

Y^* are the endogenous variables to the left of each equation, and $Y^{*\prime}$ are those on the right. The estimator assumes non-zero covariance $E[Y^*] \; /= \; 0$ between the endogenous variables and the matrix of instruments Z. Further, that $E[\mu_{it}] = 0$, the disturbances and matrix of instruments Z are orthogonal. Using these assumptions, for each equation, the GMM/IV estimator chooses a weighting matrix W to minimize the covariance between the instruments and disturbances. The weighting matrix is held to be non-singular, symmetric and positive semi-definite.

Before estimation, the lag order of the panel VAR specification has to be chosen. More lags ensures that $E[\mu_{it}] = 0$ but at the same time, implies that as j gets larger, $E[Y^*]$ tends to zero. We go about selecting the appropriate lag order using Andrews and Lu (2001) consistent moment and model selection criteria (MMSC) for GMM models, which are based on Hansen (1982) J statistic of over-identifying restrictions.

We consider three different versions of the MMSC, namely, the Akaike Information Criteria (AIC) (Akaike, 1969), Bayesian information critera (BIC) (Schwarz, 1978; Rissanen, 1978; Akaike 1979) and the Hannan-Quinn Information Criteria (HQIC) (Hannan and Quinn, 1979), together with the model coefficient of determination. The MMSCs with the lowest calculated value suggests optimality at the respective lag order, whilst the coefficient of determination captures the proportion of variation explained by the PVAR model, at different lags.

Ultimately, we are interested in tracing the impact from natural disaster shocks on debt and its determinants. This requires model stability. The PVARX model is stable if all moduli of the companion matrix A lie within the unit circle. From this point we can proceed with computing impulse response and dynamic multiplier functions.

Consider the compact form of the PVAR model in (1), abstracting for a moment from the exogenous terms. A stable model provides for invertibility and allows us to express Y_t as an infinite order vector moving average (VMA) of disturbance terms, or innovations. Starting from the PVAR compact form, the impulse response function is derived as follows:

$$Y_t = A(l)\,Y_{t-1} + \mu_t \tag{4}$$

$$(I - A(l))\,Y_t = \mu_t \tag{5}$$

$$Y_t = A_0 + A(l)^{-1}\mu_t \tag{6}$$

$$Y_t = \psi(l)\mu_t \tag{7}$$

Where $\psi(l) = \sum_{j=0}^{\infty} \varphi_j l^j = \sum_{j=1}^{\infty} A^j l^j$ is a polynomial of reduced-form responses to innovations. Note that $\varphi_0 = A_1^0 \equiv I$.

For the PVARX:

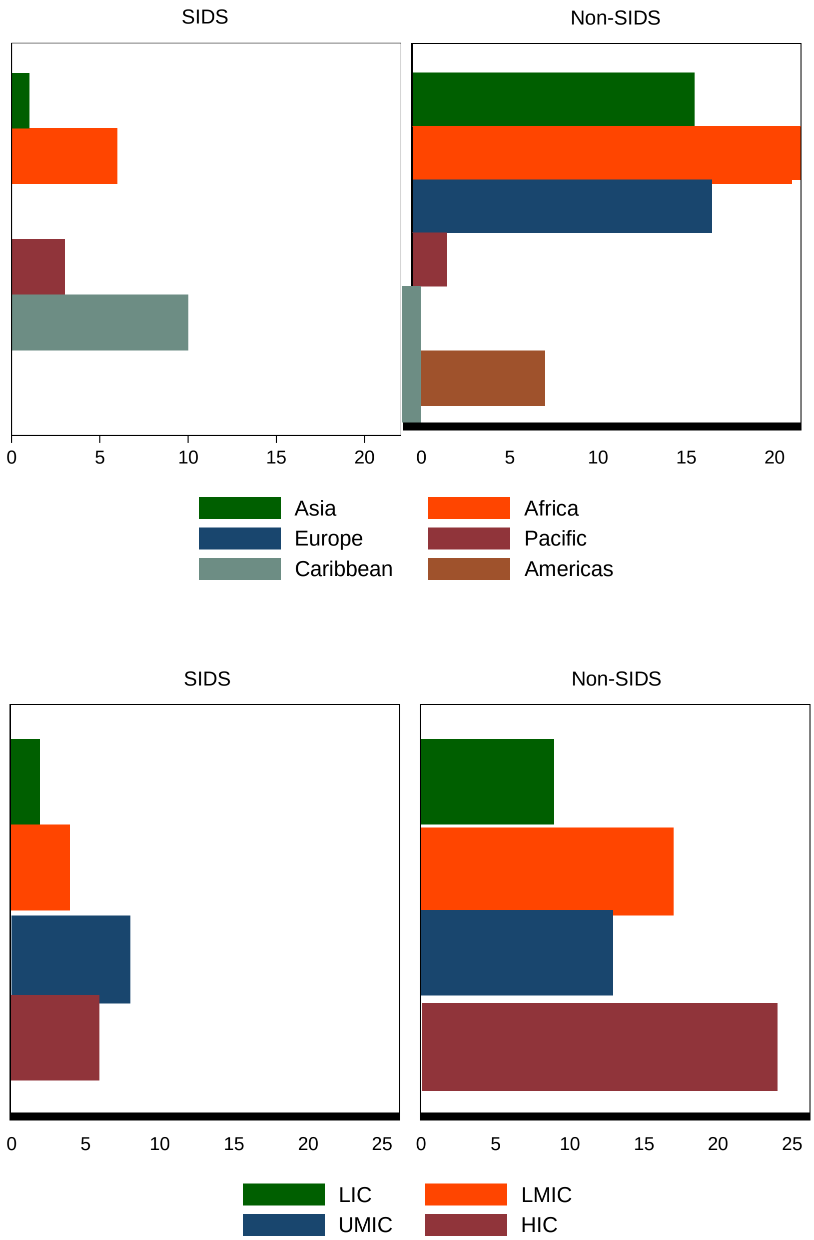
$$Y_t = \psi(l)\mu_t + D_t \tag{8}$$

Where D_t is the dynamic multiplier. This multiplier allows us to trace the impact on Y_t from a one unit change in the exogenous variables.

4 The Data

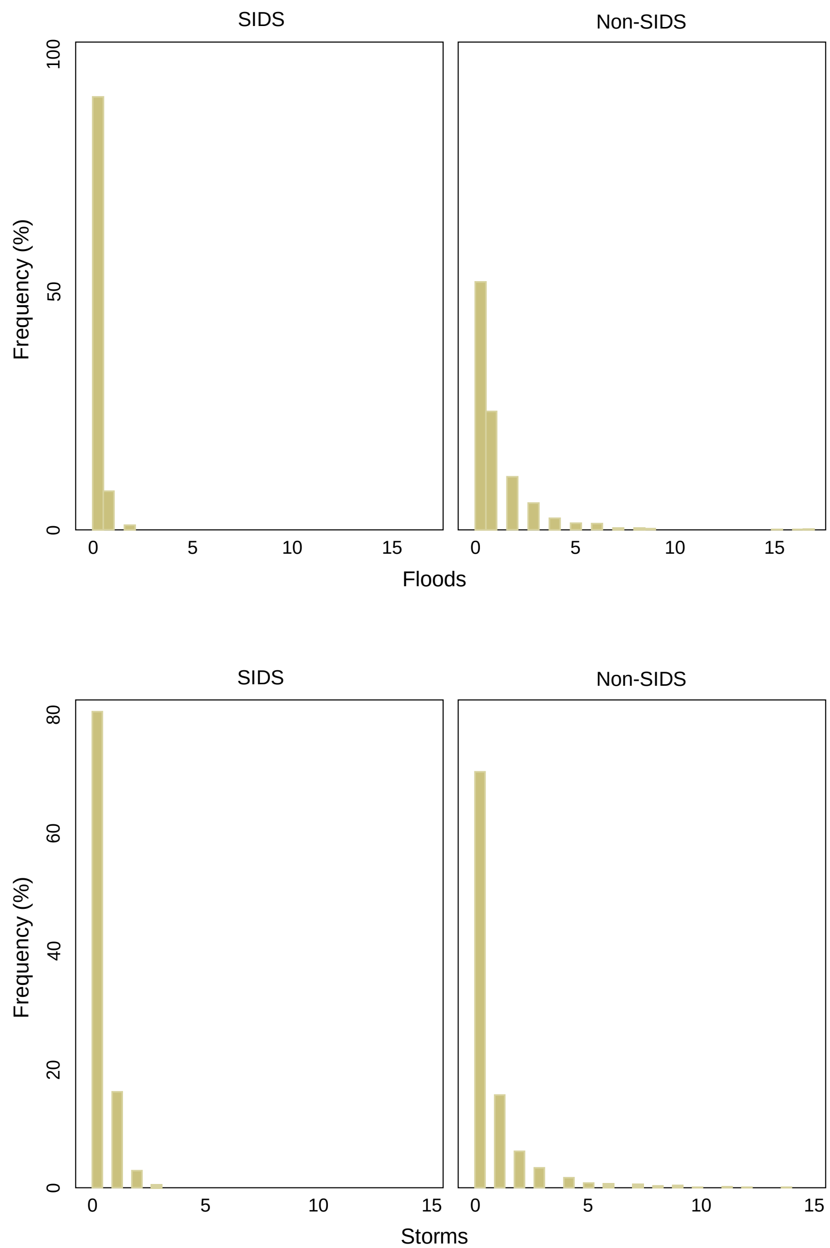
The study includes 83 countries, of which 20 are Small Island Developing States (SIDS). The United Nations definition of SIDS was utilized for the country selection. Our data covers the period 1994 to 2014, giving us a balanced panel with a total of 1743 observations.

Figure 2: Regional and Income Distribution of Countries in Sample



Data on natural disasters are taken from the International Disaster Database, EM-DAT. These include data on floods, storms, wild fires, extreme temperatures, land slides and droughts. As the data shows, storms and floods are much more prominent in both SIDS and non-SIDS when compared to the other set of disasters (see A10). Hence we focus on storm and flood impacts, and we let these variables equal one whenever a respective natural disaster occurs.

