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Multiple disasters and debt sustainability in Small Island Developing States

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Abstract

Small Island Developing States (SIDS) are the most disaster-prone countries in the world. With an increasing frequency over time, they are regularly hit by severe storms and other disasters, causing on average an annual damage of 2.1 percent of GDP. In the aftermath of disasters, reconstruction efforts require massive financial resources which are often covered through external borrowing. On top, small countries are highly dependent and exposed to economic shocks what results in a massive drop of GDP and exports during global crisis such as COVID-19. In order to provide policy makers with tools to maintain debt sustainability, a better understanding of the options and the complexity between disaster response and debt is required. This paper estimates the impact of multiple disasters on debt sustainability indicators in SIDS over the period 1980 to 2018. Applying a fixed-effects and a Synthetic Control estimator, the results indicate an only weak correlation between a severe natural disaster and external debt what can be related to the restrictions of already highly indebted SIDS to access adequate financing. The paper discusses the implications for financing stronger resilience to disasters in the future and calls for stronger multilateral cooperation and greater flexibility in the accessibility to pre- and post-disaster financial instruments.

Key words: Natural disasters, debt, SIDS, panel data

Contents

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Introduction

Currently, COVID-19 has shaken the world. In order to fight the pandemic and to recover from the economic downturn, funds have been made available and resources deployed to support those on the front-line of the pandemic with necessary equipment. Large stimulus packages were approved mainly by high-income countries, allowing public debt to increase massively. In the fight against climate change, the front liners are mostly small island developing states (SIDS) which have been regularly hit and shaken by natural disasters. Indeed, over the last 40 years, SIDS have experienced the highest number of occurrence and the largest damage caused by storms, floods and droughts, more than any other country group; and they have experienced some of the deadliest biological disasters over that period.

SIDS are highly vulnerable to external economic and financial shocks due to a high degree of openness and a strong dependence on the global economy through tourism, remittances, financial services, and concessional financing. Figure 1 (left panel) compares past and projected GDP growth rates between SIDS, emerging market and developing economies, and advanced economies. During the financial crisis in 2009, SIDS experienced the hardest drop in GDP growth to -1.3 percent (from 3.7% in 2008), compared to other developing countries and emerging markets (to 2.8 percent from 8.4% in 2008). In 2020, due to the negative impact of COVID-19, SIDS are expected to experience a fall in GDP by 9 percent compared to -3.3 percent in other developing countries. Despite large uncertainties, GDP growth is expected to recover in 2021.[1] Prospects are less optimistic regarding the negative impact on the current account balance (Figure 1; right panel). SIDS need to expect a drop from -2.7 percent of GDP in 2019 to -12.1 percent of GDP in 2020. The negative gap is expected to increase to 12.3 percent in 2021 due to the ongoing crisis. In comparison, for the group of developing countries and emerging markets the current account balance for 2020 is projected at -0.12 percent of GDP. The immense drop in external receipts from abroad is likely to put many countries in a critical position to repay external debt. More than ever, the question of debt sustainability in developing countries has received attention. The likelihood of debt default is even higher when the negative growth effects of the pandemic are exacerbated with a natural disaster. In April 2020, Vanuatu, Fiji, Solomon Islands and Tonga were hit by Cyclone Harold. 160,000 people were affected, and many lost their homes. In the Caribbean islands, two storms have killed at least 12 people in Haiti and the Dominican Republic in August 2020. Critical infrastructure including health facilities, schools and agriculture was damaged.[2] The combined effect of declining macroeconomic output, fighting a pandemic with a weakened health care system, and the threat of a coming natural disaster due to seasonal storms can be devastating for any country, especially SIDS.

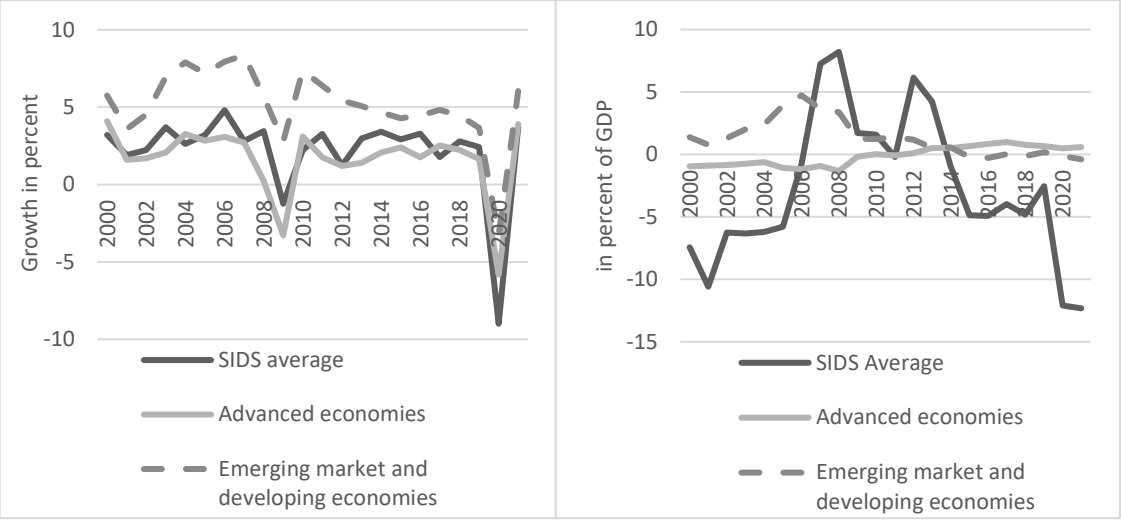
This research paper aims to assess the prospects of debt in the aftermath of a disaster and sheds light on determinants of debt sustainability, such as macroeconomic conditions, price fluctuations and trade openness. Based on data availability across countries and time, debt sustainability is proxied by the external debt-to-GDP ratio and the debt service-to-exports ratio which relates sustainability of debt to the ability for repayment. The main challenge of quantifying the fiscal impact of natural disasters lies in the measurement of the costs of natural disasters. For instance, while meteorological and geophysical disasters cause the highest damage, measured in monetary units, droughts and biological natural disasters have a severe impact on poverty and health. The study contributes to the literature by discussing different dimensions of natural disasters and differentiates *(i)* climate-related natural disasters[3] (meteorological, climatological and hydrological), *(ii)* earth-related disasters (geophysical disasters), and (*iii*) biological disasters (i.e. epidemics), all three factors are supposed to have financial implications. A standard panel-data approach and a Synthetic Control Method are applied to provide a broad assessment of debt sustainability. Both methods allow to identify short- and long-run dimensions of debt in relation to severe natural disasters.

[1] The estimates refer to the projected IMF Economic Outlook as of October 2020. The numbers have been revised downwards compared to earlier projections in 2020.

[2] https://www.undrr.org/news/extreme-weather-events-time-covid-19

[3] The paper does not provide a discussion of the link between climate change and the occurrence of natural disasters, but refers to the literature on the nexus (e.g. https://www.gfdl.noaa.gov/global-warming-and-hurricanes/.)

Figure 1: Real GDP growth rates (left) and current account balance (right) 2000 - 2021, Simple average by respective country group



Source: Author's graph based on IMF World Economic Outlook, 2020 and 2021 projected growth rates; For individual SIDS see Table 9 in the appendix.

The remainder of the paper is as follows: Section 1 provides stylized facts of SIDS' exposure to different types of disasters and discusses financial instruments to recover from such severe external shocks. Section 2 compares debt indicators across SIDS and uses descriptive case studies to outline the potential link between multiple disasters and external debt. A literature review is provided in section 3. The estimation strategy is explained in section 4, followed by the discussion of the results in section 5. Section 6 provides conclusions and policy recommendations.

1. SIDS's vulnerability to natural disasters

1.1 Data and stylized facts

SIDS are especially vulnerable to natural disasters due to a strong exposure to meteorological hazard and rising sea levels[4], their small size, the high density and concentration of population, and high per capita costs of roads, ports and airport infrastructure. For small countries, the costs of post-disaster reconstruction can be exorbitant on a per capita basis. In combination with limitations to diversification and building resilience against external shocks, external debt grows, and debt servicing capacity weakens when exports drop dramatically, such as during the current COVID-19 crisis.

The Emergency Events Database (EM-DAT) launched by the Centre for Research on the Epidemiology of Disasters (CRED)[5] is the most comprehensive database on the global occurrence of natural disasters. Other databases include NatCatSERVICE (Munich Re) and Sigma (Swiss Re).

The classification of natural disasters into climate-related, earth-related and biological disasters is based on the structure of the EM-DAT database:

[4] Rising sea levels are another major threat to infrastructure, but this paper focuses on the fiscal impact of sudden natural disasters.

[5] https://www.emdat.be/. The database differentiates between natural and technological disasters.

i) *Climate-related disasters: Met*eorological[6], *hydrological*[7] and *climatological*[8] disasters;

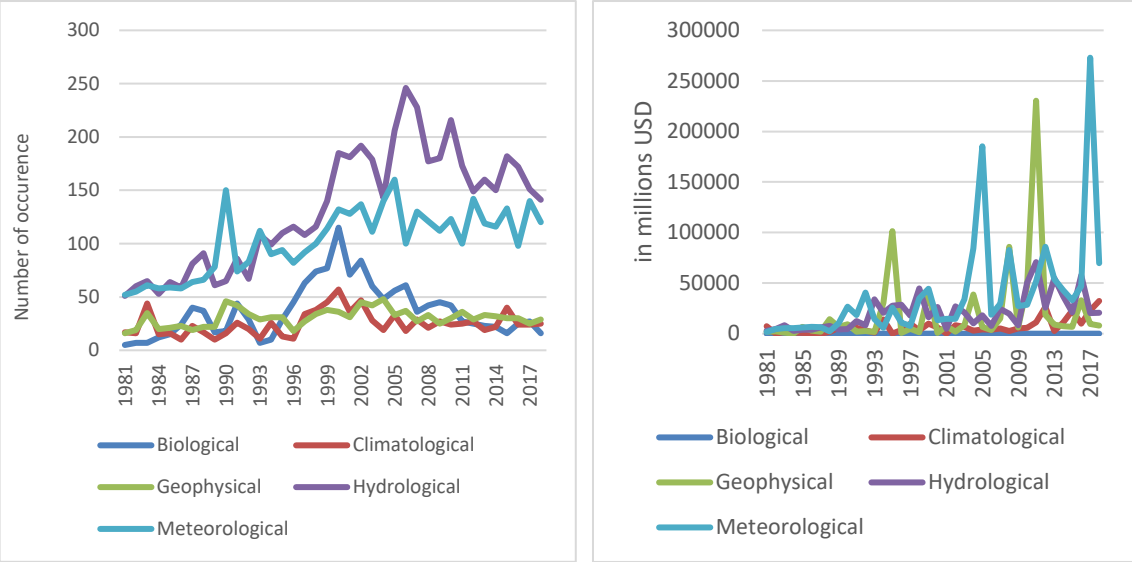
ii) *Earth-related disasters:* Geophysical[9] and extraterrestrial disaster[10];

iii) *Biological disasters (i.e. epidemics)*: A hazard caused by the exposure to living organisms and their toxic substances (e.g. venom, mold) or vector-borne diseases that they may carry.[11]

Some major drawbacks of the database (as well as other databases) are that the data relies on government reports and insurance statements without a common methodology and little transparency. In addition, the capacity of least-developed countries and SIDS to accurately measure the damage of natural disasters is often limited.

According to the available data, world natural disasters and its costs have steadily increased in the last 40 years. Figure 2 shows how climate-related natural disasters (especially meteorological and hydrological ones) have risen more strongly compared to earth-related natural and biological disasters. The occurrence per annum of climate-related disasters (Figure 2, left panel) increased from an annual average of 153 in the 1980s to 308 on average between 2010 and 2018. In terms of the costs associated with it (Figure 2, right panel), meteorological disasters generate the largest amount of annual costs with an increasing trend: from annually US$21 billion over the period 1991 to 2000 to globally US$82 billion per annum from 2010 to 2018.

Figure 2: Global occurrence (left) and damage costs (in US$) (right) of disasters by disaster-type, 1980-2018



Source: Author's graph based on EMDAT data.

[6] A hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from minutes to days (e.g extreme temperature, fog, storm).

[7] A hazard caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater (flood, landslide, wave action).

[8] A hazard caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability (drought, glacial lake outburst, wildfire).

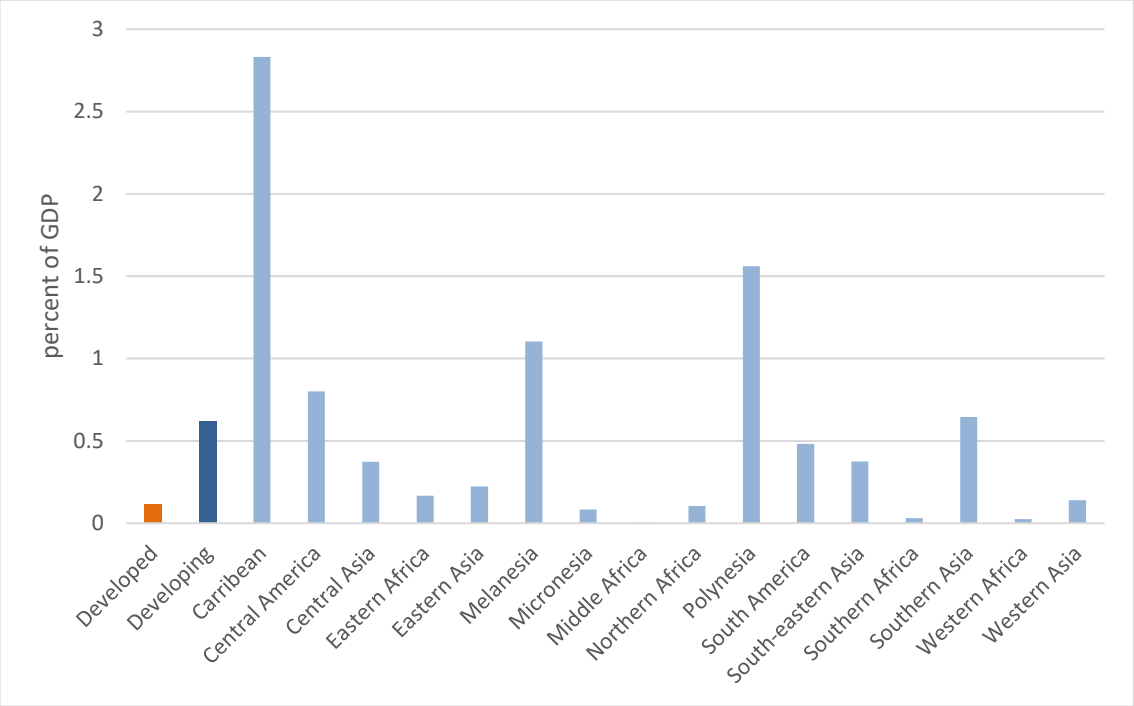
[9] A hazard originating from solid earth. This term is used interchangeably with the term geological hazard (earthquake, mass movement, volcanic activity).

[10] A hazard caused by asteroids, meteoroids, and comets as they pass near-earth, enter the Earth's atmosphere, and/or strike the Earth, and by changes in interplanetary conditions that effect the Earth's magnetosphere, ionosphere, and thermosphere (impact, space weather).

[11] Examples are venomous wildlife and insects, poisonous plants, and mosquitoes carrying disease-causing agents such as parasites, bacteria, or viruses (e.g. malaria, COVID-19). Although some biological disasters might be man-made disasters, they are classified as natural disasters in the EMDAT. This paper adopts the definition according to the reported disaster in the database.

Changes in the global climate amplify the risk of extreme weather disasters. Although the causal link between climate change and natural disasters is not yet fully understood and proven, the increase of the occurrence and the severity in terms of the costs of climate-related natural disasters is observed in the data, and this increase is much larger than that of other natural disasters over time (e.g. earthquakes, volcanic activity).[12] Among the world developing regions, Eastern Asia, the Caribbean, Southern Asia and South-Eastern Asia have been hit the most in terms of absolute costs and occurrences between 1980 and 2019. However, in larger states, damages from natural disasters are localized and therefore represent a relatively small share of the economy. In smaller countries, natural disasters present a systemic risk, as the bulk of their territory could be affected at the same time (Cebotari and Youssef, 2020). For instance, the small states in the Caribbean experience the highest damage in terms of their GDP (Figure 3). Between 1970 and 2018 natural disasters caused on average an annual damage of equivalently 2.8 percent of GDP. Pacific small states faced annual damages of around two percent of GDP. In contrast, the rest of the world faced 0.3 percent of GDP annual costs, and other small states faced 0.2 percent of GDP costs of annual natural disasters (Cebotari and Youssef, 2020).

Figure 3: Annual (1970-2018 average) damage costs of disasters, average by region (including only developing countries), in percent of GDP



Source: Author's calculation based on EMDAT data; figure includes all types of natural disasters; Country classification as reported in the database (https://www.emdat.be/)

Monetary damage indicators are only available for a few natural disasters. Some natural disasters have a smaller impact on physical capital but more strongly affect health and well-being of humans. For instance, a drought may not cause physical damage to infrastructure, but it affects people through food insecurity, malnutrition, lower productivity, loss of income, and rising poverty. In 2016, due to the warm phase of the El Niño–Southern Oscillation the Dry Corridor in Central America experienced one of the worst droughts in decades which has left 3.5 million people food insecure (FAO, 2016).

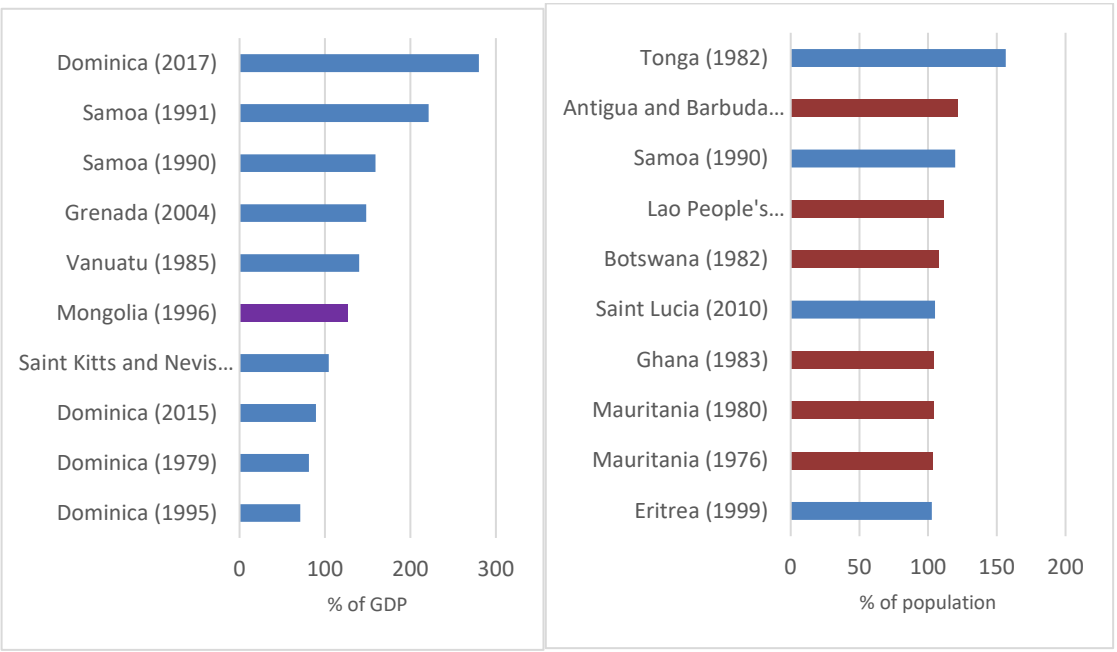
[12] The paper builds on the established link in the literature between climate change and the possibility of more droughts and intensity of storms through more water evaporation into the atmosphere. For instance, according to Mahul et al. (2014) climate change can increase the frequency and severity of extreme weather events by 40-80 percent.

Different measures need to be taken into account for the analysis of natural disasters. EMDAT provides data on affected people[13], injured people[14], homeless people and estimated monetary damage.[15] In the following, the three types of natural disasters (climate-related, earth-related, and biological) are differentiated.

i) Climate-related natural disasters

Figure 4 lists the 10 globally most severe natural disasters over the period 1970 to 2018, in terms of damage-to-GDP (left) and of the affected population per year (right). The worst natural disasters measured by damage relative to GDP have almost exclusively occurred in SIDS (except Mongolia), and are mainly storms. Of the disasters that caused the highest ratio of affected people per population worldwide (Figure 4, right panel), six are droughts and four are storms. The three worst hit countries since 1970 are SIDS (Tonga, Antigua and Barbuda, Samoa). In terms of the number of deaths, the most deadly (relative to population) drought occurred in Sudan in 1983 which killed 150,000 people (equivalent to 0.93 percent of the population). In the same year, in Ethiopia 300,000 people died from the drought (0.8 percent of population).

Figure 4: Most severe climate-related disaster years, by damage (in % of GDP) (left) and affected people (in % of population) (right), Global, 1970 - 2018



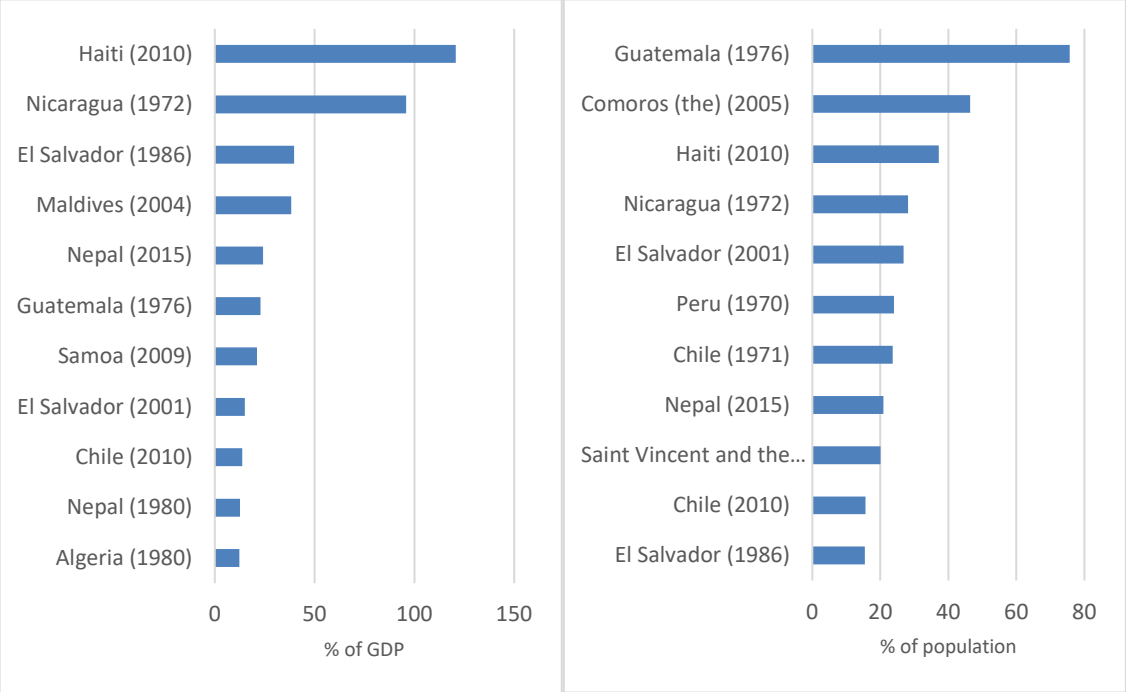
Source: Author's calculation based on EMDAT data.
Note: Climate-related disasters are the sum of meteorological, climatological and hydrological disasters. Droughts highlighted in brown; blue refer to storms and purple to wildfire.

ii) Earth-related natural disasters

The most damaging earthquake happened in Haiti in 2010 with a damage of more than 120 percent of GDP, more than 200,000 fatalities, 300,000 injured and 40 percent of the population directly affected by the earthquake. Similarly, disastrous earthquakes affected Nicaragua in 1972, Guatemala in 1976, the Comoros in 2005 and the Maldives in 2004 (Figure 5).

[13] People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.
[14] People suffering from physical injuries, trauma or an illness requiring immediate medical assistance as a direct result of a disaster.
[15] The amount of damage to property, crops, and livestock. For each disaster, the registered figure corresponds to the damage value at the moment of the event, i.e. the figures are shown true to the year of the event (https://www.emdat.be/explanatory-notes).

Figure 5: Most severe earth-related natural disasters, by damage (in % of GDP) (left) and affected people (in % of population) (right), Global, 1970 - 2018



Source: Author's calculation based on EMDAT data.

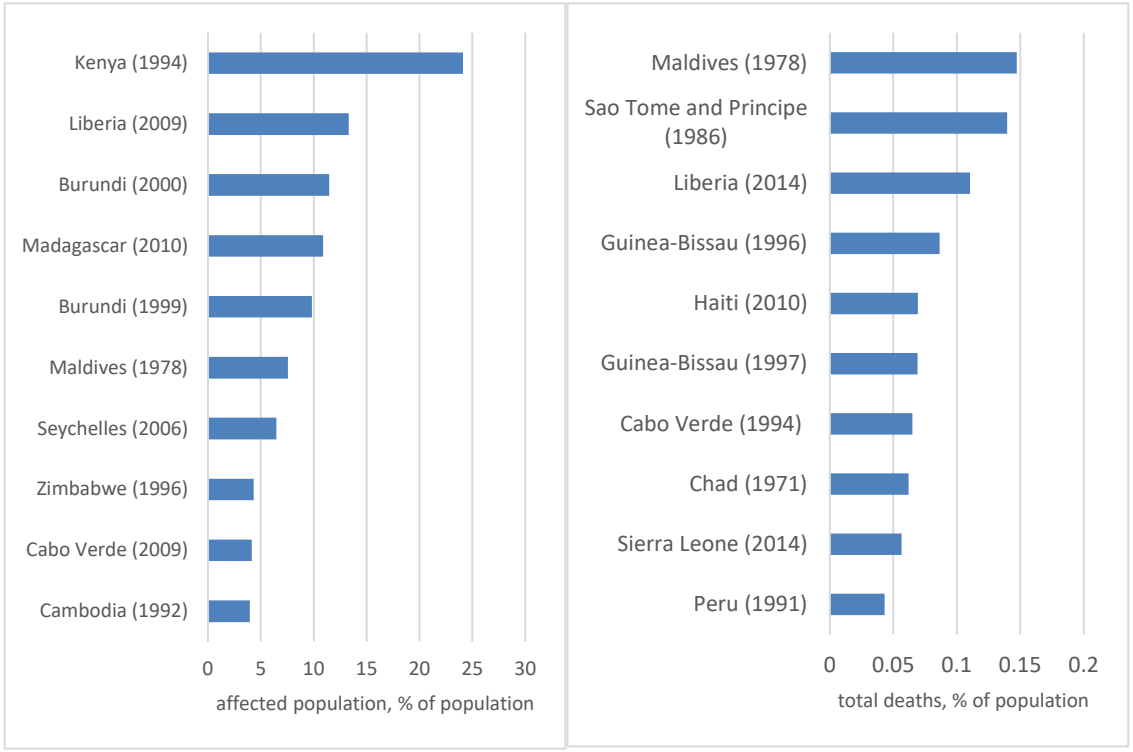
iii) Biological disasters

Over the period 1970 to 2018 biological disasters have mainly occurred in Africa (i.e. Eastern Africa, Western Africa, Middle Africa), and Southern Asia, in terms of occurrence and total number of deaths. In absolute numbers, SIDS seem to be less exposed to biological disasters.[16] Relative to their small population however, it becomes evident that SIDS are also strongly vulnerable to health-related disasters. Figure 6 lists the 10 most severe biological disasters in terms of the affected population (left panel) and fatalities (right panel) reported in a single year. The difficulty of understanding the devastating impact of a biological disaster for a country's development is illustrated by the observation that of the 1,541 reported cases of biological disasters in EMDAT, only six cases provide an estimate of the damage in monetary units.

Relative to population, the deadliest biological disaster happened in the Maldives in 1978, where 0.14 percent of the population died, and 1986 in Sao Tome and Principe (0.13 percent of the population), followed by the Ebola outbreak in Liberia in 2014 (see Figure 6). Of the 10 deadliest biological disasters, five countries are SIDS (Maldives, Sao Tome and Principe, Guinea-Bissau, Haiti and Cabo Verde). The number of COVID-19 cases in SIDS is listed in Box 1.

[16] It should be noted that many biological disasters are in fact man-made disasters. Nevertheless, the way countries are affected by these disasters can be treated as an exogenous shock for a country, at least in a short-term perspective.

Figure 6: Most severe biological disasters, Affected people (in % of population) (left) and total deaths (in % of population) (right) Global, 1970 – 2018



Source: Author's calculation based on EMDAT.

Box 1: COVID-19 cases in SIDS as of 08 November, 2020

As reported in Table 1, Bahrain and Belize have the highest number of COVID-19 cases relative to their population (5.2 percent and 2.4 percent, respectively), followed by Maldives (2.2 percent), the Bahamas (1.8 percent) and Cabo Verde (1.7 percent). The highest death-to-population ratio from COVID-19 is reported in Belize (0.05 percent), the Bahamas (0.04 percent) and Dominican Republic (0.02 percent).

Overall, SIDS seem to be less affected by COVID-19 in terms of cases and deaths. Many of the islands had been locked down and travel restrictions are still in place. For comparison, reported cases-to-population ratios are 4.26 percent in Belgium, and 3.1 percent in the United States.