Figure 3: Distribution of Storms and Floods



In addition, we follow Acevedo (2014); Fomby et al. (2009), and construct a disaster intensity variable. We code intensity = 1 if any disaster of type k in country i, of any year t affects 0.01 percent of the population. The intensity variable is as follows:

$$intensity_{i,t}^{k} = \begin{cases} 1, & if \dfrac{fatalities_{i,t}^{k} + 0.3 * totalaffected_{i,t}^{k}}{population_{i,t}} > 0.0001 \\ 0, & otherwise \end{cases} \quad (9)$$

Data on nominal gross domestic product (GDP) come from the World Development Indicators (WDI) database (Group (2016)). Nominal GDP is measured in U.S dollars and in current prices. Whereas data for general government gross debt and the primary balance come from the IMF's World Economic Outlook (WEO)(Fund (2016)). The primary balance is defined as general government net lending/borrowing plus net interest payments. Both are measured as a ratio to nominal GDP and in U.S currency. A positive primary balance signifies a primary surplus. These data are supplemented by information from IMF Article IV reports and their statistical annexes. We collect data on net ODA from the WDI database. Net ODA is also measured in U.S dollar terms.

Dummy variables are employed to control for impacts on debt and growth caused by the financial crisis and oil crises. The former is defined as 1 for the years 2008 and 2009, and 0 otherwise. The dummy for oil shock has been defined as 1 for the years 1998, 2007, and 2008, and 0 otherwise.

According to the summary statistics for the review period, the average primary surplus is higher in non-SIDS and so is the level of debt relative to GDP ratios. More importantly, on average non-SIDS debt ratios are slightly lower than the IMF's 60 percent threshold, while SIDS generally hold more elevated debt. In terms of net ODA, SIDS receive a larger share and are not as high performing. SIDS mean growth rates lag behind those of non-SIDS by 0.6 of a percentage point.

Non-SIDS experience a larger number of disaster events per country and these disasters are on average more intense. Whereas storms and floods are almost as common in SIDS, in non-SIDS there storms are relatively more frequent (see Table 1).

Table 2: Summary Statistics

SIDS	N	Mean	SD	Min	Max
Primary Balance (% of GDP)	420	0.2	5.0	-17.7	18.0
Gross Debt (% of GDP)	420	71.5	47.1	12.6	377.1
Net ODA (% of GNI)	358	6.4	8.9	-2.6	78.7
Growth (%)	420	3.1	4.2	-28.1	19.2
Intensity of Natural Disasters (Dummy)	420	0.2	0.4	0.0	1.0
Occurrence of Floods (Number of events)	420	0.1	0.3	0.0	2.0
Occurrence of Storms (Number of events)	420	0.2	0.5	0.0	3.0
Non-SIDS					
Primary Balance (% of GDP)	1323	0.3	5.4	-29.9	36.0
Gross Debt (% of GDP)	1323	58.0	37.9	0.0	355.1
Net ODA (% of GNI)	778	5.4	7.7	-0.6	94.9
Growth (%)	1311	3.7	4.2	-50.2	35.2
Intensity of Natural Disasters (Dummy)	1323	0.4	0.5	0.0	1.0
Occurrence of Floods (Number of events)	1323	1.0	1.7	0.0	17.0
Occurrence of Storms (Number of events)	1323	0.7	1.5	0.0	14.0

5 Results

The final model specification employed is a PVARX of order 1 with 1 to 6 lags in our endogenous instruments and the exogenous variables in levels. The AIC, BIC and HQIC have the lowest values at lag order 1, and the coefficient of determination is highest at this lag order. This model is estimated using a ”gmmstlye” instrument set up with robust standard errors (see Abrigo et al. (2016)).[3] Stability checks suggests the PVARX is stable since all moduli are within the unit circle (see **??**).

Mindful of degrees of freedom limitations, we test the impact of storms and floods, as well as disaster intensity via individual PVARX regressions. This involves swapping in and out each disaster variable. Here we are particularly interested in the dynamic response of our endogenous variables to a one unit innovation in each of the disaster variables. We also assess the covariance between our endogenous variables through orthoganlised impulse response functions. In conjunction with Granger causality tests, we attempt to assess the extent to which there is an indirect impact of natural disasters on macroeconomic activity and debt.

Finally, we proceed to check the sensitivity of our results through reordering our variables in the PVARX. The results indicate that the results of the PVARX(1) are robust to changes in ordering. The specific results based on graphs of dynamic and impulse response functions are discussed below. Discussions on the variables' contemporaneous statistical significance are based on the results tables in Appendices C and D.

5.1 The Impact of Floods and Storms

The results suggest that floods generally have a larger impact in both SIDS and non-SIDS, and that the impact from an innovation in floods is relatively more persistent. We find that SIDS' gross debt to GDP ratio rises with floods and that the effects of this strike on debt

[3] The gmmstyle instrument estimator replace all missing values with zero, which allows for more efficient estimates. It is computed using the Stata package pvar.ado

can linger for up to five years. Storms on the other hand, have less of an impact on SIDS' debt ratios.

This debt accumulation after floods observed in SIDS is likely linked to reconstruction costs, thereby explaining the subsequent, albeit short-lived increase in GDP growth. On the contrary, we find that storms depress rather than boost economic activity, but that its effect on the economy disappears almost immediately.

Floods attract a greater level of aid than storms according to our estimates. As would be expected, however, aid relief is delayed, but picks up sharply just around a year after. The delay in aid disbursement after floods is common, given the need to assess damage, complete necessary paper work and to agree disbursement amounts. It is more than likely that the persistence in aid is linked to the staggering of aid disbursements. In SIDS, aid relief following storms arrives within the year of the disaster.

With respect to the fiscal implications, our estimates indicate that SIDS run a primary surplus in the aftermath of floods and storms. However, this positive externality is more pronounced following a flood. Savings from donor interventions; the switch to debt financing and use of these proceeds for expenditure additional to reconstruction; together with windfalls from expanded growth-in the case of floods, could all explain this outcome.

In non-SIDS, debt to GDP ratios fall on average both after floods and storms. However, with a similar pick in growth observed in SIDS. Unlike SIDS, non-SIDS seem to finance any reconstruction via primary balances, causing them to run small primary deficits in the subsequent years. Disbursements of official aid to assist non-SIDS are quick but not as high in volume.

Figure 4: The Impact of Flood Shocks

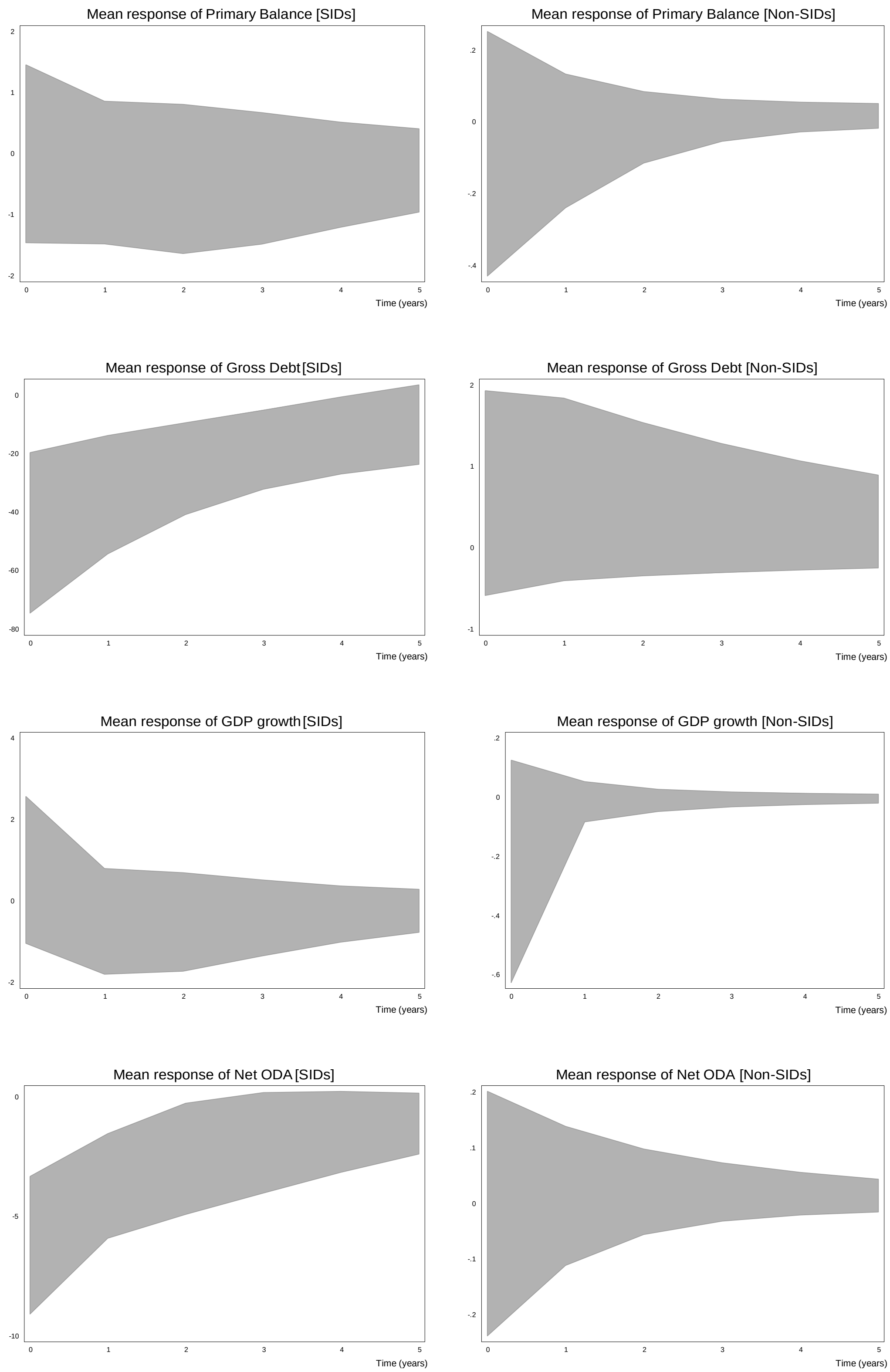
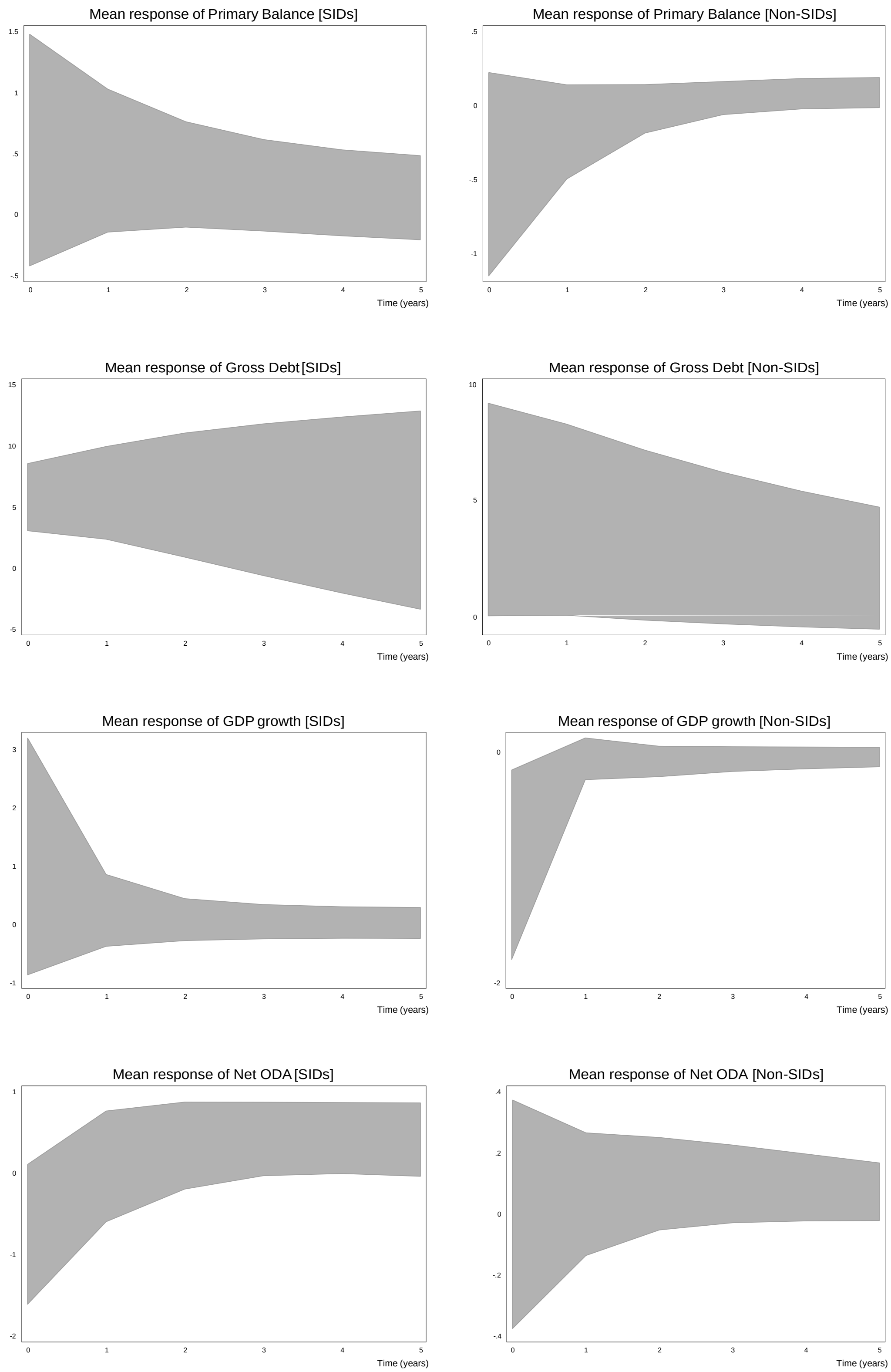


Figure 5: The Impact of Storm Shocks



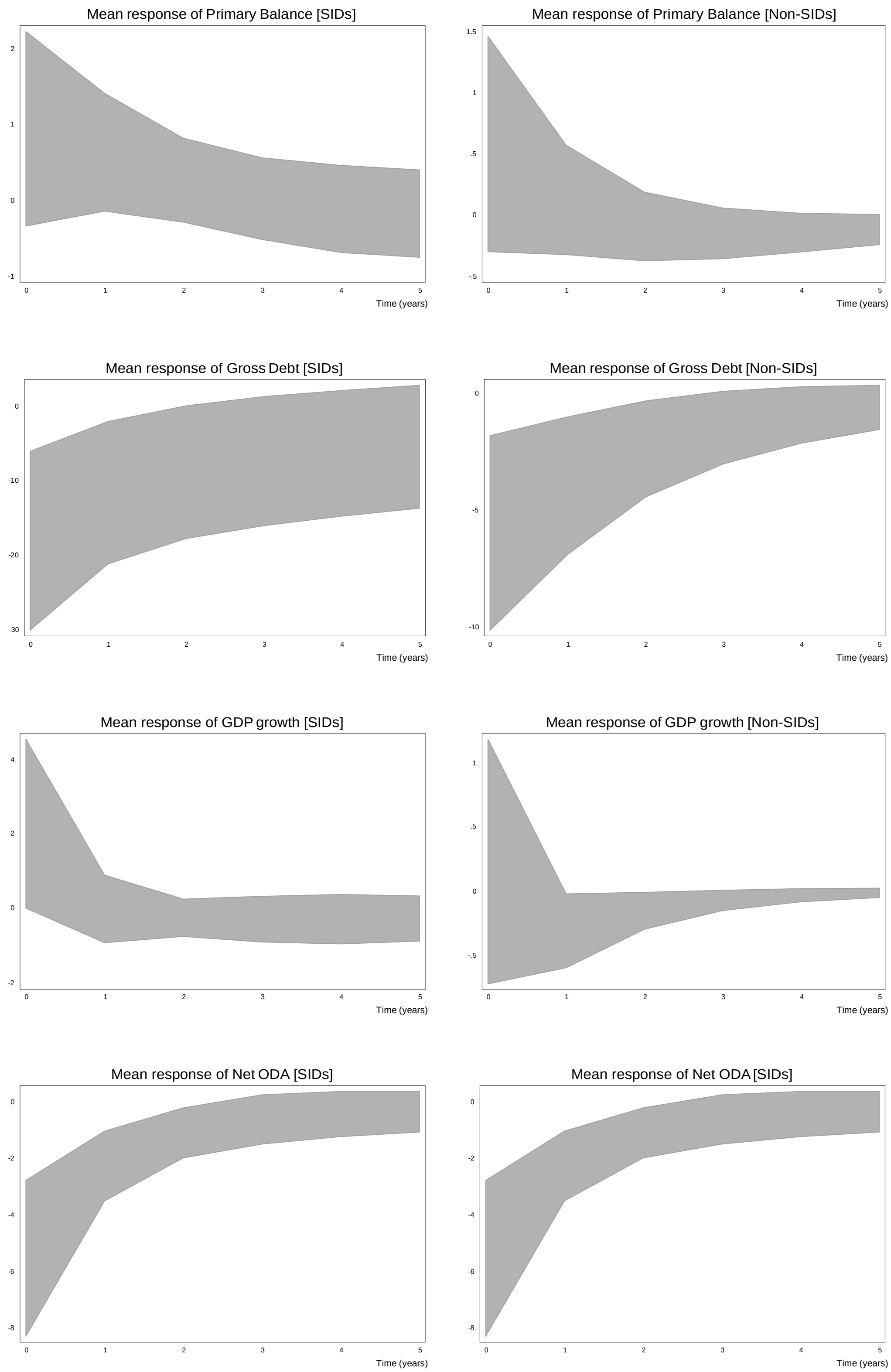
5.2 The Intensity of Natural Disasters

Using the disaster intensity indicator we find that after an intense climatic event, SIDS' gross debt to GDP ratio increases gradually year on year, with the effects of that shock fading at the end of five years. GDP growth from intense floods, for e.g, is noticeably higher, although also loosing steam in roughly two years. When we compare receipts of net aid for SIDS in the years after intense disasters, one major difference is that aid flows decrease during the first two years and then increase for the next three to four years after. This lends to our explanation above as one would expect even greater delays in assessment and aid agreement, if there is substantial disaster damage. SIDS seem to run a similar albeit larger primary surplus following intense disasters.

The growth dividend from reconstruction is much steeper and persists for longer than normal. In tandem debt ratios in non-SIDS show a more pronounced decline, while inflows of net ODA are fairly constant. That is, there doesn't seem to be a differential response of aid to intense versus less intense floods or storms.

We notice that the mean primary balance response for non-SIDS is fairly benign, which brings into question our expenditure switching argument. However, such would be the case if reconstruction efforts is carried out by the private sector on behalf of government. For example, through some public-private sector partnerships (PPP) arrangement.

Figure 6: The Impact of Intense Natural Disasters



5.3 Role of Growth, Primary Balance and Net ODA

In the above we looked at the direct impact of storms, floods and intense disasters on macroeconomic activity and debt. We are also interested in the indirect impact on the debt to GDP ratio, which can occur due to the covariance between intervening variables, including: growth, the primary balance and net ODA.

Assessing the interactions between these variables in the face of natural disaster shocks can inform on the channels through which debt to GDP ratios can be affected, beyond the direct influence of natural disasters on debt. To do this we analyze the orthogonal impulse response functions and Granger causality tests. The impulse response functions are generated using a composite disaster variable for both SIDS and non-SIDS. This variable comprises of all natural disasters affecting country i in any year t. The Granger causality test allows us to determine which variables are at least weakly exogenous in driving debt accumulation following floods or storms.

The IRFs for the weakly exogenous variables are provided in Figure 4 for SIDS and Figure 5 for non-SIDS. It would seem that aid does play a mitigating role in SIDS, least in the context of natural disasters. Our results indicate that the the debt to GDP ratio falls in response to rises in net ODA innovations, when SIDS are struck by a disaster. Aid increases following an exogenous expansion in the primary surplus but this trend reverses fairly quickly. Such implies a delay in government disaster spending of roughly one to two years. Additionally that it takes donors and affected countries at least one year to finalise aid assistance.

Debt ratio levels also fall with increases to growth, suggesting that growth too plays a mitigating role. Put differently, the growth dividend gained through reconstruction efforts help to ease the direct impact of natural disasters on debt. So debt to GDP ratios would grow in SIDS if net ODA is small and late in coming, following disasters, and if countries lack the resources to commence reconstruction.