Table 1: COVID-19 in SIDS (as of November 8, 2020)

Country	COVID-19 Cases	COVID-19 Deaths	Population	COVID-19 cases	COVID-19 deaths
	absolute numbers			in % of population	
Antigua and Barbuda	131	3	98,216	0.133	0.003
Bahamas	6,947	152	394,570	1.761	0.039
Bahrain	89,268	348	1,727,797	5.167	0.020
Barbados	242	7	287,500	0.084	0.002
Belize	9,377	197	400,879	2.339	0.049
Cabo Verde	9,291	100	558,114	1.665	0.018
Comoros	563	7	876,043	0.064	0.001
Cuba	9,492	137	11,323,452	0.084	0.001
Dominica	63	0	72,050	0.087	0.000
Dominican Republic	155,184	2364	10,897,258	1.424	0.022
Fiji	34	2	898,743	0.004	0.000
Grenada	30	0	112,708	0.027	0.000
Guinea-Bissau	2,444	44	1,988,844	0.123	0.002
Guyana	5,943	156	788,281	0.754	0.020
Haiti	9,588	234	11,465,467	0.084	0.002
Jamaica	9,472	218	2,965,754	0.319	0.007
Kiribati	0	0	115,847	0.000	0.000
Maldives	11,962	39	543,870	2.199	0.007
Marshall Islands	1	0	59,331	0.000	0.000
Mauritius	453	10	1,272,519	0.036	0.001
Micronesia	0	0	112,640	0.000	0.000
Nauru	0	0	12,704	0.000	0.000
Palau	0	0	17,907	0.000	0.000
Papua New Guinea	725	8	9,023,299	0.008	0.000
Saint Kitts and Nevis	19	0	53,332	0.036	0.000
Saint Lucia	123	0	183,925	0.067	0.000
Saint Vincent and the Grenadines	76	0	110,065	0.069	0.000
Samoa	0	0	196,130	0.000	0.000
Sao Tome and Principe	962	16	220,579	0.436	0.007
Seychelles	158		98,563	0.160	0.000
Singapore	58,341	29	5,871,253	0.994	0.000
Solomon Islands	13		692,718	0.002	0.000
Suriname	5,359	117	589,019	0.910	0.020
Timor-Leste	30	0	1,327,203	0.002	0.000
Tonga	0	0	103,197	0.000	0.000
Trinidad and Tobago	5,838	111	1,401,099	0.417	0.008
Tuvalu	0	0	11,508	0.000	0.000
Vanuatu	0	0	292,680	0.000	0.000

Source: https://www.worldometers.info/coronavirus/#countries

1.2 Financing Natural Disasters

A natural disaster is associated with an immediate destruction of human and physical capital. Direct instruments to manage the financial risks from meeting these costs include i) self-insurance, ii) risk-transfer to the insurance market (e.g. catastrophe bonds), iii) pre-arranged loans from financial institutions and central banks, iv) fiscal spending and borrowing. In reality, much of post-disaster financing needs is covered through official borrowing and reliance on grants. Due to rising costs of multiple disasters, donor countries struggle to provide sufficient help which makes it crucial to facilitate investments to build resilience. Financing the costs of natural disasters is not only a matter of post-disaster but also pre-disaster financing arrangements to accelerate investments in resilience building.

i) Self-insurance

The management of a Sovereign wealth fund can play a crucial role for disaster financing.[17] However, for small developing countries this financing option has its limitation due to the availability of resources and assets. Individual fiscal buffers where fiscal surpluses during good years are invested in a stabilization fund (or natural disaster fund)[18] created by a single country are often not sufficient to cover the costs of the most severe natural disaster. Losses from natural disasters burden households and small businesses in many countries, and often these households have no, or poor insurance coverage, relying more on assistance from the government where natural disasters occur. In Grenada, for example, traditional insurance of physical assets covered only 4.5 percent of the total damage of recent large natural disasters (Cebotari and Youssef, 2020). For small and vulnerable countries traditional insurance markets often fail due to high risk premia. Even in high-income countries, only a third of disaster losses in the period 1980-2004 was insured by commercial disaster insurance held by citizens (Linnerooth-Bayer, 2009).

While micro-insurance systems are often insufficient to cover the costs of large disasters, an insurance pool proved to be an important instrument. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) was set up in 2007 and restructured into a segregated portfolio company (SPC) in 2014. This instrument offers governments insurance policies for cyclones, earthquakes, excess rainfall and the fisheries sector. In 2017, in the aftermath of Hurricane Irma and Maria, the risk pool provided quick help to the Caribbean countries affected by the storms. The average premium income of the insurance pool is US$21.5 million. Between June 2007 and October 2019, a total of US$106.4 million has been paid out for tropical cyclones, US$9.2 million for earthquake and US$36.4 million for excess rainfalls; the current pay-out per hazard per year is limited to US$100 million (CCRIF SPC, 2019). In 2015 Dominica received US$2.4 million pay-out within 14 days after the island was hit by hurricane Erika. Compared to an estimated damage of US$482 million the limitations of the insurance facility become obvious. For instance, in Haiti, the CCRIF was able to cover only 0.1 percent of the estimated total losses caused by the earthquake (IMF, 2016).

Similarly, the Pacific Islands Climate Change Insurance Facility (PICCIF) and the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) Insurance Program, established in 2013, are important financial instruments. The diversified portfolio helps countries to pool the risk and to give incentives for countries to invest in risk reduction through a pay-out limit on risk. The African Risk Capacity (ARC) is a specialized agency of the African Union to improve response to climate-related food security emergencies.[19] The insured members are Burkina Faso, Mali, Mauritania, Niger, Senegal and the Gambia; other eligible countries include Chad, Ethiopia, Madagascar, Malawi, Kenya, and Zimbabwe.

The question of the optimal insurance coverage largely depends on fiscal space for annual premium payments. Insurance would be expected to increase debt because annual insurance premia may exceed pay-outs. Higher risk transfer in the form of catastrophe bonds could be the main, not only complementary option (see below).

[17] A sovereign insurance would simply mean that the national government is the buyer of the risk.

[18] For resource-abundant countries, such a fund could be funded from resource revenues (Nakatani, 2019).

[19] http://www.africanriskcapacity.org/

ii) Risk-transfer to the insurance market

Catastrophe bonds are an innovative instrument which are issued by insurance and re-insurance companies to transfer the risk to investors. As described in Munevar (2018), such bonds can be attractive to investors because of higher returns compared to other investments in times of low interest rates. Such bonds have a high-risk rating with maturity of up to 3 years. If no natural disaster happens, the insurance company pays a coupon; if it happens, the debt would be forgiven, and the insurance company uses the money to pay clients.

Recently, a specific type of catastrophe bonds, pandemic bonds (first issued in 2017), have been tested in terms of its functionality. Pandemic catastrophe bonds have only been issued by the World Bank. In 2017, the high-coupon securities proved to be popular and raised US$370 million.[20] However, criticism has been raised that the pay-out of US$200 million of the bonds has been too slow and too little to help poor nations deal with the pandemic. A new round of pandemic bonds had been dropped by the World Bank. One of the main criticisms of pandemic bonds is that it is counterproductive to wait for a pandemic to rise, to affect at least two countries and cause at least 2,500 deaths to mobilize the maximum pay-out. When the Democratic Republic of the Congo was hit by the Ebola epidemic the bonds failed to provide sufficient financial support. Although the bank granted US$80 million it allowed the death toll to rise before paying out the full insurance element.[21]

Risk pools require strong political commitment and assistance from developed countries.[22] The Asian Development Bank supports its developing member countries in strengthening their disaster preparedness and recovery after being hit by a natural disaster with the so-called contingent financing mechanism (CDF). In order to receive rapid financial support countries must show commitment in pre-disaster times to implementation of policy reforms which strengthen preparedness. However, the regional pooling of risk is insufficient to cover the large costs of natural disasters.

iii) Pre-arranged instruments from financial institutions and central banks

The IMF provides support through the Rapid Credit Facility (RCF) and Rapid Financing Instrument (RFI) at 0 percent interest rate. The RCF financing is based on a case-by-case selection considering balance of payments, strength of macroeconomic policies, capacity to repay the fund, amount of outstanding fund credit and member's record of the past use of fund credit, and the size of the shock. In response to the pandemic and the economic crisis, these instruments have been used by many SIDS (see Box 2). For example, the Comoros requested financial assistance after Cyclone Kenneth in April 2019. The estimated financing need was around 12.7 percent of GDP cumulative over a period 2019-2025. The IMF approved US$12.3 million, approximately 8 percent of the needs and is expected to catalyze additional donor funds (IMF, 2019). The Catastrophe Containment and Relief (CCR) trust is also supposed to provide post-catastrophe relief assistance to 38 low-income countries eligible for concessional borrowing. However, it should be noted that the eligibility criteria (disaster affects at least one third of population and more than a quarter of country's productive capacity or caused damage exceeding 100 percent of GDP) require sufficient administrative capacity to measure and report the impact. Moreover, due to the increased frequency of natural disasters the criteria of a single natural disaster may not be adequate any longer. When a country is regularly hit by multiple shocks, and causing regular loss of GDP without passing the threshold of 100 percent of GDP, a country is likely to face immense financing problems and would need to be eligible to debt relief under the CCR trust. During the COVID-19 crisis, some adjustments have been made to provide grants to pay debt service of low-income countries.[23]

Another pre-arranged instrument to increase resilience to natural disasters are the so-called "debt-for-nature" swaps which have been used to reduce some of the countries' debt in exchange for environmental project support. Without pro-active measures to adapt to climate change and increasing hazards, the future negative impact will only be stronger (Fuller et al., 2018; Micale et al., 2018). Klöck and Nunn (2019) provide a comprehensive literature review of adaption actions in SIDS. The authors analyze that most documented climate

[20] https://www.afr.com/companies/financial-services/coronavirus-to-trigger-pandemic-catastrophe-bonds-20200309-p5483y

[21] https://www.ft.com/content/30dc1a0c-8da4-11e9-a24d-b42f641eca37; https://www.ft.com/content/949adc20-5303-494b-9cf1-4eb4c8b6aa6b

[22] https://www.gfdrr.org/en/feature-story/what-makes-catastrophe-risk-pools-work

[23] Initial relief has been made available to 25 countries (see Introduction).

change adaptation is of structural or physical infrastructure, mainly engineered such as seawalls, coastal protection or building standards (e.g. retrofit roofs to withstand winds; houses strengthened and water storage facilities). Largest constraints to successful adaptation are access to financial resources, lack of technical know-how and equipment.

Central banks and regulators should play a complementary role to support economic activity. Central banks in Fiji, Papua New Guinea, and Vanuatu have reduced policy rates and/or reserve requirements. Other central banks in the region have provided liquidity assistance in various forms during the pandemic[24]. According to IMF (2016), domestic bank financing was only available for middle-range disaster, causing a damage in percent of GDP of 2 to 35 percent. For larger disasters, external grant financing, external loan financing and remittances were the main financing option. For middle-range disasters remittances were not included in sources of financing. Additional external financing of 22 percent of GDP was necessary on average for large (more than 35 percent of GDP) disasters.

Box 2: Financial implications for COVID-19 response

The negative impact from COVID-19 on growth and the fiscal account balance is mostly transmitted through the external economic shock: the severe drop in tourism and lower demand for exports. The current COVID-19 crisis with its far-reaching impact on the tourism sector uncovers the volatility of SIDS. According to UNCTAD estimates[1], a decline in tourism by 25 percent will result in a fall of GDP by 7.3 percent in SIDS. In addition to falling tourism revenues, remittances will decline. While SIDS already faced the risk of a liquidity crisis in the past, COVID-19 triggers a solvency crisis since net interest payments may exceed current account inflows. Financing the damage of a potential disaster in combination with a drop in GDP is expected to cause an explosion of external debt. Most SIDS will probably be unable to serve their debt repayments.

In response to COVID-19, the G20 agreed to suspend bilateral loan repayments for low-income countries until the end of 2020. This applies to 76 countries eligible to receive assistance from the World Bank's International Development Association. However, tourism is not expected to fully recover before 2023 which is why existing debt service suspension initiatives must be extended for another 2 to 3 years. Moreover, the IMF approved debt service relief to 25 of the IMF's member countries under the IMF's revamped Catastrophe Containment and Relief Trust (CCRT) as part of the Fund's response to help address the impact of the COVID-19 pandemic (5 SIDS are covered - Comoros, Guinea-Bissau, Haiti, Sao Tome and Principe and Solomon Islands). As of September 2020, Bahamas, Barbados, Cabo Verde, Comoros, Dominica, Dominican Republic, Jamaica, Grenada, Guinea-Bissau, Haiti, Maldives, Papua New Guinea, Samoa, Sao Tome and Principe, Seychelles Solomon Islands, St. Lucia and St. Vincent and the Grenadines received financial assistance and debt relief service form the IMF.[2]

Sources:
[1]https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2341;
[2] Most of the financial assistance was realized through the Rapid Financing Instrument and the Rapid Credit Facility (RCF) instrument. Of the 1 trillion lending capacity, currently $250 billion have been made available to member countries (https://www.imf.org/en/Topics/imf-and-covid19/COVID-Lending-Tracker).

iv) Fiscal spending and borrowing

The number of instruments i) to iii) may be adequate to cover the costs of relatively small natural disasters but are generally not sufficient for severe disaster. In such an event, a country needs to mobilize domestic resources by increasing taxes, running out of foreign exchange reserves or borrowing money (domestically and abroad). SIDS with limited domestic resources and a small financial sector depend heavily on external borrowing. For instance, Hurricane Maria which hit Dominica in 2017 caused an estimated damage of US$1.45 billion, or 280 percent of GDP. The country received a total of US$3.1 million in bilateral donations and US$7.7 million in donations from multilateral donors (of which US$7.1 million from the World Bank); the islands received a pay-out of US$20.6 million from the CCRIF; and the government had deposits of 24 percent of GDP mainly from the Citizenship-By-Investment (CBI) program. These financial resources fell short on what was needed to

[24] https://www.imf.org/en/News/Articles/2020/05/27/na-05272020-pacific-islands-threatened-by-covid-19

rebuild destroyed infrastructure. The resulting current account deficit was financed mainly through external borrowing, i.e. official and bilateral loans. In the aftermath of the hurricane, the World Bank has approved US$115 million over 3 years of International Development Association credits and grants from the Caribbean Development Bank (IMF, 2018a).

Low-income countries barely access non-concessional funding, despite high returns of potential reconstruction projects. The role of non-concessional external financing with multilateral institutions plays a larger role especially for infrastructure projects but the constraints due to limited creditworthiness for high volumes of non-concessional finance remains large and requires intensified public private partnership.

2. Debt vulnerability to multiple disasters

The SAMOA Pathway, adopted at the Third International Conference on small island developing states held in Apia, Samoa, in 2014, is a dedicated 10-year programme of action to promote international assistance to address the unique set of challenges these islands face. Nevertheless, SIDS are among the most indebted developing countries in the world. The following section provides an overview of debt sustainability and discusses the vulnerability of debt development in response to multiple disasters for the most disaster-prone SIDS.

2.1 Debt Sustainability in SIDS: An overview

The previous section has pointed out that financial instruments to respond in a sufficient manner is limited by the availability of domestic resources in a small country and the market access for such high amounts of required money. Therefore, to cover the reconstruction costs, a country is expected to face a large fiscal deficit in the aftermath of a shock. Small countries with limited domestic resources depend heavily on borrowing abroad. If the income of a country becomes insufficient to pay its outstanding debt, this becomes a problem. Considering increasing financing needs to achieve the SDGs and to finance climate change adaptation and mitigation, debt has already become a problem in many developing countries. “Debt justice” initiatives have provided debt relief and debt restructuring programs (see Box 3 for the Heavily Indebted Poor Countries (HIPC) Initiative and Multilateral Debt Relief Initiative (MDRI)).