In non-SIDS the IRFs suggests more mainstream economic relationships, and a larger tool kit for responding to accelerations in debt. This could explain the finding that in non-SIDS, the impact on debt is softer than in SIDS. Governments in non-SIDS response positively and successfully to increases in the debt to GDP ratio. Further more, if this debt is used for reconstruction, the response of growth is large and long lasting, which contributes positively to the subsequent debt reduction effort. We find that donors provide support for non-SIDS even after their economy is growing. All this point to a low probability of indirect effects on non-SIDS debt to GDP ratios.

Figure 7: Natural Disaster Shocks and the Covariance of Macroeconomic Variables in SIDS

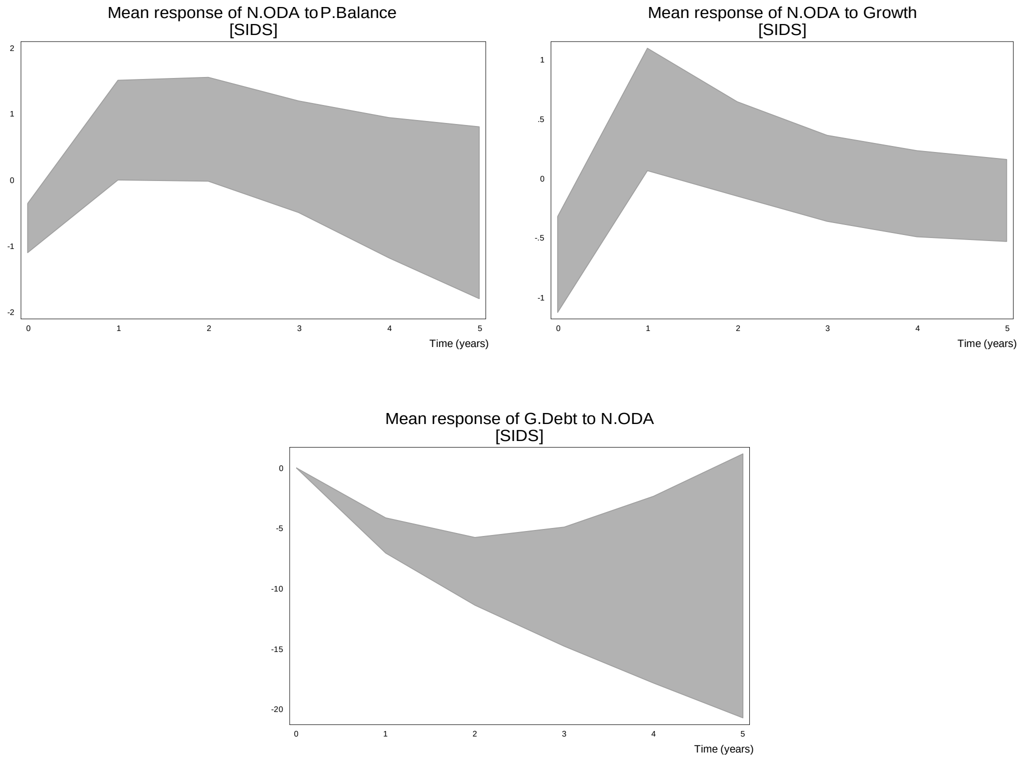
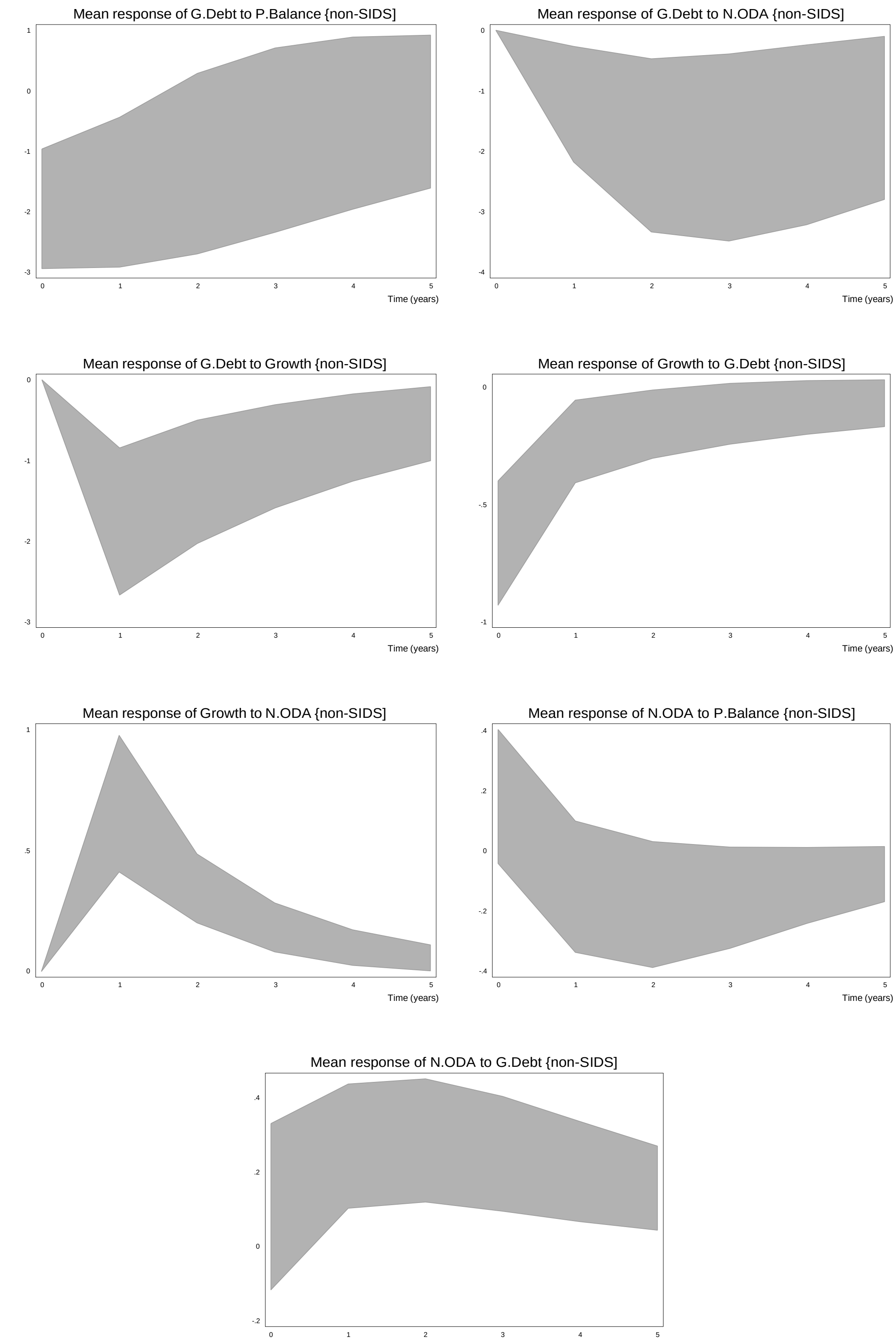


Figure 8: Natural Disaster Shocks and the Covariance of Macroeconomic Variables in non-SIDS



6 Conclusion

The study investigated the impact of natural disasters on debt in SIDS and non-SIDS. We find statistical evidence that debt to GDP ratios rise in SIDS following natural disasters, and that the accumulation of debt is greater than in non-SIDS. The result is more in line with expectations than that derived by Avecedo. It is worth the while explaining why this is the case.

Most of the literature, has focused on the differential impact of natural disasters for developing and developed countries. None have considered whether size rather than income determines disaster impact. Avecedo's data set is limited to the set of ECCU countries, which many in the literature have found to suffer negative macroeconomic effects following natural disaster events. In the context of debt however, it is not surprising that Avecedo failed to find a significant result given that these countries have limited access to capital markets, and the fact that they are more dependent on aid for relief and other purposes. Our data set is wider than the ECCU and includes a set of countries who are more indebted and have access to capital markets. Jamaica is a good example.

In addition to the above, we find that the impact on debt in SIDS differ when wedisaggregate disasters by floods and storms. Floods cause more damage and thus, invokes a larger increase in debt as measured against GDP.

In both cases there is evidence of a growth dividend, which we attribute to reconstruction efforts post disaster. However, we find that in contrast to floods, storms actually depress economic activity.

Our evidence lends support to the claim that aid plays a mitigating role with respect to the impact of disasters on debt. The IRFs indicate that this occurs by way of donors' budget support, which helps to cushion SIDS and non-SIDS' primary balances.

Intense disasters increase debt in SIDS but not in non-SIDS. We provide a few explanations to support this finding. SIDS have more equipped fiscal tools to respond to natural disaster shocks, and thus the capability of limiting pass-through effects. Also, there is a larger and much more protracted growth dividend in non-SIDS, driven in part it would seem by PPPs rather than by pure increases in government activity.

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Appendices

A Disaster Statistics

Table A1: Occurence of Natural Disasters in SIDS (1995-2014)

SIDS	Storms	Floods	Droughts	Land Slides	Wild Fire	Ext.Temps
Antigua and Barbuda	6	0	0	0	0	0
Bahamas, The	12	1	0	0	0	0
Barbados	4	0	1	0	0	0
Cabo Verde	0	1	2	0	0	0
Comoros	2	2	0	0	0	0
Dominica	6	0	0	0	0	0
Fiji	12	9	1	0	0	0
Grenada	3	0	1	0	0	0
Guinea-Bissau	0	4	2	0	1	0
Jamaica	16	2	2	0	0	0
Lesotho	6	2	3	0	0	0
Mauritius	5	1	1	0	0	0
Papua New Guinea	4	9	1	8	1	0
Seychelles	2	2	0	0	0	0
Singapore	0	0	0	0	0	0
St. Lucia	5	2	1	1	0	0
St. Vincent and the Grenadines	5	2	0	0	0	0
Suriname	0	2	0	0	0	0
Trinidad and Tobago	2	1	1	1	0	0
Vanuatu	8	2	0	0	0	0
Total	98	42	16	10	2	0

Table A2: Occurence of Natural Disasters in Non-SIDS (1995-2014)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fires	Ext.Temps
Albania	0	0	0	0	0	0
Algeria	0	0	0	0	0	0
Australia	50	38	2	2	20	5
Austria	7	11	0	2	0	5
Bahrain	0	0	0	0	0	0
Bangladesh	79	46	1	3	0	17
Belgium	13	10	0	0	0	6
Bhutan	2	3	0	0	1	0
Botswana	1	7	1	0	0	0
Brazil	9	69	10	11	3	4
Brunei Darussalam	0	0	0	0	1	0
Bulgaria	4	18	1	0	4	9
Canada	24	26	0	0	12	2
Denmark	7	0	0	0	0	0
El Salvador	12	11	4	0	0	1
Ethiopia	0	39	9	2	1	0
Finland	0	1	0	0	0	0
France	32	32	1	2	5	11
Gabon	3	1	0	0	0	0
Germany	31	13	0	1	0	10
Ghana	0	14	0	0	0	0
Greece	4	20	0	0	8	3
Haiti	28	33	2	0	0	0
Honduras	13	20	9	0	1	0
Iceland	0	0	0	2	0	0
India	67	153	4	25	1	31
Italy	7	28	3	5	4	8
Japan	72	18	0	6	1	6
Jordan	2	1	2	0	0	1
Kenya	0	40	9	4	0	0
Kuwait	0	1	0	0	0	0
Madagascar	36	5	5	0	0	0
Malawi	2	27	4	0	0	0
Malaysia	6	29	2	4	4	0
Morocco	4	20	1	0	0	2
Namibia	0	13	5	0	0	0
New Zealand	8	10	2	0	0	1
Nigeria	4	40	0	2	0	1
Norway	3	3	0	0	0	0
Pakistan	14	54	1	14	0	11
Panama	1	27	1	0	1	0

Table A2: Occurence of Natural Disasters in Non-SIDS (1995-2014)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fires	Ext.Temps
Paraguay	7	10	6	0	1	3
Philippines	156	99	3	21	1	0
Portugal	7	8	2	0	5	4
Qatar	0	0	0	0	0	0
Rwanda	0	9	3	3	0	0
Saudi Arabia	0	13	0	0	0	0
Senegal	3	14	3	0	0	0
South Africa	20	24	2	1	8	2
Spain	12	15	1	1	10	6
Sri Lanka	5	37	3	3	0	0
Sudan	2	29	4	0	1	0
Swaziland	2	3	2	0	1	0
Sweden	4	0	0	0	1	1
Switzerland	14	5	0	4	0	6
Tanzania	4	24	5	1	1	0
Tunisia	0	5	0	0	0	0
Uganda	4	18	6	4	0	0
United Kingdom	21	28	0	0	0	7
Venezuela,	2	24	1	1	0	0
Vietnam	61	59	4	5	1	0
Zambia	0	16	2	1	0	0
Zimbabwe	2	11	5	0	0	0
Total	871	1332	131	130	97	163

Table A3: Damage from Natural Disasters in SIDS (1995-2015, Percent of GDP)

SIDS	Storms	Floods	Droughts	Land Slides	Wild Fires	Ext.Temps
Antigua and Barbuda	4.193	0.000	0.000	0.000	0.000	0.000
Bahamas, The	1.640	0.025	0.000	0.000	0.000	0.000
Barbados	0.007	0.000	0.000	0.000	0.000	0.000
Cabo Verde	0.000	0.000	0.000	0.000	0.000	0.000
Comoros	0.000	0.043	0.000	0.000	0.000	0.000
Dominica	4.371	0.000	0.000	0.000	0.000	0.000
Fiji	0.272	0.231	0.000	0.000	0.000	0.000
Grenada	7.135	0.000	0.000	0.000	0.000	0.000
Guinea-Bissau	0.000	0.000	0.000	0.000	0.000	0.000
Jamaica	0.661	0.010	0.003	0.000	0.000	0.000
Lesotho	0.000	0.000	0.000	0.000	0.000	0.000
Mauritius	0.231	0.000	0.194	0.000	0.000	0.000
Papua New Guinea	0.000	0.068	0.000	0.000	0.000	0.000
Seychelles	0.031	0.014	0.000	0.000	0.000	0.000
Singapore	0.000	0.000	0.000	0.000	0.000	0.000
St. Lucia	0.167	0.000	0.000	0.000	0.000	0.000
St. Vincent and the Grenadines	0.334	0.714	0.000	0.000	0.000	0.000
Suriname	0.000	0.000	0.000	0.000	0.000	0.000
Trinidad and Tobago	0.000	0.000	0.000	0.000	0.000	0.000
Vanuatu	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.952	0.055	0.010	0.000	0.000	0.000

Table A4: Damage from Natural Disasters in non-SIDS (Percent of GDP)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fires	Ext.Temps
Albania	0.000	0.000	0.000	0.000	0.000	0.000
Algeria	0.000	0.000	0.000	0.000	0.000	0.000
Australia	0.081	0.066	0.024	0.000	0.016	0.000
Austria	0.017	0.082	0.000	0.001	0.000	0.005
Bahrain	0.000	0.000	0.000	0.000	0.000	0.000
Bangladesh	0.269	0.697	0.000	0.000	0.000	0.000
Belgium	0.010	0.003	0.000	0.000	0.000	0.000
Bhutan	0.000	0.000	0.000	0.000	0.040	0.000
Botswana	0.000	0.004	0.000	0.000	0.000	0.000
Brazil	0.003	0.014	0.025	0.001	0.000	0.004
Brunei Darussalam	0.000	0.000	0.000	0.000	0.002	0.000
Bulgaria	0.046	0.106	0.000	0.000	0.007	0.000
Canada	0.021	0.027	0.000	0.000	0.008	0.000
Denmark	0.095	0.000	0.000	0.000	0.000	0.000
El Salvador	0.474	0.206	0.082	0.000	0.000	0.000
Ethiopia	0.000	0.008	0.010	0.000	0.000	0.000
Finland	0.000	0.000	0.000	0.000	0.000	0.000
France	0.055	0.014	0.000	0.000	0.000	0.011
Gabon	0.000	0.000	0.000	0.000	0.000	0.000
Germany	0.033	0.046	0.000	0.000	0.000	0.004
Ghana	0.000	0.022	0.000	0.000	0.000	0.000
Greece	0.007	0.037	0.000	0.000	0.048	0.000
Haiti	0.618	0.001	0.000	0.000	0.000	0.000
Honduras	3.564	0.120	0.014	0.000	0.000	0.000
Iceland	0.000	0.000	0.000	0.004	0.000	0.000
India	0.076	0.164	0.021	0.000	0.000	0.003
Italy	0.003	0.085	0.006	0.000	0.000	0.014
Japan	0.044	0.011	0.000	0.000	0.000	0.000
Jordan	0.000	0.001	0.000	0.000	0.000	0.000
Kenya	0.000	0.017	0.000	0.000	0.000	0.000
Kuwait	0.000	0.000	0.000	0.000	0.000	0.000
Madagascar	0.616	0.130	0.000	0.000	0.000	0.000
Malawi	0.000	0.022	0.000	0.000	0.000	0.000
Malaysia	0.003	0.029	0.000	0.000	0.014	0.000
Morocco	0.013	0.033	0.108	0.000	0.000	0.000
Namibia	0.000	0.010	0.025	0.000	0.000	0.000
New Zealand	0.001	0.021	0.029	0.000	0.000	0.018
Nigeria	0.000	0.024	0.000	0.000	0.000	0.000
Norway	0.002	0.009	0.000	0.000	0.000	0.000
Pakistan	0.054	0.473	0.019	0.000	0.000	0.000
Panama	0.000	0.009	0.022	0.000	0.000	0.000

Table A4: Damage from Natural Disasters in non-SIDS (Percent of GDP)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fires	Ext.Temps
Paraguay	0.004	0.004	0.000	0.000	0.010	0.000
Philippines	0.356	0.096	0.000	0.002	0.000	0.000
Portugal	0.006	0.027	0.034	0.000	0.090	0.000
Qatar	0.000	0.000	0.000	0.000	0.000	0.000
Rwanda	0.000	0.000	0.000	0.000	0.000	0.000
Saudi Arabia	0.000	0.012	0.000	0.000	0.000	0.000
Senegal	0.000	0.040	0.000	0.000	0.000	0.000
South Africa	0.008	0.017	0.000	0.000	0.007	0.000
Spain	0.009	0.008	0.024	0.000	0.011	0.011
Sri Lanka	0.004	0.054	0.002	0.000	0.000	0.000
Sudan	0.000	0.099	0.000	0.000	0.000	0.000
Swaziland	0.000	0.000	0.000	0.000	0.000	0.000
Sweden	0.037	0.000	0.000	0.000	0.001	0.000
Switzerland	0.036	0.035	0.000	0.020	0.000	0.004
Tanzania	0.000	0.000	0.000	0.000	0.000	0.000
Tunisia	0.000	0.000	0.000	0.000	0.000	0.000
Uganda	0.000	0.001	0.001	0.000	0.000	0.000
United Kingdom	0.017	0.045	0.000	0.000	0.000	0.000
Venezuela, RB	0.000	0.159	0.000	0.000	0.000	0.000
Vietnam	0.477	0.350	0.101	0.001	0.000	0.000
Zambia	0.000	0.028	0.000	0.000	0.000	0.000
Zimbabwe	0.001	0.227	0.000	0.000	0.000	0.000
Total	0.112	0.059	0.009	0.000	0.004	0.001

Table A5: Damage from Natural Disasters in SIDS (1995-2014, US Dollars Per Capita)

SIDS	Storms	Floods	Droughts	Land Slides	Wild Fire	Ext.Temps
Antigua and Barbuda	314.90	0.00	0.00	0.00	0.00	0.00
Bahamas, The	354.22	5.67	0.00	0.00	0.00	0.00
Barbados	0.91	0.00	0.00	0.00	0.00	0.00
Cabo Verde	0.00	0.00	0.00	0.00	0.00	0.00
Comoros	0.00	0.32	0.00	0.00	0.00	0.00
Dominica	143.56	0.00	0.00	0.00	0.00	0.00
Fiji	8.93	9.41	0.00	0.00	0.00	0.00
Grenada	414.96	0.00	0.00	0.00	0.00	0.00
Guinea-Bissau	0.00	0.00	0.00	0.00	0.00	0.00
Jamaica	27.40	0.36	0.11	0.00	0.00	0.00
Lesotho	0.00	0.00	0.00	0.00	0.00	0.00
Mauritius	7.77	0.00	7.09	0.00	0.00	0.00
Papua New Guinea	0.00	0.57	0.00	0.00	0.00	0.00
Seychelles	4.93	1.05	0.00	0.00	0.00	0.00
Singapore	0.00	0.00	0.00	0.00	0.00	0.00
St. Lucia	11.47	0.00	0.00	0.00	0.00	0.00
St. Vincent and the Grenadines	17.93	47.04	0.00	0.00	0.00	0.00
Suriname	0.00	0.00	0.00	0.00	0.00	0.00
Trinidad and Tobago	0.04	0.00	0.00	0.00	0.00	0.00
Vanuatu	0.00	0.00	0.00	0.00	0.00	0.00
Total	65.35	3.22	0.36	0.00	0.00	0.00