The choice of indicators for debt sustainability is based on a literature review of UNCTAD’s latest research on debt sustainability (e.g. UNCTAD, 2019, Munevar, 2018; UNCTAD, 2017). The most commonly used indicators are total external debt (in percent of GDP) and total debt service (in percent of exports) due to data availability across countries and time. For analytical purposes, time-series data is obtained from the World Bank International Debt Statistics for 17 SIDS[25] from 1970 to 2018. For other SIDS, debt figures for the latest possible year are obtained from the IMF Debt Sustainability Analysis (DSA) reports. The Debt Sustainability Framework (DSF) by the IMF is a tool ”designed to guide the borrowing decisions of Low-Income Countries (LIC) in a way that matches their financing needs with current and prospective repayment ability.”[26] In different words, the objective of the external debt sustainability analysis by the IMF is to evaluate a country’s capacity to finance its outstanding debt.[27] As a general rule, the IMF DSA introduced debt burden thresholds for low-income countries according to which a country has a heavy debt burden when its Present Value (PV) of external debt is higher than 55 percent of GDP or 240 percent of exports, and when external debt service is higher than

[25] Cabo Verde, Comoros, Dominica, Dominican Republic, Fiji, Grenada, Jamaica, Maldives, Mauritius, Saint Lucia, Saint Vincent and Grenadines, Samoa, Sao Tome and Principe, Solomon Islands, Timor-Leste, Tonga, Vanuatu

[26] https://www.imf.org/en/About/Factsheets/Sheets/2016/08/01/16/39/Debt-Sustainability-Framework-for-Low-Income-Countries

[27] According to the IMF, a country can remain solvent if the present value of net interest payments does not exceed the present value of other current account inflows (e.g. through exports) (solvency risk). Liquidity problems are caused by a drop in export earnings (liquidity risk). The main indicators for debt sustainability are the debt stock or the debt service relative to measures of repayment capacity (i.e. GDP, exports).

21 percent of exports.[28] Present value of debt outstanding is the nominal value of all future debt service obligations on existing debt discounting at prevailing market of interest. This indicator is used in the DSA for the low-income countries. For market-access countries, the DSA is done based on nominal values. Due to data availability across countries the assessment in this paper is based on nominal values of external debt stocks.

Debt distress is defined as not being able to pay external debts. According to the IMF DSA, many SIDS are close to being in debt distress. As of August 2020, Grenada and Sao Tome and Principe are rated as being already "in debt distress" despite debt restructuring efforts; 17 SIDS are in "high" risk of debt distress, 13 are at "moderate" risk and three countries at "low" risk (see Figure 7 and Table 7 in the Appendix). Figure 7 compares total external debt stock, as a percentage of GDP, across SIDS for the year 2018. The countries with the highest external debt are Jamaica, Suriname, Seychelles and Cabo Verde. Regarding total annual debt service, as a percentage of exports (Figure 8), Papua New Guinea, Mauritius, Jamaica, and Dominica face the highest burden of annual debt repayment. Relative to their export earnings, Papua New Guinea pays 26.2 percent, Mauritius 23.3 percent and Jamaica 20.6 percent of export earnings to external lenders. Although Mauritius faces one of the highest external debt stocks and annual debt repayment costs, the country is less vulnerable to debt distress than other SIDS. Given its strong macro-financial linkages, stronger outcomes in education and health, its debt appears to be sustainable.

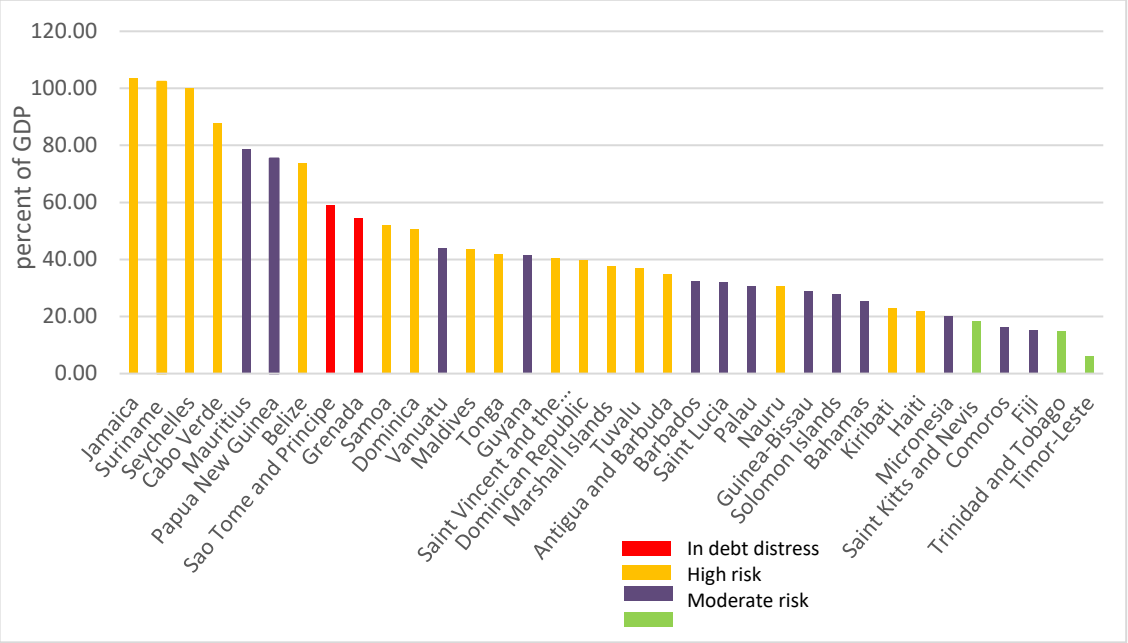
Of the total external debt, long term debt makes up more than 80 percent on average in SIDS (see Table 7 in the appendix). Long-term debt can be further broken down into public and publicly guaranteed (PPG) debt and external debt held by private borrowers. Public debt is the main component of external debt in most SIDS, except for Mauritius and the Solomon Islands, where 77 percent and 70 percent, respectively of the reported long-term external debt is owed by private borrowers.

The structure of long term, public (and publicly guaranteed) debt, strongly varies across SIDS. Traditionally, lower-middle income economies[29] (Cabo Verde, Comoros, Sao Tome and Principe, the Solomon Islands, Timor-Leste, Vanuatu) depend more on official creditors, multilateral as well as bilateral ones. The role of private debt (relief) is only important in a few countries such as Jamaica and St. Lucia where 62 percent and 51 percent of the public debt is to private creditors. Bonds make up the larger part of the private creditors, at an increasing share. For the SIDS with information on interest rates on new private debt, the interest rate was high: 7.2 percent for Jamaica, 6.5 percent for Maldives, and 6.5 percent for St. Vincent and the Grenadines. Average interest rates, including public and private new debt commitments are much lower ranging between 0.5 percent in Cabo Verde to 5.4 percent in the Maldives (Table 7 in the appendix reports the average of public and private interest rates). Given the large share of the public debt and the importance of the public sector in SIDS due to small market size, the public sector is particularly vulnerable to multiple shocks. The occurrence and severity of disasters clearly puts pressure on public external debt. For these reasons, the paper at hand focuses on external public debt.

[28] In some cases, the IMF applies different thresholds of debt sustainability. For instance, for Kiribati, the external debt burden thresholds are (i) PV of debt-to-GDP ratio: 30 percent; (ii) PV of debt-to-exports ratio: 100 percent; (iii) debt service-to-exports ratio: 15 percent. For Vanuatu, the external debt burden thresholds are: (i) PV of debt-to-GDP ratio: 40 percent; (ii) PV of debt-to-exports ratio: 150 percent; (iii) debt service-to-exports ratio: 20 percent.

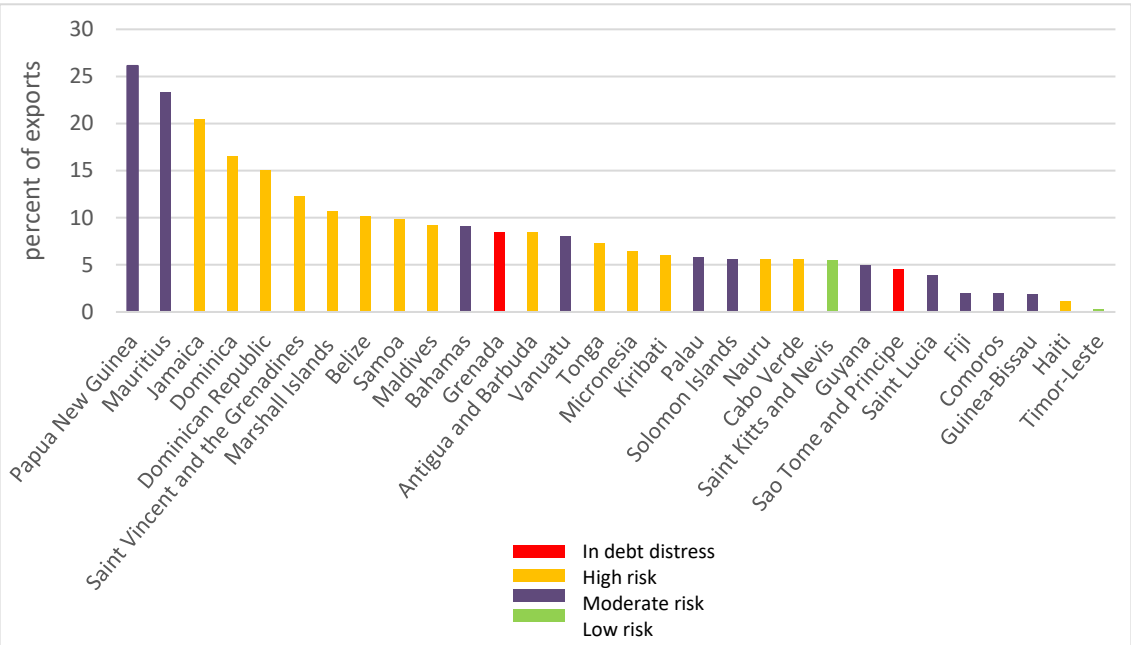
[29] Lower-middle income economies have a per capita income level between US$1,026 and US$3,995).

Figure 7: External debt stocks, total (% of current GDP), 2018, SIDS



Source: Author's graph based on World Bank International Debt Statistics; IMF Country Reports; Note: Projected estimate of external debt for 2017 for the countries Barbados, Saint Kitts and Nevis, Kiribati, Marshall Islands; External debt stock comprise PPG long-term external debt, private non-guaranteed long-term external debt, and short-term external debt including interest arrears on long-term debt.

Figure 8: Total debt service in % of exports, 2018, SIDS



Source: Author's graph based on World Bank International debt statistics; IMF Country reports; Note: Projected estimate of external debt for 2017 for the countries Barbados, Saint Kitts and Nevis, Kiribati, Marshall Islands.

Box 3: SIDS eligible for the Heavily Indebted Poor Countries (HIPC) Initiative and Multilateral Debt Relief Initiative (MDRI)

The joint IMF-World Bank initiative from 1996 aims to ensure that no poor country faces a debt that it cannot manage. Debt relief under the HIPC and MDRI initiatives substantially alleviated debt burdens and enabled recipient countries to increase their poverty-reducing expenditures. In 2005, the HIPC was supplemented by the Multilateral Debt Relief Initiative (MDRI) to allow for 100 percent debt relief for countries completing the HIPC process. In order to grant access to the HIPC and MDRI, countries have to meet certain criteria and demonstrate a good track record. Once a country meets the criteria and reaches the decision point, it begins to receive relief on its debt service. In a second step, in order to receive a full reduction in debt, a country must further demonstrate good performance in implementing key reforms and adopting the Poverty Reduction Strategy Paper. After this, a country reaches completion point with full debt relief committed at the decision point. The largest creditors are the World Bank, the African Development Bank, the IMF, the Inter-American Development Bank, and all Paris Club creditors) (IMF, 2020).

39 countries have been covered: Afghanistan, Benin, Bolivia, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo (DRC), Congo (Rep.), Cote d'Ivoire, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Nicaragua, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia, (Eritrea, Somalia and Sudan). Among SIDS, Comoros, Guinea-Bissau, Guyana, Haiti and Sao Tome and Principe had access to the HIPC. Of the small and vulnerable countries, Bolivia, Honduras, Mauritania, Nicaragua have had access to the initiative.

Comoros has completed the assistance under HIPC initiative in December 2012. Debt servicing has been cut from US$9.2 million to US$2.1 million, which was equivalent to a cut from 10.4 percent of exports to 2.0 percent (OECD, 2018).

Sao Tome and Principe had experienced a massive debt service of 155 percent of exports (17.9 percent of GDP) in 2006. After the finalized debt relief in March 2007, debt servicing, as a percentage of exports has decreased to 10.9 percent in 2008 and to 3.1 percent in 2017 (OECD, 2018).

Haiti's debt cut was completed in June 2009 from a high of 12.7 percent of exports in 2007 to 1.6 percent in 2010. Between 2015 and 2017, debt servicing has again increased from 1.7 to 7.5 percent of exports. The 2010 earthquake was the worst natural disaster to Haiti. In 2016, Hurricane Matthew, the strongest storm since 1964, also caused a damage of US$1.9 billion. Long-run negative impacts are still being felt, as the country struggles with soil productivity, poverty, lack of education (OECD, 2018).

For **Guinea-Bissau**, the initiative was completed in December 2010, debt services were cut from 7.2 percent of exports, to 3.0 in 2010 to 1.2 percent in 2011. In 2017, debt services increased from 1.9 to 14.7 percent of exports. According to the IMF, in 2017, Guinea-Bissau's government contracted loans totaling some US$112million to boost electricity supply and road construction and diversify agriculture.

Guyana reached the completion point in December 2003. Debt service to GDP declined from 9 percent in 2003 to 2.1 in 2007, or 5.0 percent of GDP to 1.1 percent of GDP. Debt services has remained significantly lower despite a small increase up to 3.8 percent of exports in 2017.

Source: Various sources.

2.2 Descriptive country case studies

The following section illustrates debt development over time for the most disaster-prone SIDS in terms of damage-to-GDP ratio. Cumulated over the period 1970 to 2018, Dominica has experienced a damage from natural disasters of 538 percent of its GDP, Samoa 488 percent of its GDP and Vanuatu 223 percent of GDP. While Dominica and Samoa face a high risk of debt default, according to the IMF DSA, Vanuatu only faces moderate risk with a lower external debt stock. Grenada, in contrast, which ranks the seventh highest

cumulative damage, is already in debt distress. The comparative case studies provide a first indication on how an increase in debt could be linked to a disaster.

Dominica

Relative to the country's GDP, Dominica experienced the most severe natural disaster in the world in 2017 when storm Maria hit the island. Of the 10 globally most severe climate-related natural disasters for a single country, four occurred alone in Dominica – in 2017, 2015, 1979 and 1995.