Table A6: Damage from Natural Disasters in Non-SIDS (1995-2014, U.S Dollars Per Capita)

Non-SIDS	Storm	Flood	Drought	Land Slide	Wild Fire	Ext. Temps
Albania	0.00	0.00	0.00	0.00	0.00	0.00
Algeria	0.00	0.00	0.00	0.00	0.00	0.00
Australia	30.19	28.68	4.85	0.00	5.77	0.00
Austria	8.17	26.22	0.00	0.25	0.00	1.64
Bahrain	0.00	0.00	0.00	0.00	0.00	0.00
Bangladesh	1.21	2.88	0.00	0.00	0.00	0.00
Belgium	3.87	1.09	0.00	0.00	0.00	0.00
Bhutan	0.00	0.00	0.00	0.00	0.30	0.00
Botswana	0.00	0.14	0.00	0.00	0.00	0.00
Brazil	0.14	1.18	1.96	0.06	0.01	0.14
Brunei Darussalam	0.00	0.00	0.00	0.00	0.30	0.00
Bulgaria	3.59	5.40	0.00	0.00	0.12	0.00
Canada	6.79	11.41	0.00	0.00	3.04	0.00
Denmark	35.60	0.00	0.00	0.00	0.00	0.00
El Salvador	13.65	7.88	1.82	0.00	0.00	0.00
Ethiopia	0.00	0.01	0.01	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00	0.00
France	15.95	4.44	0.01	0.01	0.01	3.37
Gabon	0.00	0.00	0.00	0.00	0.00	0.00
Germany	12.21	15.14	0.00	0.00	0.00	1.13
Ghana	0.00	0.09	0.00	0.00	0.00	0.00
Greece	1.46	5.30	0.00	0.00	10.43	0.01
Haiti	3.05	0.01	0.00	0.00	0.00	0.00
Honduras	31.64	1.24	0.09	0.00	0.00	0.00
Iceland	0.00	0.00	0.00	1.03	0.00	0.00
India	0.56	1.57	0.09	0.00	0.00	0.02
Italy	1.04	17.80	1.62	0.03	0.09	3.76
Japan	15.72	4.11	0.00	0.01	0.00	0.00
Jordan	0.00	0.01	0.00	0.00	0.00	0.00
Kenya	0.00	0.17	0.00	0.00	0.00	0.00
Kuwait	0.00	0.00	0.00	0.00	0.00	0.00
Madagascar	1.91	0.41	0.00	0.00	0.00	0.00
Malawi	0.00	0.03	0.00	0.00	0.00	0.00
Malaysia	0.12	2.24	0.00	0.00	0.66	0.00
Morocco	0.42	0.48	1.50	0.00	0.00	0.00
Namibia	0.00	0.45	1.33	0.00	0.00	0.00
New Zealand	0.46	4.67	10.14	0.00	0.00	2.45
Nigeria	0.00	0.19	0.00	0.00	0.00	0.00
Norway	1.34	3.28	0.00	0.00	0.00	0.00
Pakistan	0.51	5.18	0.09	0.01	0.00	0.00
Panama	0.00	0.39	2.50	0.00	0.00	0.00

Table A6: Damage from Natural Disasters in Non-SIDS (1995-2014, U.S Dollars Per Capita)

Non-SIDS	Storm	Flood	Drought	Land Slide	Wild Fire	Ext. Temps
Paraguay	0.20	0.10	0.00	0.00	0.24	0.00
Philippines	7.98	1.81	0.00	0.02	0.00	0.00
Portugal	1.33	6.14	6.13	0.00	15.36	0.00
Qatar	0.00	0.00	0.00	0.00	0.00	0.00
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00
Saudi Arabia	0.00	2.06	0.00	0.00	0.00	0.00
Senegal	0.00	0.22	0.00	0.00	0.00	0.00
South Africa	0.25	0.88	0.00	0.00	0.43	0.00
Spain	2.51	1.72	3.82	0.02	3.00	1.99
Sri Lanka	0.13	1.47	0.06	0.00	0.00	0.00
Sudan	0.00	0.80	0.00	0.00	0.00	0.00
Swaziland	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	15.63	0.00	0.00	0.00	0.74	0.00
Switzerland	18.41	18.31	0.00	7.93	0.00	1.82
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00
Tunisia	0.00	0.00	0.00	0.00	0.00	0.00
Uganda	0.00	0.01	0.00	0.00	0.00	0.00
United Kingdom	5.06	16.44	0.00	0.00	0.00	0.00
Venezuela, RB	0.00	6.81	0.00	0.00	0.00	0.00
Vietnam	3.46	2.12	0.40	0.00	0.00	0.00
Zambia	0.00	0.10	0.00	0.00	0.00	0.00
Zimbabwe	0.00	1.10	0.00	0.00	0.00	0.00
Total	3.88	3.37	0.58	0.15	0.64	0.26

Table A7: Frequency of Natural Disasters Per Land Area in SIDS (1995-2014, Sq Km)

SIDS	Storms	Floods	Droughts	Land Slides	Wild Fire	Ext.Temps
Antigua and Barbuda	0.014	0.0E+00	0	0	0	0
Bahamas, The	0.001	1.0E-04	0	0	0	0
Barbados	0.009	0.0E+00	0.002325581	0	0	0
Cabo Verde	0.000	2.5E-04	0.000496278	0	0	0
Comoros	0.001	1.1E-03	0	0	0	0
Dominica	0.008	0.0E+00	0	0	0	0
Fiji	0.001	4.9E-04	5.47345E-05	0	0	0
Grenada	0.009	0.0E+00	0.002941176	0	0	0
Guinea-Bissau	0.000	1.4E-04	7.11238E-05	0	3.55619E-05	0
Jamaica	0.001	1.8E-04	0.000184672	0	0	0
Lesotho	0.000	6.6E-05	9.88142E-05	0	0	0
Mauritius	0.002	4.9E-04	0.000492611	0	0	0
Papua New Guinea	0.000	2.0E-05	2.20819E-06	1.76655E-05	2.20819E-06	0
Seychelles	0.004	4.4E-03	0	0	0	0
Singapore	0.000	0.0E+00	0	0	0	0
St. Lucia	0.008	3.3E-03	0.001639344	0.001639344	0	0
St. Vincent and the Grenadines	0.013	5.1E-03	0	0	0	0
Suriname	0.000	1.3E-05	0	0	0	0
Trinidad and Tobago	0.000	1.9E-04	0.000194932	0.000194932	0	0
Vanuatu	0.001	1.6E-04	0	0	0	0
Total	0.073	0.016	0.009	0.002	0.000	0.000

Table A8: Frequency of Natural Disasters Per Land Area in Non-SIDS (1995-2014, Sq Km)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fire	Ext.Temps
Albania	0	0	0	0	0	0
Algeria	0	0	0	0	0	0
Australia	6.49351E-06	4.93506E-06	2.5974E-07	2.5974E-07	2.5974E-06	6.49351E-07
Austria	8.48166E-05	0.000133283	0	2.42333E-05	0	6.05833E-05
Bahrain	0	0	0	0	0	0
Bangladesh	0.000606899	0.000353384	7.68226E-06	2.30468E-05	0	0.000130598
Belgium	0.000429326	0.000330251	0	0	0	0.000198151
Bhutan	5.247E-05	7.8705E-05	0	0	2.6235E-05	0
Botswana	1.76451E-06	1.23516E-05	1.76451E-06	0	0	0
Brazil	1.07143E-06	8.21429E-06	1.19048E-06	1.30952E-06	3.57143E-07	4.7619E-07
Brunei Darussalam	0	0	0	0	0.000189753	0
Bulgaria	3.6846E-05	0.000165807	9.2115E-06	0	3.6846E-05	8.29035E-05
Canada	2.63736E-06	2.85714E-06	0	0	1.31868E-06	2.1978E-07
Denmark	0.000164978	0	0	0	0	0
El Salvador	0.000579151	0.000530888	0.00019305	0	0	4.82625E-05
Ethiopia	0	0.000039	0.000009	0.000002	0.000001	0
Finland	0	3.29066E-06	0	0	0	0
France	5.84414E-05	5.84414E-05	1.82629E-06	3.65259E-06	9.13147E-06	2.00892E-05
Gabon	1.16428E-05	3.88093E-06	0	0	0	0
Germany	8.89424E-05	3.72984E-05	0	2.86911E-06	0	2.86911E-05
Ghana	0	6.15276E-05	0	0	0	0
Greece	3.10318E-05	0.000155159	0	0	6.20636E-05	2.32739E-05
Haiti	0.001015965	0.001197388	7.25689E-05	0	0	0
Honduras	0.000116186	0.000178747	8.04361E-05	0	8.93735E-06	0
Iceland	0	0	0	1.99501E-05	0	0
India	2.23333E-05	0.000051	1.33333E-06	8.33333E-06	3.33333E-07	1.03333E-05
Italy	2.37982E-05	9.51928E-05	1.01992E-05	1.69987E-05	1.3599E-05	2.71979E-05
Japan	0.000197498	4.93746E-05	0	1.64582E-05	2.74303E-06	1.64582E-05
Jordan	2.25276E-05	1.12638E-05	2.25276E-05	0	0	1.12638E-05
Kenya	0	7.02815E-05	1.58133E-05	7.02815E-06	0	0
Kuwait	0	5.61167E-05	0	0	0	0
Madagascar	6.18769E-05	8.59402E-06	8.59402E-06	0	0	0
Malawi	2.12134E-05	0.000286381	4.24268E-05	0	0	0
Malaysia	1.82621E-05	8.82666E-05	6.08735E-06	1.21747E-05	1.21747E-05	0
Morocco	8.96258E-06	4.48129E-05	2.24065E-06	0	0	4.48129E-06
Namibia	0	1.57903E-05	6.07319E-06	0	0	0
New Zealand	3.03824E-05	3.7978E-05	7.59561E-06	0	0	3.7978E-06
Nigeria	4.39189E-06	4.39189E-05	0	2.19594E-06	0	1.09797E-06
Norway	8.21366E-06	8.21366E-06	0	0	0	0
Pakistan	1.81611E-05	7.00498E-05	1.29722E-06	1.81611E-05	0	1.42694E-05
Panama	1.34517E-05	0.000363196	1.34517E-05	0	1.34517E-05	0