With a total external debt stock of 50.7 percent of GDP in 2018, the island also faces a high risk of debt default. Figure 9 graphs the development of external debt (in % of GDP) (left panel) and debt service (in % of exports) (right panel) over the period 1970 to 2018. The vertical lines indicate the most severe natural disasters. During the second half of the 1980s, external debt was about to decrease after a continuous rise in the beginning of the 1980s from 17.5 percent in 1981 to 49.6 percent in 1987.[30] Similarly, total debt service in percent of exports has strongly increased after 1980, one year after a severe storm in 1979. In the aftermath of the disaster in 1995, external debt stock started to increase again up to over 90 percent of GDP in 2003. Annual debt service payments similarly rose from a low level of 5.6 percent in 1996 to 14 percent of exports in 2001. In order to avoid a debt default, the restructuring program of private debt in 2004 helped to steadily decrease the stock of external debt (to 55 percent of GDP in 2010). Since multilateral and bilateral debt was not part of the program, the debt service-to-exports ratio has remained high at more than 10 percent.

In the aftermath of Hurricane Maria which hit the island in 2017, current GDP declined by 10 percent but recovered to positive growth of 6 percent again in 2018. According to IMF estimates, tax revenue declined by 23 percent while expenditures increased by 18 percent, due to rehabilitation costs, public investments, and wage advances. The massive fall in tax revenues due to the natural disaster was partially offset by the grants and buoyant Citizenship-by-Investment (CBI)[31] sales revenues. Government deposits, grants and insurance pay-out helped to meet the financing needs of reconstruction after Hurricane Maria. However, the grants and donations received only covered a small share of the caused damage. According to UNOCHA Services (2017), Dominica received roughly US$30 million emergency funding from various donors where the United States contributed 25 percent and the UK 22 percent.[32] The IMF (2018) Country Report on Dominica provides an estimate of the damage for each sector, suggesting that the manufacturing sector has been hit hardest with a drop in output by 32 percent in 2017. Agriculture output fell by 10 percent. The construction sector experienced an increase of 22.7 percent in 2017 due to reconstruction investments. Dominica has made remarkable progress in building resilience. The country launched the Climate Resilience Execution Agency for Dominica (CREAD), funded by the UK, Canada and Dominica, to implement large reconstruction efforts and boost socioeconomic development. In order to facilitate investments by the private sector, the Climate Resilience and Recovery Plan's ResilienSEA Blue Economy Investment Fund provides equity investment combined with a technical assistance facility to support the development of small and medium-sized businesses operating in coastal areas, or dependent on the broader marine environment in sustainable ways.[33] However, necessary investments have caused debt servicing to increase to 16.5 percent of exports. Concessional loans only account for 18.5 percent of total external debt.

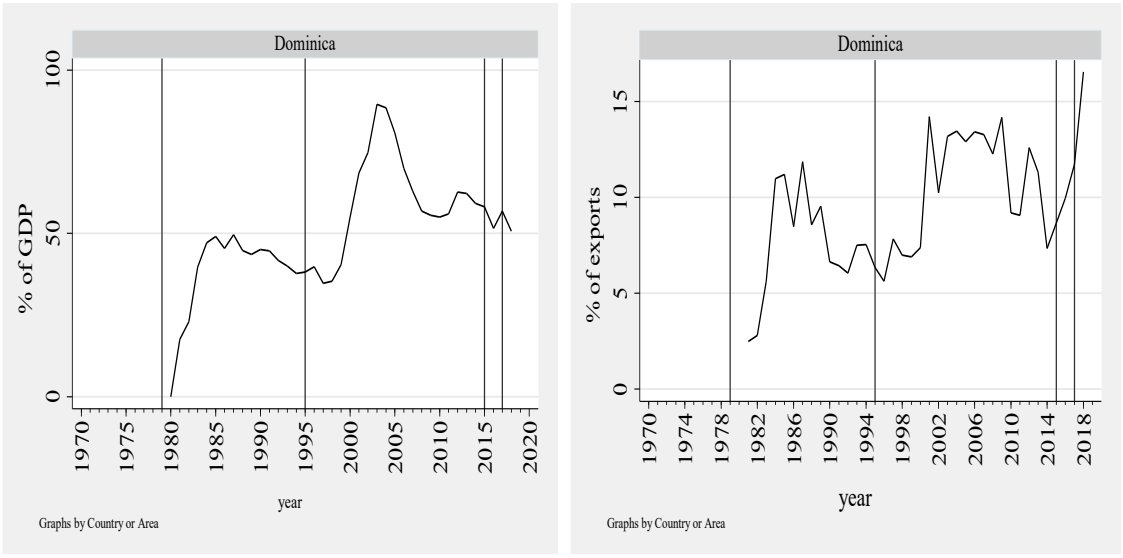
[30] Despite the lack of sufficient data before 1980, much of the increase during that period can be associated with a storm in 1979.

[31] The CBI program allows foreigners to obtain citizenship through either a cash contribution of US$100,000 or investment of US$200,000 in a pre-selected real estate project.

[32] For detailed payments by sector and unit see https://fts.unocha.org/appeals/632/summary

[33] https://nextbillion.net/dominica-first-climate-resilient-nation/

Figure 9: Dominica, external debt (% of GDP) (left), total debt service (% of exports) (right) and natural disasters, 1970 – 2018



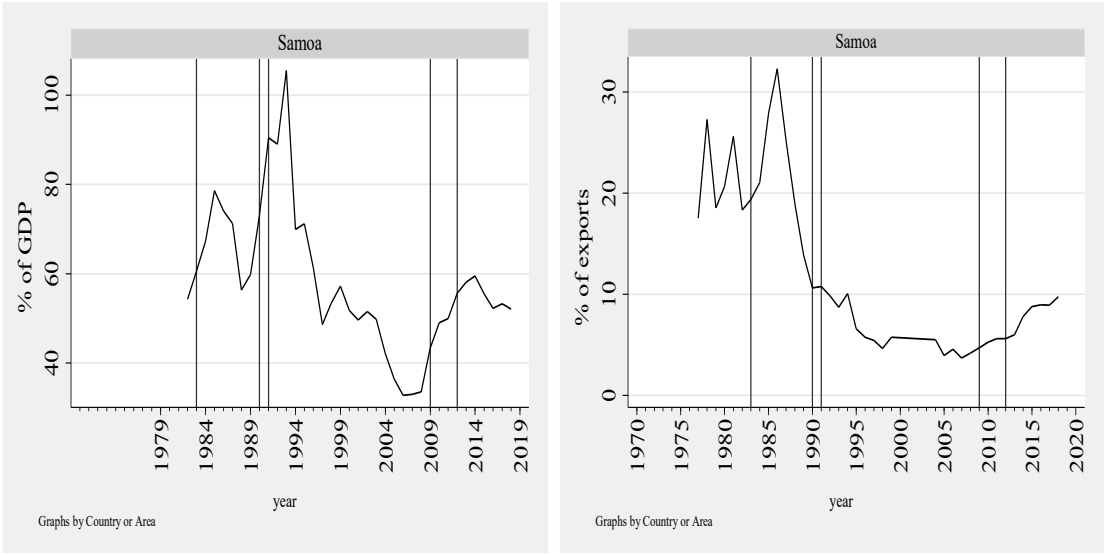
Source: Author's calculation based on World Bank Debt Indicators and EMDAT data.
Note: Vertical lines present severe natural disasters in 1979, 1995, 2015 and 2017

Samoa

Figure 10 shows Samoa's external debt stock (left panel) and total debt service (right panel) over time from 1970 to 2018. The vertical lines represent the worst natural disasters Samoa experienced (1983, 1990, 1991, 2009 and 2012; see Appendix Table 5). In the aftermath of the Cyclones Ofa and Val which hit the island in 1990 and 1991, external debt (as a percentage of GDP) jumped from 60 percent in 1989 to 105 percent of GDP in 1993, two years after the Cylone Val. After debt reached a peak in 1993, debt steadily declined to 32 percent of GDP in 2007. In contrast, total debt service (as a percentage of exports) continued to decline in the aftermath of the storms 1990/1991, even despite the fall in exports from US$40 million in 1989 to US$29 million in 1992. The share of concessional debt in Samoa's external debt was high at that time and had increased from 76 percent of total external debt in 1989 to 90 percent in 1994 and 96 percent in 2006. The high share of concessional debt is associated with low or zero interest rates. After Samoa's graduation from the Least Developed Countries (LDC) status in 2014, access to concessional loans decreased. In 2018, 61 percent of debt is concessional with reduced interest rates and 95 percent of the total external debt is public and publicly guaranteed.

Fiscal measures to restore macroeconomic stability and strong economic growth have continuously lowered the debt-to-GDP ratio. Additionally, after 2001, measures to increase government revenue were taken (e.g. increase in Samoa Sales Tax Rate (VAGST), income tax in fishing sector, increase in taxes on alcoholic beverages, petroleum products and tobacco) (IMF, 2004). However, followed by a severe earthquake and tsunami in 2009, and another storm in 2012, external debt increased to 60 percent of GDP in 2014 which is above the government's target of 50 percent (IMF, 2018b).

Figure 10: Samoa, external debt (% of GDP) (left), total debt service (% of exports) (right) and natural disasters, 1970 – 2018



Source: Author's calculation based on World Bank Debt Indicators and EMDAT data.
Note: Vertical lines present severe natural disasters in 1983, 1990, 1991, 2009 and 2012

In 2017, the risk of debt distress was revised by the IMF from moderate to high, due to the incorporation of natural disasters and its impact on medium-term growth and fiscal projections. Lately, the IMF has approved US$22.03 million disbursement to Samoa to be able to address the COVID-19 pandemic. The outbreak has caused a larger economic contraction than from past natural disasters due to the devasting effect of loss of export earnings for the economy. Samoa has done relatively well in its debt performance and managed to build resilience to economic shocks.[34] In the region of Pacific islands, including Samoa, China is the second biggest lender after Australia. In an interview in 2018, Prime Minister Malielegaoi[35] stated, that their debt conditions to China are relatively soft.

Vanuatu

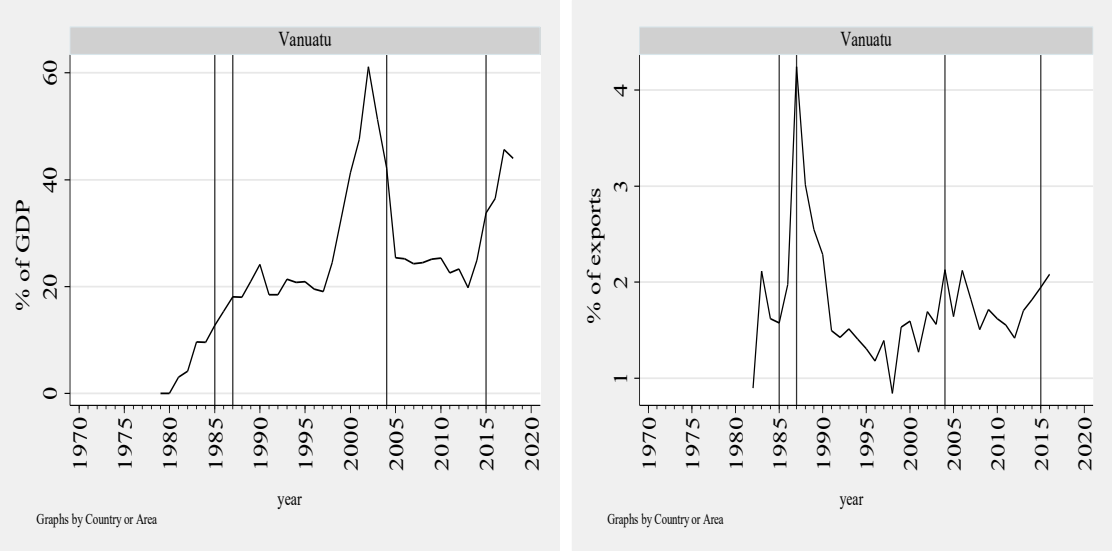
The island was hit by the fifth most destructive natural disaster in the world in 1985. Only recently in April 2020, the island was hit by Cyclone Harold, causing severe damage. Dealing with the post-natural disaster costs at times of an economic recession due to COVID-19 exacerbates existing vulnerabilities.

The development of Vanuatu's debt is illustrated in Figure . Between 2002 and 2013 the debt-to-GDP ratio declined from 60 percent to 20 percent, but it increased again in the aftermath of cyclone Pam (2015) to 36.5 percent (2016) and up to 44 percent in 2018. Real GDP growth declined to 0.2 percent but recovered to 3.5 annual growth rate. According to Marto et al. (2018), a current account surplus was realized in 2018, driven by the economic citizenship program. Although the recovery from the severe damages caused by cyclone Pam had been overall positive, the high exposure to natural disasters continuously requires building adequate fiscal buffers and to strengthen governance, and to enhance disaster resilience. Despite these vulnerabilities, the risk of debt distress is only moderate for the LDC. According to the latest IMF DSA assessment, planned future infrastructure projects will cause an upward trend of external debt. However, such an "increase in indebtedness is expected to be manageable (…)" (IMF, 2018c, p. 1) thanks to Vanuatu's access to concessional lending.

[34] https://www.imf.org/en/News/Articles/2020/04/24/pr20189-samoa-imf-executive-board-approves-us-million-disbursement-address-covid-19-pandemic

[35] https://www.reuters.com/article/us-pacific-debt-samoa/lenders-not-to-blame-for-ballooning-pacific-debts-samoa-pm-idUSKCN1LF1BP

Figure 11: Vanuatu, external debt (% of GDP) (left), total debt service (% of exports) (right) and natural disasters, 1970 – 2018

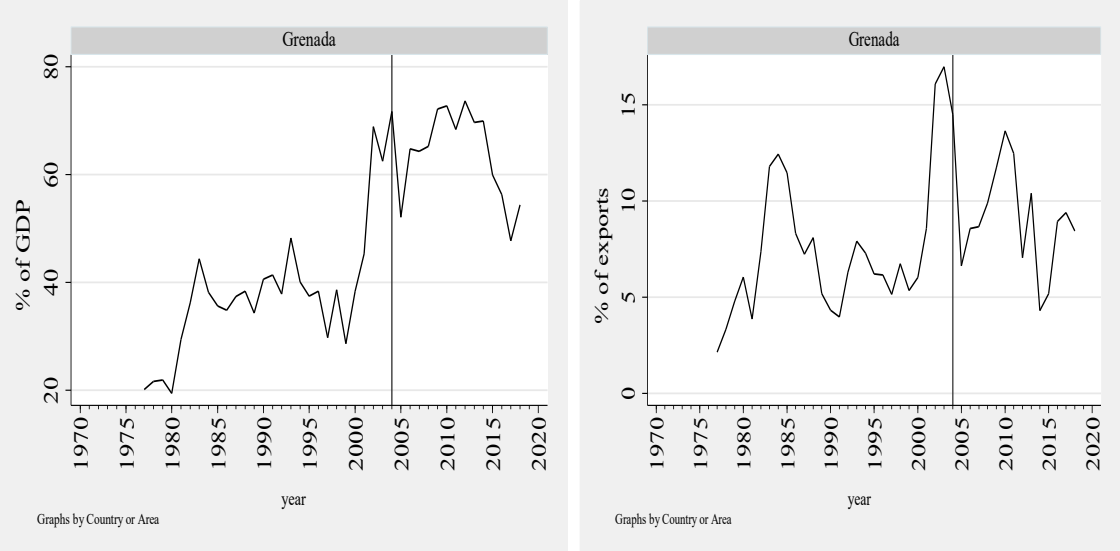


Source: Author's calculation based on World Bank Debt Indicators and EMDAT data.
Note: Vertical lines present severe natural disasters in 1985, 1987, 2004, and 2015

Grenada

In 2004, Grenada experienced the world's fourth most severe climate-related natural disaster (Hurricane Ivan) between 1970 and 2018, causing a damage of roughly 148 percent of its GDP and destroying 89 percent of housing. The cumulative damage from natural disasters over the same period amounts to 154 percent of GDP, caused almost exclusively by Hurricane Ivan. As illustrated in Figure 12, external debt stock strongly increased before the event of the disaster in 2004. Between 1980 and 2002 debt-to-GDP ratio increased from 20 percent to almost 70 percent. One year after Hurricane Ivan hit the island, the ratio fell to 52 percent of GDP, and rose back to 64 percent in 2006. These fluctuations are due to the volatile GDP growth which declined due to Hurricane Ivan from 9.4 percent (2003) to -0.64 percent in 2004 but went up again to 13.3 percent growth in 2005. Due to a higher per capita GDP than those of Samoa and Dominica, the share of concessional debt is relatively low. Indeed, the share of concessional debt in total external debt even dropped during the event of the natural disaster in 2004 to 9.7 percent (from 10.8 percent in 2003). In the aftermath of Hurricane Ivan, massive financial resources were required but Grenada ran short on liquidity and faced difficulties to access affordable credit due to an already increasing debt in the pre-disaster period. In order to prevent insolvency, Grenada secured US$150 million donor assistance. However, only US$12 million were actually available (Asonuma et al., 2017). The country underwent debt restructuring from 2004 to 2006 and despite the drop of debt servicing in 2005, debt stock and debt servicing rose again (Figure 12 (right panel)). Although the program provided a relief to debt services of 3.2 percent of GDP in 2005, there had been no nominal cut in outstanding debt, causing a prompt rise in total debt servicing in the aftermath of the restructuring program. In addition, Grenada's credit rating was downgraded in 2007 from B- to CCC+ resulting in mounting fiscal pressure (Asonuma et al., 2017). The outcome of the first debt restructuring phase had been unsuccessful regarding Grenada's debt sustainability due to low economic growth rates. After a deep economic crisis in 2011-2012, a second phase of debt restructuring followed in 2013-2015, exchanging old bonds for State-Contingent Debt Instruments.

Figure 12: Grenada, external debt (% of GDP) (left), total debt service (% of exports) (right) and natural disasters, 1970 – 2018



Source: Author's calculation based on World Bank Debt Indicators and EMDAT data.
Note: Vertical lines present severe natural disasters in 2004

With the debt restructuring in 2015, Grenada reached financial agreement with private creditors that led to some innovative terms of debt exchange. Two innovative agreements include the Hurricane clause and the Citizenship-by-Investment Program Revenue Sharing Clause. The Hurricane clause would enable to defer payments of up to two periods but in an event of a severe natural disaster this instrument would not provide sufficient debt payment relief. A Hurricane clause was also inserted in Barbados' restructuring clause.[36] Although Hurricane-clauses are one option to provide assistance to countries prone to natural disasters they also bear some risks. Such clauses have only been included in some restructuring debt contracts, but not in traditional bond sales. A more direct financing option, such as a catastrophe bond would be more appropriate to share the risk and financing of natural disasters with the market (IMF, 2017, Sovereign debt restructuring in Grenada). In order to share future costs, Grenada has purchased insurance against the risk of natural disasters as part of the Caribbean Catastrophic Risk Insurance Facility (CCRIF). The Citizenship-by-Investment (CBI) program has also been an innovate feature that is now used by several SIDS (St. Lucia, Antigua and Barbuda, Dominica, St. Kitts and Nevis, Grenada, Vanuatu).

Overall, the ability of a country to respond adequately to a natural disaster or economic shock depends on its pre-disaster economic performance and debt development. Countries with already high debt face limitations to access sufficient funding to support its population and will risk poverty increases and long-term negative impacts on development. Moreover, it requires strong governance, institutional capacity and efficient coordination to manage the challenges of reconstruction. For instance, Haiti received debt relief as part of the HIPC program before and after the earthquake in 2010. External debt stock was cut to 10 percent of GDP and debt services was reduced from 12.7 percent of exports in 2007 to 1.6 percent in 2010. Still, 10 years after the disastrous earthquake, 30,000 people are internally displaced in camps[37] and 300,000 people live in Canaan, a new informal settlement.[38] In contrast to the post-2009 earthquake management in Samoa, a lack of coordination had caused inadequate reconstruction action.

[36] https://www.ft.com/content/4917e73a-8305-11e9-b592-5fe435b57a3b
[37] https://reliefweb.int/report/haiti/dtm-haiti-round-33-earthquake-affected-population-12-january-2019
[38] https://www.eurodad.org/10_years_haiti

The link between debt and natural disasters must be assessed empirically. The case studies suggest that on the one hand, debt response depends on pre-disaster debt levels (country-specific factors), access to concessional financing and the eligibility of a country to debt relief programs. On the other hand, a positive link between a natural disaster and debt might not be a negative sign for long-run debt sustainability as indicated by the examples of Dominica and Samoa. While debt increased in the aftermath of a disaster, a temporary surge in financing needs was necessary to build back (better).

3. Natural disasters, the macroeconomic and fiscal impact: A literature review

Theoretical literature and simulation studies

Marto et al. (2017) explore the implications of natural disasters on debt sustainability with and without any support from development partners. For small countries, the access to financial markets is limited and domestic resources are scarce. Therefore, additional resources to finance disaster reconstruction without external aid must be mobilized from an increase in consumption tax, or external borrowing. Studying the post-Cyclone Pam (2015) period in Vanuatu, the authors project that an additional 50 percent of the pre-Pam amount in grants would be necessary to close the government's fiscal deficit over 15 years in the aftermath of the cyclone. In reality, despite large commitments, external aid fell short compared to what would have been needed. To finance important infrastructure projects and boost reconstruction, the government of Vanuatu suspended value-added taxes and import duties on construction material. GDP growth decreased by 2 percentage points in 2015 to 0.2 percent and the fiscal deficit increased from 5.0 percent in 2014 to 9.6 percent in 2015 (Lee, Zhang and Nguyen, 2018). The negative impact on the domestic economy of raising higher taxes or increasing debt on the one hand, and the insufficient availability of external financial support on the other hand, strongly calls for a greater incorporation of private sector risks and facilitating the use of risk transfers and insurance instruments.

For SIDS (as well as other small developing countries), the uncertainty of foreign aid and remittances as important financial flows to mitigate the impact of natural disasters may hamper economic stabilization (Nakatani, 2019). The income volatility makes it harder to liquidate long-term investment for economic diversification. Studies by Noy and Nualsri (2011), Nakatani (2019) and Frankel et al. (2013) show that fiscal policy in developing countries is mostly procyclical mainly due to the lack of timely macroeconomic data, weakening the scope of countercyclical fiscal policy. Small states have no well-defined economic cycles due to larger volatilities what makes it difficult to evaluate or formulate a structural budget balance target. Debt targets are important for fiscal sustainability, including an escape clause for severe shocks. In a simulation study, Cantelmo et al. (2019) estimate the welfare effects of natural disasters as a function of received grants showing that sufficiently large grants could eliminate negative effects of natural disaster losses but would have to amount to on average 2.6 percent of annual GDP which by far outweighs the amounts typically received. While this emphasizes that disaster-prone countries cannot improve welfare alone by self-financing, international aid commitments fall short on what is needed. The authors scenarios also show that ex-ante financing to build resilience can be more effective than post-disasters capital flows.

The International Institute for Applied Systems Analysis has led modeling research on risk and resilience building to better understand the global challenge of climate change adaptation.[39] The team has built a stochastic debt assessment CATSIM (catastrophe simulation) model to calculate the fiscal costs of extreme climate risks in European countries. Their model of fiscal vulnerability shows that considerably small island developing states face high fiscal risks due to limited availability of ex-ante resources (e.g. reserve funds, contingent credit agreement and insurance) and constrained ex-post revenues. In a variation, the Inter-industry Impact assessment CATSIM model aims to estimate the costs of natural disasters across sectors and quantifies the impact on infrastructure, labor, and the interruptions of supply chains. The model requires input-output

[39] https://iiasa.ac.at/web/home/research/researchPrograms/RISK/CATSIM.en.html

tables and has been applied for specific case studies such as in 2015, to assess the higher order impact of flood damage in Cambodia and Laos.[40]

Empirical studies

The Intergovernmental Panel on Climate Change (IPCC) report 2012 provides a qualitative literature review on economic vulnerability to natural disasters through business interruption costs, income losses of households being unable to work, or the deterioration of the fiscal account. The macroeconomic impact of natural disasters has been intensively studied, yet the results are inconclusive. The state of development matters for the costs of a natural disaster since high income countries also have higher damages in terms of GDP due to larger capital stock (machines, houses, infrastructure), whereas low income countries are primarily impacted by the number of population affected (see, amongst others, Anbarci *et al.*, 2005; Kahn, 2005; Toya and Skidmore, 2007; Noy, 2009; Strobl, 2012). Many empirical studies find a negative impact of natural disasters but also acknowledge that the vulnerability of growth depend on the level of human capital, institutions, and the size of a country.
Despite the increasing number of natural disasters and the tremendous social and economic costs associated with it, there is also evidence that points to some positive long-run welfare impact for per capita GDP growth (Sawada et al., 2019) and imports and exports (Li and van Bergeijk, 2016).

As expected from the descriptive overview of natural disasters, different types of natural disasters have adverse impacts. For instance, Fombey et al. (2013) find in a study for 84 countries (including 60 developing countries) that only severe natural disasters have a negative impact on economic growth. Felbermayr and Groschl (2014) differentiate the intensity of natural disasters and argue that lower-income countries are more negatively affected than advanced economies.

Koetsier (2017) analyzes the impact of natural disasters on government debt for a sample of 160 countries over a period from 1971 to 2014 using a synthetic control method (SCM). The effect of a severe natural disaster[41] on debt is investigated up to ten years after. Natural disasters are differentiated by the total number of affected people over population, number of deaths over population and damage as percentage of GDP. The most damaging disasters lead to a debt increase of 21.4 percent of GDP. The authors also investigate the impact of a natural disaster on SIDS and find an average increase in government debt by 9.4 percent of GDP in the aftermath of severe natural disaster (damage-to-GDP ratio above 95 percentile). UNCTAD (2010) provides empirical evidence for large natural disasters that occurred in low-income countries between 1980 and 2008 and reveals that such shocks can add on average 24 percentage points to the debt-to-GDP ratio (UNCTAD, 2010; 2019). These cross-country studies however report average estimates and pay little attention to the heterogenous impact of natural disaster on debt sustainability dependent on a country's structure and post-disaster management.

Disaster-prone countries' debt is not only directly affected by natural disasters through reconstruction costs but also through a potential increase in the interest rates of sovereign bonds. For instance, Jamaica experienced an increase in the interest rate on Treasury Bills of 3.15 percent in the month in which a natural disaster occurred (Cantelmo et al., 2019). Standard & Poor's (S&P) (2015) notes that direct- and indirect economic losses adversely affect the country's credit worthiness.

Regarding the literature on SIDS, various studies examined the impact of natural disasters on macroeconomic output of affected countries in the Caribbean (Rasmussen, 2004[42]; Heger et al., 2008[43]; Stroble, 2012;

[40] https://iiasa.ac.at/web/home/research/researchPrograms/RISK/catsimvariations.html
[41] 0.5%, 1%, 1.5%, 2%, 2.5% and 5% largest natural disasters.
[42] Rasmussen (2004) finds a median increase of external debt of 6.5 percentage points in the short-run aftermath of a natural disaster.
[43] Heger et al. (2008) find a drop in output in the short-run, but GDP recovers and debt decreases in the following year which the authors mainly attribute to foreign aid and subsequent debt relief of external debt.

Acevedo, 2014[44]) and in the Pacific (e.g. Lee, Zhang and Nguyen, 2018; Cabezon et al., 2015[45]). There is no doubt in the literature that natural disasters negatively affect output in the short-run but the findings for the long-run are inconclusive. van Bergeijk and Lazzaroni (2016) find in a meta-analysis that overall, the impact of disasters is significantly negative and that findings differ by use of database[46], the time frame and country coverage. The paper at hand contributes to the discussion of the sensitivity of the results by allowing a longer time frame and different country samples.

In terms of research question and methodology, this paper is closest to Lee, Zhang and Nguyen (2018). The authors apply a panel data analysis for 12 Pacific Island Countries from 1995 to 2016 where the primary measure of natural disaster is the damage-to-GDP ratio. The authors explore the impact on the fiscal-balance-to GDP change in a Fixed-effects model and a first difference generalized method of moments dynamic model. Control variables are the lagged dependent variable, lagged population (log), inflation (logs) and trade openness. Their results suggest that the dummy for natural disasters at the 75th percentile is not significant but only at the 85th percentile. The results find that a severe natural disasters (higher 80-85 the percentile rank) may lead to a reduction of fiscal-balance-to-GDP ratio by on average 1.1 to 1.5 percent, but results are partly insignificant for less severe disasters due to other country-specific factors (development expenditures in the aftermath of a disaster). However, while standard panel estimation shows to be the most efficient way to assess the impact in a small sample of countries, it is unable to assess the long-run development path. Moreover, there is still little research on comparative country case studies. This paper compares both, results obtained from the Fixed-effects regressions and the SCM estimates for the most disaster-prone SIDS.

This paper contributes to the literature in several prospects: First, to the best of my knowledge, the paper is the first that empirically assesses the link between natural disasters and debt development for the group of the most natural-disaster prone countries - Small Island Developing States (see Section 1). Second, while recent literature has looked at Caribbean or Pacific Islands countries it largely focused on climate-related natural disasters. However, although climate-related natural disasters hit SIDS with the highest frequency and cause most of the cumulative damage over time, other types such as earthquakes and biological disasters, must receive greater attention. SIDS are affected by multiple shocks and this paper will close this gap in the literature. Third, in methodological terms, the paper provides a sound estimation strategy using different estimators and comparing alternative model specifications.

4. Econometric analysis

Model specification

The descriptive part of the paper (Section 2.2) suggested that debt may not increase immediately after a disaster but with a delay of several years. A panel-data model is estimated where the natural disaster event enters with a lag of one (baseline regressions) or more years (*t-k*).[47] The model specification in equation (1) is guided by the literature (e.g. Lee, Zhang and Nguyen, 2018):

$$\Delta y_{it} = \beta_0 + \beta_1 Intense\ ND\ dummy_{it-k} + \beta_2\, y_{it-1} + \beta_3 \ln real\ per\ capita\ GDP_{it-1} + \beta_4 \ln Population_{it-1} + \beta_5 Inflation_{it-1} + \beta_6 Terms\ of\ Trade_{it-1} + \beta_7 Trade\ openness_{it-1} + \beta_8 Debt\ restructuring\ dummy_{it-1} + \beta_9\, X_{it-1} + \alpha_i + \gamma_t + \mu_{it} \quad (1)$$

[44] Acevedo (2014) studies Caribbean countries over 1970 to 2009 using the Fixed effect unbalanced panel vector autoregression model with exogenous variables.