Table A8: Frequency of Natural Disasters Per Land Area in Non-SIDS (1995-2014, Sq Km)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Wild Fire	Ext.Temps
Paraguay	1.76189E-05	2.51699E-05	1.51019E-05	0	2.51699E-06	7.55097E-06
Philippines	0.000523191	0.000332025	1.00614E-05	7.04296E-05	3.35379E-06	0
Portugal	7.64192E-05	8.73362E-05	2.18341E-05	0	5.45852E-05	4.36681E-05
Qatar	0	0	0	0	0	0
Rwanda	0	0.000364816	0.000121605	0.000121605	0	0
Saudi Arabia	0	6.19048E-06	0	0	0	0
Senegal	1.5582E-05	7.27159E-05	1.5582E-05	0	0	0
South Africa	1.66667E-05	0.00002	1.66667E-06	8.33333E-07	6.66667E-06	1.66667E-06
Spain	2.39899E-05	2.99874E-05	1.99916E-06	1.99916E-06	1.99916E-05	1.1995E-05
Sri Lanka	7.97321E-05	0.000590018	4.78393E-05	4.78393E-05	0	0
Sudan	8.33333E-07	1.20833E-05	1.66667E-06	0	4.16667E-07	0
Swaziland	0.000116279	0.000174419	0.000116279	0	5.81395E-05	0
Sweden	9.81981E-06	0	0	0	2.45495E-06	2.45495E-06
Switzerland	0.000354287	0.000126531	0	0.000101225	0	0.000151837
Tanzania	4.51569E-06	2.70942E-05	5.64462E-06	1.12892E-06	1.12892E-06	0
Tunisia	0	3.21833E-05	0	0	0	0
Uganda	1.99481E-05	8.97666E-05	2.99222E-05	1.99481E-05	0	0
United Kingdom	8.6802E-05	0.000115736	0	0	0	2.8934E-05
Venezuela, RB	2.26745E-06	2.72093E-05	1.13372E-06	1.13372E-06	0	0
Vietnam	0.00019673	0.00019028	1.29003E-05	1.61254E-05	3.22508E-06	0
Zambia	0	2.1523E-05	2.69038E-06	1.34519E-06	0	0
Zimbabwe	5.16996E-06	2.84348E-05	1.29249E-05	0	0	0
Total	0.005289587	0.007029358	0.000933482	0.000542284	0.000533021	0.000930904

Table A9: Total Affected as Percentage of Population in SIDS (1995-2014)

Non-SIDS	Storms	Floods	Droughts	Land Slides
Antigua and Barbuda	0.02507447	0	0	0
Bahamas, The	0.004465313	0.000146404	0	0
Barbados	0.000936515	0	0	0
Cabo Verde	0	1.5606E-05	0.004161604	0
Comoros	0.000766687	0.005285537	0	0
Dominica	0.009187763	0	0	0
Fiji	0.005294605	0.001834422	0.015185782	0
Grenada	0.028633322	0	0	0
Guinea-Bissau	0	0.001924933	0.004340321	0
Jamaica	0.01124032	0.000545147	0.001663517	0
Lesotho	0.000232481	0.000124308	0.042277494	0
Mauritius	0.000171617	3.23508E-06	0	0
Papua New Guinea	0.001450592	0.003189898	0.003985449	8.85009E-05
Seychelles	0.005608714	0.003246187	0	0
Singapore	0	0	0	0
St. Lucia	0.052646168	0.006360942	0	5.06352E-05
St. Vincent and the Grenadines	0.003390783	0.007758817	0	0
Suriname	0	0.003056337	0	0
Trinidad and Tobago	2.05898E-05	7.35348E-06	0	4.41209E-05
Vanuatu	0.02511888	0.000908718	0	0
Total	0.174238818	0.034407842	0.071614169	0.000183257

Table A10: Total Affected as Percentage of Population in Non-SIDS (1995-2014)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Ex.Temps
Albania	0	0	0	0	0
Algeria	0	0	0	0	0
Australia	0.009447053	0.000623602	0	2.36418E-07	0.003750577
Austria	1.74555E-06	0.000358513	0	5.81851E-05	0
Bahrain	0	0	0	0	0
Bangladesh	0.007713703	0.036511865	0	1.89108E-05	0.000141694
Belgium	8.0325E-06	1.61508E-05	0	0	0
Bhutan	0.004906479	0.000120775	0	0	0
Botswana	1.02502E-05	0.004051452	0	0	0
Brazil	4.49155E-05	0.001820958	0.011096166	4.11291E-05	0
Brunei Darussalam	0	0	0	0	0
Bulgaria	5.423E-06	0.000365699	0	0	2.39465E-06
Canada	1.31963E-05	0.000261307	0	0	0
Denmark	0	0	0	0	0
El Salvador	0.002132183	0.002542511	0.003235961	0	0
Ethiopia	0	0.001177919	0.025030586	1.2296E-07	0
Finland	0	3.62624E-06	0	0	0
France	0.003047061	5.1559E-05	0	2.13471E-07	7.74878E-06
Gabon	0.0001519	0.002730865	0	0	0
Germany	1.77148E-05	0.000257625	0	0	9.59317E-08
Ghana	0	0.004185832	0	0	0
Greece	2.65591E-06	6.26221E-05	0	0	7.6379E-07
Haiti	0.013656501	0.00266703	0.00540098	0	0
Honduras	0.016575671	0.007440585	0.014027127	0	0
Iceland	0	0	0	1.33497E-05	0
India	0.002078859	0.017608533	0.014827996	5.6515E-05	2.11829E-09
Italy	8.61026E-08	7.76096E-05	0	3.23254E-06	0
Japan	0.000479565	0.000215254	0	2.30415E-07	4.16994E-05
Jordan	2.01982E-06	0	0.002962404	0	1.07724E-07
Kenya	0	0.003976791	0.061404248	3.54386E-08	0
Kuwait	0	3.9154E-06	0	0	0
Madagascar	0.01501582	0.000360765	0.004205672	0	0
Malawi	2.25518E-05	0.007020601	0.03884801	0	0
Malaysia	9.04757E-05	0.001402976	0.00416091	5.49127E-07	0
Morocco	0.000184508	0.000367275	0.000433673	0	1.18274E-05
Namibia	0	0.0261352	0.020543035	0	0
New Zealand	3.50701E-05	9.5451E-05	0	0	0
Nigeria	5.52119E-06	0.003442988	0	1.03445E-07	0
Norway	6.13859E-06	6.2409E-05	0	0	0
Pakistan	0.000691745	0.015599137	0.000693787	1.05415E-05	1.02176E-07
Panama	0.00010935	0.00206404	0	0	0

Table A10: Total Affected as Percentage of Population in Non-SIDS (1995-2014)

Non-SIDS	Storms	Floods	Droughts	Land Slides	Ex.Temps
Paraguay	0.001161891	0.006216403	0.014965479	0	0
Philippines	0.061302219	0.012300983	0.001473252	0.000179205	0
Portugal	1.97035E-05	1.98091E-05	0	0	0
Qatar	0	0	0	0	0
Rwanda	0	0.000331071	0.010792967	4.33402E-05	0
Saudi Arabia	0	4.84492E-05	0	0	0
Senegal	0.000412412	0.005004199	0.00755265	0	0
South Africa	0.000147396	0.000503708	0.015680936	0	0
Spain	3.89526E-07	1.5653E-05	0	1.42753E-07	7.74626E-08
Sri Lanka	0.001310136	0.022539623	0.011235736	4.38926E-06	0
Sudan	4.5516E-08	0.006591411	0.014656154	0	0
Swaziland	0.000330948	0.011838325	0.059428477	0	0
Sweden	0	0	0	0	0
Switzerland	6.12424E-07	3.57311E-05	0	1.13617E-05	0
Tanzania	4.62586E-06	0.000301266	0.012052689	1.83469E-07	0
Tunisia	0	0.000160638	0	0	0
Uganda	1.74268E-05	0.001824462	0.006608846	3.3633E-05	0
United Kingdom	0.000244334	0.000304425	0	0	3.69627E-08
Venezuela, RB	3.13498E-06	0.001552869	0	9.3868E-07	0
Vietnam	0.008738652	0.013488551	0.003583411	6.29883E-07	0
Zambia	0	0.017297724	0.00983691	5.96609E-07	0
Zimbabwe	0	0.00125235	0.043766173	0	0
Total	0.150150121	0.245311092	0.418504234	0.000477776	0.003957127

B Model Specification and Stability

Table A11: Consistent Moment and Model Selection Criteria

Lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	0.9973907	75.41252	0.6243229	-358.9351	-84.58748	-195.2785
2	0.9982847	69.70665	0.2916097	-277.7715	-58.29335	-146.8461
3	0.9983388	57.09498	0.17298	-203.5136	-38.90502	-105.3196
4	0.9965926	20.57186	0.9406103	-153.1672	-43.42814	-87.70454

: **note: With IV of 1 to 6 lags, the CD, MBIC, MAIC and MQIC all indicate a PVAR of lag order 1.