[45] Cabezon et al. (2015) analyze the growth impact of natural disasters in the Pacific islands suggesting that for damage equivalent to 1 percent of GDP, growth drops by 0.7 percentage point in the year of the event.

[46] For instance, using the EMDAT database reduces the probability of significantly negative results for macroeconomic indirect costs (impact on GDP) of 36 percent.

[47] The feasibility of other empirical models such as the CATSIM (catastrophe simulation) model from IIASA cannot be applied for this study mainly due to data limitations on input-output tables and the complexity of such macroeconomic models.

where y_{it} denotes country *i*'s external debt-to-GDP ratio or the debt service-to-exports ratio in period *t*. *k* refers to the lag of years. Δ indicates annual change and ln denotes the natural logarithm.

Theoretically, a severe natural disaster forces the government to look for external financing sources to pay costs of recovery. The access to external financing sources, however, may well depend on initial levels of debt which is why it is important to estimate a dynamic model and introduce the past *t-1* value of debt stock (y_{it-1}).

The construction of the variable $Intense\ ND\ dummy_{it-k}$ is guided by the literature (i.e. Acevedo, 2014; Lee, Zhang and Nguyen, 2018). The dummy variables for severe natural disasters at different percentiles are each set to one when the damage-to-GDP ratio[48], or affected people-to-population ratio (including fatalities and total affected[49]), is above the 75th, 85th or 95th percentile (see equation (2)).

$$intense\ ND\ dummy_{i,t} = \begin{cases} 1, if\ \frac{damage_{i,t}}{GDP_{i,t}} > percentile\ (75, 85, 95\%)\ or \frac{Affected\ population_{i,t}}{Total\ population_{i,t}} > percentile\ (75, 85, 95\%) \\ 0, otherwise \end{cases} \quad (2)$$

The disaster dummies are further differentiated: *i)* climate-related severe natural disasters, *ii)* earth-related natural disasters, *iii)* biological disasters (see Table 2 for the different percentile thresholds).

For smaller disasters, private financing (e.g. insurance) and domestic financing may cover part of the costs. However, being hit by a natural disaster every year, even if the damage is below a certain threshold, may result in unsustainable debt stocks in the long run. Therefore, several robustness checks are conducted for the cumulated number of natural disasters over time and for each occurrence of a disaster.

The control variables include real per capita GDP ($\ln real\ per\ capita\ GDP_{it-1}$), obtained from UNCTAD statistics. On one hand, higher real per capita GDP may make a country less dependent on external financing sources. On the other hand, higher economic development can make a country more eligible to external borrowing. The population size ($\ln Population_{it-1}$) captures the vulnerability of small countries and may be negatively associated with external debt. The smaller the population the smaller are domestic financial resources and the higher the change in external debt. Inflation can have a bi-directional, non-linear, association with debt-to-GDP ratio. Higher inflation, ($Inflation_{it-1}$) can reduce the debt-to-GDP ratio because of a reduction in consumption but it can also increase the debt ratio when inflationary effects are caused by economic instabilities or shortages. Trade openness ($Trade\ openness_{it-1}$), defined as the sum of exports and imports relative to GDP, is expected to reduce the debt-to-GDP ratio due to a potentially positive association between GDP growth, trade openness, and export earnings. However, a positive relationship would also not come as a surprise, as more open economies such as SIDS face higher vulnerability; and disruption in trade flows can result in debt default. A rise in the terms-of-trade ($Terms\ of\ Trade_{it-1}$) increases export earnings and would reduce the debt-service-to-exports ratio as well as external debt stock relative to GDP. Data is obtained from UNCTAD statistics. The debt restructuring dummy is equal to one for the period *t* during which country *i* underwent a debt restructuring programme. The dummy is expected to significantly reduce external debt due to the debt relief. X_{it} refers to additional control variables which are separately included to account for additional determinants of debt: First, Net Official Development Assistance (ODA) as a percentage of GDP (World Bank World Development Indicators) is included, where a positive sign of the coefficient estimate is expected as part of ODA is in soft concessional terms. However, it can also be negative as ODA is supposed to spur economic growth and exports, resulting in a lower debt ratio in the long run. Second, a higher export diversification index (obtained from UNCTAD statistics) is expected to reduce the debt-service-to-exports ratio due to higher export earnings. Third, financial depth is proxied by broad money (as a percentage to GDP) and is expected to decrease additional external debt as more domestic financing options might be available. Fourth,

[48] Damage to property, corps and livestock as reported in EMDAT.

[49] Total affected according to the EMDAT database includes injured and homeless people.

exchange rate fluctuations can cause higher debt as external debt is in foreign currency (mostly in US-Dollars in the Caribbean countries, but also some Pacific Islands; see Table 7 in the appendix) and hence, a depreciation of the domestic currency against the US-Dollar increases the nominal debt in US-Dollar. The analysis aimed to include an institutional proxy. The democracy index is available from 1980 to 2018 but with an insufficient country coverage. A long time period is preferred for the econometric analysis to have sufficient within-country variation of natural disasters and debt. α_i controls for such unobservable country-specific characteristics; γ_t accounts for a common time trend; μ_{it} is a standard error term.

The sample consists of 16 SIDS[50] for which data on debt is available at least over the period from 1980 to 2018. An even longer time frame is not feasible for the econometric analysis due to many missing observations of the dependent variable before 1980. Despite the lack of data for half of SIDS a potential selection bias is less of a concern as the 16 included countries are the ones that experienced the most severe disasters. Nevertheless, the obtained results from a seemingly selective small sample must be tested on robustness compared to a control group. The control group includes the group of Small and Vulnerable Economies (SVEs)[51] and LDCs (see Appendix, Table 4 for country classification).

Table 2: Threshold of percentile for severe natural disasters, per type and sample

	Only SIDS			SIDS, SVEs and LDCs		
	Climate-related	Earth-related	Biological	Climate-related	Earth-related	Biological
Damage-to-GDP ratio, in %						
95 percentile	81.2	38.3	n/a	22.8	38.3	n/a
85 percentile	17.1	21.2	n/a	5.5	10.8	n/a
75 percentile	7.6	12.4	n/a	2.7	2.9	n/a
Affected people-to-population ratio, in %						
95 percentile	67.9	20.1	6.5	29.3	7.78	0.7
85 percentile	16.1	4.0	1.2	9.03	1.63	0.18
75 percentile	8.9	3.7	0.7	3.9	0.49	0.09

Source: Author's calculations.

Estimation strategy

Equation (1) is estimated using a fixed-effects (FE) panel estimator to be able to account for marginal effects of types of natural disasters on dynamic changes in external debt. The inclusion of the lagged dependent variable may cause a Nickell bias which would favor the use of system-Generalized method of moments (GMM) estimator to control for endogeneity. However, system-GMM can be biased when N is small compared to T, as in the main sample of only SIDS. The Nickell bias is relatively small in the model because of the sufficiently large number of time periods. Moreover, in case of weak instruments, the bias might even be higher than in the FE estimation. Therefore, results are only reported for the FE estimation.[52] Additional robustness checks are provided for a traditional static log-linearized model. However, as suggested by the descriptive part in section 2, the relationship might not be linear, especially for a higher lag structure. Endogeneity caused by reverse causality is not of a big concern for the research question of natural disasters.

However, a main caveat of panel fixed effects studies is that these models often fail to construct a true counterfactual for the case of missing treatment, i.e. for the case of no severe natural disaster. Therefore, comparative case studies where researchers compare one or more units exposed to an event or shock of interest to one or more unexposed units might be more informative. The econometric tool that has received

[50] Comoros, Cape Verde, Dominica, Fiji, Grenada, Jamaica, St. Lucia, Maldives, Mauritius, Solomon Islands, Sao Tome and Principe, Timor-Leste, Tonga, Saint Vincent and the Grenadines, Vanuatu, Samoa

[51] SVEs are WTO members that account for only a small fraction of world trade, being particularly vulnerable to economic uncertainties and external shocks (https://www.wto.org/english/thewto_e/minist_e/min11_e/brief_svc_e.htm).

[52] Some robustness checks have been conducted using the system-GMM but the results are inconclusive.

large attention in comparative studies and has been used in several studies on the impact of natural disaster on economic growth is the Synthetic Control Method (SCM).[53] However, applying this estimator to the underlying panel data set comes with additional caveats. Therefore, the SCM approach and the obtained results from the case studies are only discussed as part of a range of robustness checks in Section 5.2.

5. Results

5.1 Baseline fixed-effects regressions

The results obtained from the standard fixed-effects regression for the sample of SIDS are provided in Table 3, for the change in total external debt (columns (1)-(7)) and for debt service (columns (8)-(14)). The regressions separately include the dummies for the most severe natural disasters (at the 95th, 85th and 75th percentile) and the control variables X_{it-1}.

According to the coefficient estimates, the occurrence of a natural disaster cannot be associated with a significant change in neither total external debt nor the debt service-to-exports ratio despite the tremendous damage they can cause. Instead, the within-country change in external debt and debt servicing in *t* is mainly explained by past values of debt indicators, causing largely insignificant results of the control variables. In addition, much of the within-variation in external debt stock is explained by the debt restructuring dummy, suggesting a reduction of the debt-to-GDP ratio by on average roughly 13 percentage points during the year(s) of the restructuring program. According to the estimates reported in columns (8) to (14) in Table 3, debt restructuring has however not been able to significantly reduce annual debt servicing. While debt reconstruction or debt relief would have an immediate impact on debt stock, repayments are distrusted over a long period and the benefits of debt restructuring, if any, would materialize in the long run. Marchesi and Masi (2018) highlight that the relationship between creditors and debtors as well as the size of restructuring is important in explaining controversial impacts.

In the next step, equation (1) is separately estimated for each type of severe natural disasters. Comparison of the coefficients estimates for each dummy is provided in Figure 9. Irrespective of the type of natural disasters and the percentile of the severity, the estimates are not significant. A positive association with an increase in the debt-to-GDP ratio can be found for earth-related natural disasters and biological disasters. For instance, for earth-related disasters the estimates suggest, though not significant, that a severe earthquake (at the 95th and 85th percentile) in period *t* can be associated with an increase of the debt-to-GDP ratio of 3.6 percentage points in the following year.

Higher lag-order (k=2, … ,5) and higher frequency of disasters

As suggested in the descriptive part in section 2, debt might not increase immediately after a disaster but with a lag of more than two years. Indeed, reconstruction costs may evolve over time and recovering from a natural disaster is likely to take several years. The $Intense\ ND\ dummy_{it-k}$ enters separately with *k=2, k=3, k=5* in the regressions. The obtained results are discussed shortly.[54] Compared to the results reported in Table 3, the natural disaster dummies become positive but remain insignificant, with one exception: For earth-related natural disasters, a significantly positive association can be found between the event and the increase in debt servicing (as a percentage of exports) with a time lag of two years. The coefficient estimates range from 13.25*** (at the 95th percentile of most severe earthquakes) to 7.08** (75th percentile). However, such a high difference in the coefficient estimate compared to other specifications must be treated with caution. In fact, the estimate is driven by Comoros which experienced an all-time high of debt service of 34 percent of exports in 2007. This record is observed two years after the island experienced one of the most severe earthquakes with an affected population of 46 percent (there is no reported damage in monetary units). Due to the lack of

[53] For an impact analysis of natural disasters, the SCM approach has been applied in Fujiki and Hsiao (2015); DuPont et al. (2015); Koetsier (2019); Cavallo et al. (2013).
[54] To save space, results are not reported but available upon request.

information and literature on this event I refrain from an interpretation with regards to causality. Unfortunately, data on debt service-to-exports is missing for the years 1996 to 2002 what does not allow a valid SCM approach for the Comoro Islands.

In EMDAT, all reported natural disasters are defined as *severe* for the economy and have caused an emergency status. Instead of a dummy for a natural disaster at the highest percentile, equation (1) is estimated including i) a cumulative (over time) sum of the occurrence of natural disasters, and ii) each natural disaster as reported in EMDAT. The results are strongly in line with those reported in Table 3 showing no significant association between debt and natural disasters, irrespective of the type of disaster.

The results suggest that, on average, controlling for past values of debt, macroeconomic conditions and trade performance, natural disasters in SIDS cannot be linked to within-country changes in external debt. Before drawing conclusions, the following section tests the robustness of the findings to an alternative estimation approach and several model specifications.

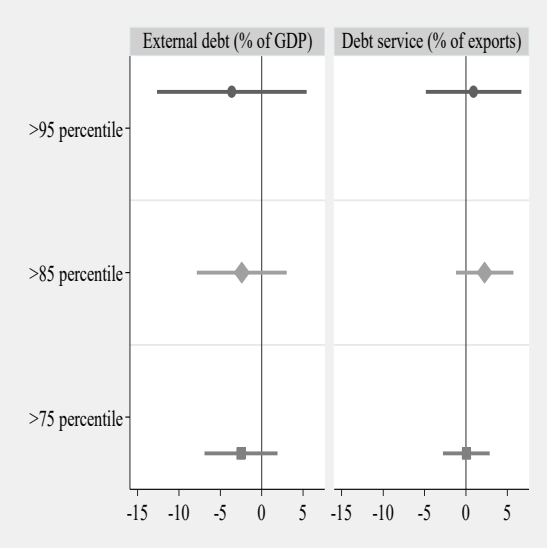
Table 3: Fixed effects regression results for different dummies, SIDS only, 1980 - 2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	External debt-to-GDP change							External debt service-to-exports change						
L. External debt, % of GDP	-0.133***	-0.138***	-0.133***	-0.136***	-0.138***	-0.133***	-0.133***							
	(0.018)	(0.019)	(0.018)	(0.020)	(0.019)	(0.018)	(0.018)							
L. Debt service, % of exports								-0.503***	-0.542***	-0.537***	-0.584***	-0.504***	-0.504***	-0.504***
								(0.054)	(0.056)	(0.055)	(0.062)	(0.055)	(0.054)	(0.054)
L.dummy_nat95_sids	-3.220	-3.208	-2.931	-3.208	-3.340			0.775	1.069	1.255	0.763	0.774		
	(4.306)	(4.314)	(4.346)	(4.771)	(4.300)			(2.749)	(2.733)	(2.746)	(3.055)	(2.755)		
L.dummy_nat85_sids						-1.363							1.093	
						(2.416)							(1.548)	
L.dummy_nat75_sids							-1.556							-0.507
							(2.007)							(1.284)
L.(log) real per capita GDP	4.843	6.924	5.967	-5.018	3.889	5.016	5.043	-2.272	-1.650	-2.882	-4.657	-2.284	-2.431	-2.199
	(3.798)	(4.497)	(4.201)	(9.313)	(3.852)	(3.819)	(3.811)	(2.406)	(2.836)	(2.693)	(5.171)	(2.459)	(2.415)	(2.412)
L.(log) population	2.906	3.607	2.519	5.225	5.169	3.310	3.132	-12.48**	-11.71**	-13.59**	-18.22**	-12.45**	-12.58**	-12.65**
	(8.793)	(8.836)	(8.914)	(14.12)	(8.924)	(8.775)	(8.775)	(5.654)	(5.656)	(5.656)	(8.716)	(5.793)	(5.638)	(5.645)
L. Inflation rate (CPI)	-0.119	-0.116	-0.109	-0.206	-0.104	-0.119	-0.118	0.0666	0.0648	0.0666	0.00147	0.0668	0.0648	0.0689
	(0.116)	(0.116)	(0.118)	(0.168)	(0.116)	(0.116)	(0.116)	(0.0730)	(0.0736)	(0.0743)	(0.104)	(0.0734)	(0.0730)	(0.0730)
L. Terms-of-trade growth	-5.206	-4.998	-5.509	-5.443	-5.666	-4.413	-4.260	-4.378	-4.314	-3.708	-7.719	-4.380	-4.504	-4.611
	(6.894)	(6.910)	(6.932)	(9.235)	(6.890)	(6.798)	(6.794)	(4.577)	(4.562)	(4.572)	(6.241)	(4.587)	(4.502)	(4.502)
L. Trade openness (% of GDP)	5.952	6.012	6.664	-0.135	2.967	5.618	5.643	-1.005	-3.759	-3.318	3.495	-1.039	-0.872	-1.008
	(5.265)	(5.277)	(5.412)	(7.011)	(5.669)	(5.265)	(5.259)	(3.273)	(3.441)	(3.538)	(4.201)	(3.546)	(3.271)	(3.271)
Debt restructuring dummy	-12.62***	-12.54***	-12.63***	-12.68***	-12.56***	-12.76***	-12.69***	-1.251	-1.385	-1.416	-1.366	-1.250	-1.265	-1.157
	(3.085)	(3.091)	(3.094)	(3.246)	(3.080)	(3.075)	(3.077)	(1.902)	(1.942)	(1.940)	(1.999)	(1.906)	(1.895)	(1.898)
L.Net ODA (% of GNI)		0.0931							0.079					
		(0.108)							(0.066)					
L. Broadmoney (% of GDP)			-0.045							-0.036				
			(0.081)							(0.051)				
L. Export diversification index				16.04							-16.68			
				(18.01)							(11.62)			
L. (log) exchange rate					-2.815							-0.0319		
					(2.004)							(1.292)		
Observations	333	332	332	280	333	333	333	329	326	325	276	329	329	329
R-squared	0.351	0.353	0.352	0.340	0.355	0.350	0.351	0.359	0.376	0.378	0.386	0.359	0.360	0.359
Number of countries	16	16	16	16	16	16	16	16	16	16	16	16	16	16