Table A12: Roots of the Companion Matrix

Eigenvalue		
Real	Imaginary	Modulus
0.6237367	0	0.6237367
0.6117308	0.0931694	0.6187852
0.6117308	-0.0931694	0.6187852
0.1033067	0	0.1033067

**note: Eigenvalues lie inside the unit circle. PVAR satisfies the stability condition.

C PVARX Results for SIDS

Table A13: Impact of Floods in SIDS

	Endogenous Variables			
	Primary Balance	Gross Debt	GDP Growth	Net ODA
	b/se	b/se	b/se	b/se
L.Primary Balance	0.47***	-0.33	0.08	0.34**
	(0.08)	(0.31)	(0.07)	(0.11)
L.Gross Debt	0.02	0.94***	0.02	0.02
	(0.01)	(0.07)	(0.02)	(0.02)
L.GDP growth	-0.02	-0.66+	0.09	0.13+
	(0.06)	(0.36)	(0.08)	(0.07)
L.Net ODA	-0.09+	-1.73***	-0.04	0.45***
	(0.05)	(0.24)	(0.06)	(0.06)
Floods	0.00	-47.04***	0.77	-6.21***
	(0.72)	(14.19)	(0.95)	(1.49)
Financial Crisis	-0.04	-1.82	-3.06***	-6.82***
	(0.70)	(4.60)	(0.73)	(1.70)
Debt Restructuring	4.92	-9.65	3.93	4.23*
	(3.50)	(6.52)	(3.73)	(2.02)
No.of Observations	318.00			
No.of Panels	18.00			
Max Lag Order	1.00			
Criterion Function	0.21			
Hansen's J Stat	66.60			
Hansen's J Df	80.00			

+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table A14: Impact of Storms in SIDS

	Endogenous Variables			
	Primary Balance b/se	Gross Debt b/se	GDP Growth b/se	Net ODA b/se
L.Primary Balance	0.46***	-0.84**	0.05	0.14+
	(0.08)	(0.27)	(0.09)	(0.08)
L.Gross Debt	0.02+	1.08***	0.00	0.03+
	(0.01)	(0.04)	(0.02)	(0.02)
L.GDP growth	-0.06	-0.66**	0.14	0.19**
	(0.07)	(0.21)	(0.10)	(0.06)
L.Net ODA	-0.16**	-1.49***	-0.03	0.52***
	(0.06)	(0.19)	(0.08)	(0.05)
Storms	0.53	5.79***	1.16	-0.75+
	(0.50)	(1.39)	(1.03)	(0.43)
Financial Crisis	0.12	5.13*	-2.52**	-4.28**
	(0.74)	(2.10)	(0.86)	(1.49)
Debt Restructuring	5.05	-17.09**	8.78	3.01*
	(3.71)	(6.22)	(5.54)	(1.30)
No.of Observations	318.00			
No.of Panels	18.00			
Max Lag Order	1.00			
Criterion Function	0.18			
Hansen's J Stat	55.99			
Hansen's J Df	80.00			

+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table A15: The Intensity of Natural Disasters

	Endogenous Variables			
	Primary Balance b/se	Gross Debt b/se	GDP Growth b/se	Net ODA b/se
L.Primary Balance	0.49***	-0.93*	0.06	0.18+
	(0.08)	(0.41)	(0.09)	(0.11)
L.Gross Debt	0.03+	0.99***	0.04	0.01
	(0.02)	(0.10)	(0.03)	(0.03)
L.GDP growth	0.00	-0.33	0.08	0.17
	(0.08)	(0.42)	(0.13)	(0.11)
L.Net ODA	-0.12+	-1.43***	-0.10	0.46***
	(0.07)	(0.41)	(0.11)	(0.09)
Disaster Intensity	0.94	-18.09**	2.28*	-5.53***
	(0.69)	(5.70)	(1.12)	(1.42)
Financial Crisis	-0.04	7.12	-3.27**	-5.05**
	(0.71)	(5.47)	(1.07)	(1.72)
Debt Restructuring	6.24+	-21.42	5.55	4.59
	(3.47)	(14.44)	(4.19)	(3.96)
No.of Observations	318.00			
No.of Panels	18.00			
Max Lag Order	1.00			
Criterion Function	0.16			
Hansen's J Stat	52.46			
Hansen's J Df	80.00			

+ p¡0.1, * p¡0.05, ** p¡0.01, *** p¡0.001

D PVARX Results for non-SIDS

Table A16: Impact of Floods in non-SIDS

	Endogenous Variables			
	Primary balance	Gross Debt	GDP growth	Net ODA
	b/se	b/se	b/se	b/se
L.Primary Balance	0.57***	-0.04	-0.03	-0.06+
	(0.06)	(0.16)	(0.05)	(0.03)
L.Gross Debt	0.02***	0.83***	-0.02**	0.01**
	(0.01)	(0.04)	(0.01)	(0.00)
L.GDP growth	0.07	-0.58***	-0.01	-0.03
	(0.05)	(0.16)	(0.05)	(0.03)
L.Net ODA	0.03	-0.57**	0.24***	0.48***
	(0.05)	(0.21)	(0.05)	(0.05)
nsidsOccurfl	-0.09	0.67	-0.25	-0.02
	(0.17)	(0.65)	(0.19)	(0.11)
Financial Crisis	0.08	-4.36*	-0.53	0.91**
	(0.41)	(2.09)	(0.60)	(0.35)
Debt Restructuring	-0.24	11.67**	-1.49*	3.53***
	(0.58)	(4.40)	(0.58)	(0.60)
No.of Observations	691.00			
No.of Panels	40.00			
Max Lag Order	1.00			
Criterion Function	0.12			
Hansen's J Stat	83.67			
Hansen's J Df	80.00			

+ p¡0.1, * p¡0.05, ** p¡0.01, *** p¡0.001

Table A17: Impact of Storms in non-SIDS

	Endogenous Variables			
	Primary balance	Gross Debt	GDP growth	Net ODA
	b/se	b/se	b/se	b/se
L.Primary Balance	0.54***	0.14	-0.05	-0.06*
	(0.06)	(0.17)	(0.05)	(0.03)
L.Gross Debt	0.02***	0.85***	-0.03***	0.01**
	(0.01)	(0.04)	(0.01)	(0.00)
L.GDP growth	0.01	-0.31	-0.04	0.02
	(0.05)	(0.19)	(0.05)	(0.03)
L.Net ODA	0.02	-0.64**	0.26***	0.52***
	(0.04)	(0.21)	(0.04)	(0.05)
nsidsOccurst	-0.46	4.63*	-0.98*	-0.00
	(0.35)	(2.32)	(0.42)	(0.19)
Financial Crisis	0.52	-6.98***	-0.43	0.83**
	(0.44)	(2.10)	(0.59)	(0.30)
Debt Restructuring	1.69***	-0.80	0.05	3.01***
	(0.42)	(2.90)	(0.50)	(0.56)
No.of Observations	691.00			
No.of Panels	40.00			
Max Lag Order	1.00			
Criterion Function	0.11			
Hansen's J Stat	78.00			
Hansen's J Df	80.00			

+ p¡0.1, * p¡0.05, ** p¡0.01, *** p¡0.001

Table A18: The Intensity of Natural Disasters in non-SIDS

	Endogenous Variables			
	Primary balance	Gross Debt	GDP growth	Net ODA
	b/se	b/se	b/se	b/se
L.Primary Balance	0.57***	-0.12	-0.03	-0.08*
	(0.06)	(0.20)	(0.05)	(0.04)
L.Gross Debt	0.04***	0.73***	-0.01	0.00
	(0.01)	(0.05)	(0.01)	(0.01)
L.GDP growth	0.06	-0.61***	0.00	-0.00
	(0.05)	(0.17)	(0.05)	(0.04)
L.Net ODA	0.01	-0.44*	0.25***	0.47***
	(0.05)	(0.22)	(0.05)	(0.05)
Disaster Intensity	0.58	-5.98**	0.24	-1.36***
	(0.45)	(2.10)	(0.49)	(0.40)
Financial Crisis	0.61	-6.38**	-0.38	0.78*
	(0.46)	(2.39)	(0.60)	(0.33)
Debt Restructuring	0.72	4.90	-0.96	2.87***
	(0.47)	(4.12)	(0.61)	(0.67)
No.of Observations	691.00			
No.of Panels	40.00			
Max Lag Order	1.00			
Criterion Function	0.11			
Hansen's J Stat	77.00			
Hansen's J Df	80.00			

+ p¡0.1, * p¡0.05, ** p¡0.01, *** p¡0.001

E PVAR Granger Causality Wald Tests

Table A19: Testing for Weak Exogeneity of Endogenous Variables

	SIDS			Non-SIDS		
Equation	$\tilde{X}^2$	df	Prob>$\tilde{X}^2$	$\tilde{X}^2$	df	Prob>$\tilde{X}^2$
Primary Balance						
Gross Debt	2.132	1	0.144	6.098	1	0.014
GDP Growth	0.025	1	0.875	0.623	1	0.43
Net ODA	2.621	1	0.105	1.17	1	0.279
ALL	2.802	3	0.423	8.343	3	0.039
Gross Debt						
Primary Balance	0.736	1	0.391	0.168	1	0.682
GDP Growth	0.345	1	0.557	3.811	1	0.051
Net ODA	18.087	1	0.000	12.699	1	0
ALL	18.821	3	0.000	15.749	3	0.001
GDP Growth						
Primary Balance	0.054	1	0.816	0.743	1	0.389
Gross Debt	1.977	1	0.16	16.638	1	0
Net ODA	0.521	1	0.471	38.617	1	0
ALL	3.204	3	0.361	42.52	3	0
Net ODA						
Primary Balance	6.169	1	0.013	3.872	1	0.049
Gross Debt	0.095	1	0.758	7.993	1	0.005
GDP Growth	4.869	1	0.027	0.003	1	0.956
ALL	12.019	3	0.007	10.415	3	0.015

Ho: Excluded variable does not Granger-cause Equation variable

Ha: Excluded variable Granger-causes Equation variable

F Robustness Checks

Table A20: Impact of Floods in SIDS

	Endogenous Variables			
	Gross Debt	Net ODA	Primary balance	GDP growth
	b/se	b/se	b/se	b/se
L.Gross Debt	0.94***	0.02	0.02	0.02
	(0.07)	(0.02)	(0.01)	(0.02)
L.Net ODA	-1.73***	0.45***	-0.09+	-0.04
	(0.24)	(0.06)	(0.05)	(0.06)
L.Primary Balance	-0.33	0.34**	0.47***	0.08
	(0.31)	(0.11)	(0.08)	(0.07)
L.GDP growth	-0.66+	0.13+	-0.02	0.09
	(0.36)	(0.07)	(0.06)	(0.08)
Floods	-47.04***	-6.21***	0.00	0.77
	(14.19)	(1.49)	(0.72)	(0.95)
Financial Crisis	-1.82	-6.82***	-0.04	-3.06***
	(4.60)	(1.70)	(0.70)	(0.73)
Debt Restructuring	-9.65	4.23*	4.92	3.93
	(6.52)	(2.02)	(3.50)	(3.73)
No.of Observations	318.00			
No.of Panels	18.00			
Max Lag Order	1.00			
Criterion Function	0.21			
Hansen's J Stat	66.60			
Hansen's J Df	80.00			

+ p¡0.1, * p¡0.05, ** p¡0.01, *** p¡0.001