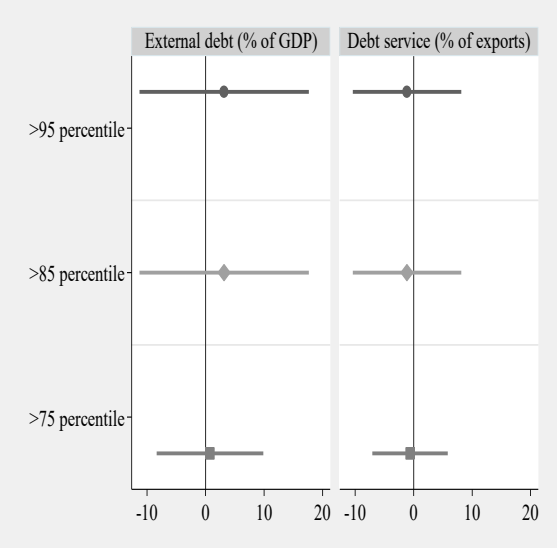
Note: Standard errors in parentheses; Country- and year-fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Figure 9: Coefficient estimates of the fixed effects regressions, by type of disaster, SIDS only, 1980 - 2018

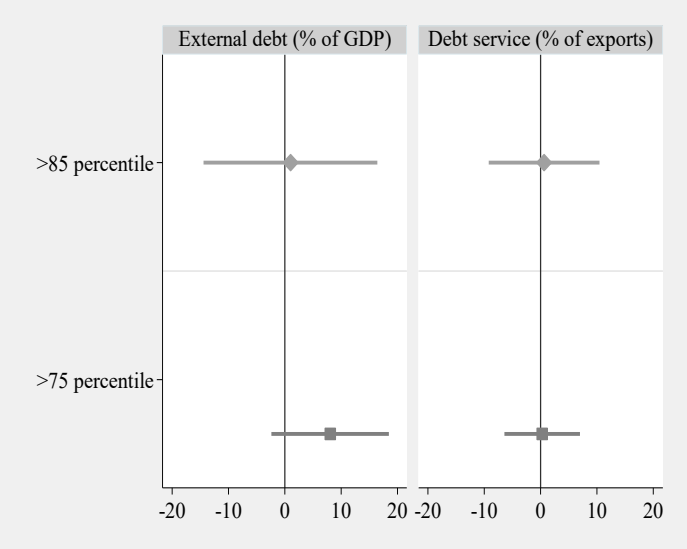
a) Climate related disasters



b) Earth related disasters



c) Biological disasters



Note: Results are obtained from a fixed effects regression with Country- and year-fixed effects.

5.2 Modified model specification

Synthetic Control Method (SCM)

Using the Synthetic Control Method, this section aims to test whether the occurrence of a severe climate-related, earth-related or biological disaster can cause long-run unsustainable debt development. The challenge of the SCM is to find a valid synthetic control group which must consist of non-disaster countries that show similar pre-disaster levels of macroeconomic, geographic, and fiscal conditions. It is, however, often these structural factors and geographic conditions that make countries prone to disasters. Any valid synthetic control group must not be affected by a similarly severe natural disaster at least 10 years before and after the treated event.[55] It is unlikely that an exact match of the synthetic control group and the disaster country is possible, but the SCM can apply country weights based on the best possible match.[56] In contrast to equation (1), the list of control variables slightly varies due to data coverage and the need to find the best fit between the treated country and the control group.[57] In addition to the fixed-effect estimation, real GDP growth, government expenditures (in % of GDP), population density, agriculture value added (in % of GDP) and the share of concessional debt (in % of external debt) are included (see Appendix, Table 8 for variable description). Particularly agriculture value added is included to match countries with similar economic structure. Many SIDS depend on agriculture output which makes production vulnerable to natural disasters. The choice of control variables is restricted to available data from 1980 to 2018. The SCM approach requires a strongly balanced data set and no missing observations at least for the treated unit.

The comparative case studies discussed in this section cover the most severe climate-related, earth-related and biological disasters in SIDS. In particular, the paper applies the SCM on the SIDS that experienced the most severe storm (Dominica), one of the most damaging earthquakes/tsunamis (Samoa) (see Section 2) and a severe biological disaster (Cabo Verde). The selection of the case studies discussed here is subject to the availability of sufficient data and the validity of the estimator based on the RMSPE (root mean square prediction error).[58]

i) Climate-related natural disaster: Dominica (1995)

In 1995, Dominica was hit by Hurricane Luis which caused a damage of 71 percent of GDP and a total affected population of 7 percent. This event is chosen in order to have a sufficient pre- and post-disaster time period. Moreover, Section 2.2 illustrated that external debt increased in the aftermath of this disaster. The SCM approach aims to project the potential path of debt without a similarly large disaster at least until 2005. The results for the external debt-to-GDP ratio and debt service-to-exports ratio are presented in Figure 10. Controlling for structural factors and the occurrence of other disasters in the pre-Luis period, the SCM results suggest that debt has increased significantly more in Dominica than in the synthetic control group. In the aftermath of the disaster in 1995, debt increased to over 90 percent of GDP, while that of the control group only increased up to 60 percent despite following a similar trend over that period. Total debt service has also continuously increased from 5.6 percent in 1996 to 14 percent of exports (2002). However, compared to the synthetic control group, no significant difference can be observed. After the restructuring program in 2004, debt had been kept low in the Caribbean country in contrast to the control group which was not eligible to debt restructuring. This finding suggests that although external debt stock has significantly increased with a delay of three years, the restructuring program strongly helped to sustain debt development and improve economic conditions.

[55] Only countries that have not been affected by a severe natural disaster (below 75-percentile threshold) over the assessed period can serve as potential control group. All other countries must be deleted from the estimation as they would influence the estimates. Abadie et al. (2010) reveal that the synthetic control group does not need a large number of comparison units but should rather be valid control groups not affected by similar events. The potential control group includes SVEs and LDCs.

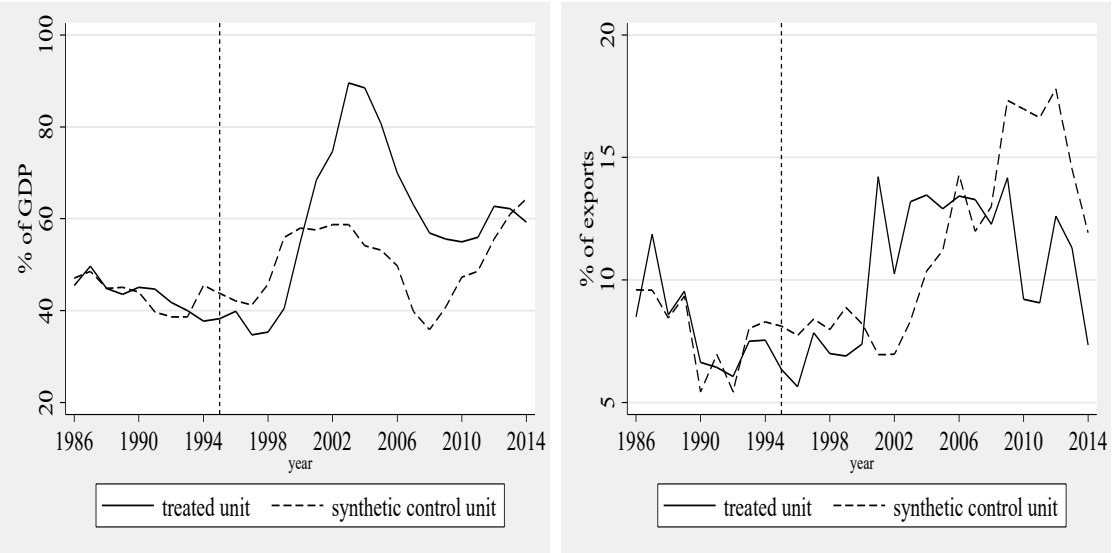
[56] The option "nested" (implemented in STATA) optimizes the weights of valid control groups which leads to a very small of number of control units in most case studies. The procedure minimizes the Root Mean Square Percentage Error (RMSPE).

[57] The choice of control variables for the SCM is guided by the literature (e.g. Acevedo, 2014; Kotsier, 2019).

[58] The lower the RMSPE, the more the synthetic resembles the characteristics of the treated country (Marchesi and Masi, 2018). A number of other SCM tests have been conducted (e.g. Vanuatu for the storm in 1985, Fiji Islands for a severe drought in 1998) but the results are not valid.

Figure 10: Dominica 1995 – SCM results, External debt (% of GDP) (a) and total debt service (% of exports) (b)

a) External debt, % of GDP b) Total debt service, % of exports



Note: a) Control group Central African Republic, Cabo Verde, Mauritius; RMSPE = 4.72, b) Control group: Cabe Verde, Mauritius; RMSPE = 4.91

ii) Earth-related natural disasters: Samoa (2009)

Samoa experienced one of the most severe earthquakes with a following tsunami in 2009. In the aftermath, debt continuously increased from only 33 percent in 2008 to 59 percent in 2014. As suggested by the SCM results, illustrated in Figure 11, this rise would not have happened without the natural disaster. In the "no-event" scenario, proxied by the synthetic control group, debt would have stayed relatively stable or continued to decrease even further. In the long run, debt remained at a higher level compared to the counterfactual. Similarly, annual debt servicing (as a percentage of exports) steadily rose from 4.1 percent in 2008 to 9.7 percent in 2018 while the counterfactual group experienced a lower level of around 4 percent of exports.

Allowing external debt to increase beyond the government's target of 50 percent was necessary to manage the massive financial reconstruction needs. The government of Samoa in cooperation with international community have made major efforts to manage the impact of the disaster. In 2011, 95 percent of affected houses have already been replaced or repaired and 90 percent of tourism infrastructure had been restored. Access to social services has been expanded along with a range of structural reforms. At that time, Samoa was still a LDC, the country graduated in 2014. Indeed, thanks to motivated and well-structured management, the economic recovery and reconstruction was even better than before. This was however only possible due to low levels of debt in the pre-2009 period which enabled the government to borrow money on reasonable terms. The expansion of debt to reconstruct helped to spur economic growth.[59]

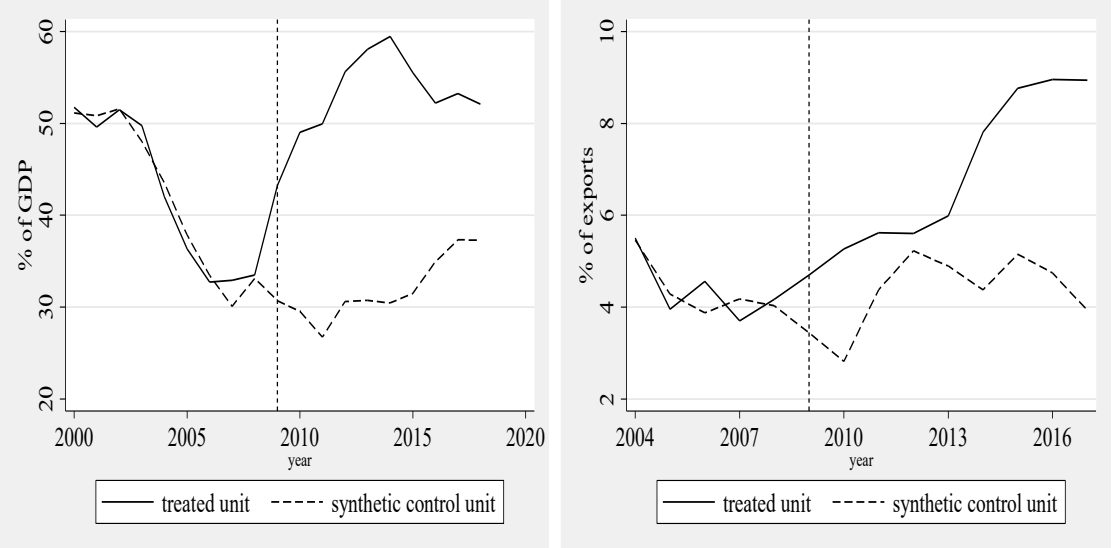
Although Samoa remains at high risk of debt default, according to the IMF DSA, debt remains to be sustainable as it has been transferred into a rise in income and improvements in the Human Development Index – positioning the country at 111 out of 189 countries. Between 1990 and 2018, the HDI value increased by 13.7

[59] https://blogs.worldbank.org/eastasiapacific/rebuilding-paradise-samoas-recovery-from-the-2009-tsunami

percent (UNDP, 2019). The country's economic success despite its vulnerability to natural disasters is underlined by the graduation from the LDC status in 2014.

Figure 11: SCM Samoa 2009, SCM results, External debt (% of GDP) and total debt service (% of exports)

a) External debt, % of GDP b) Total debt service, % of exports



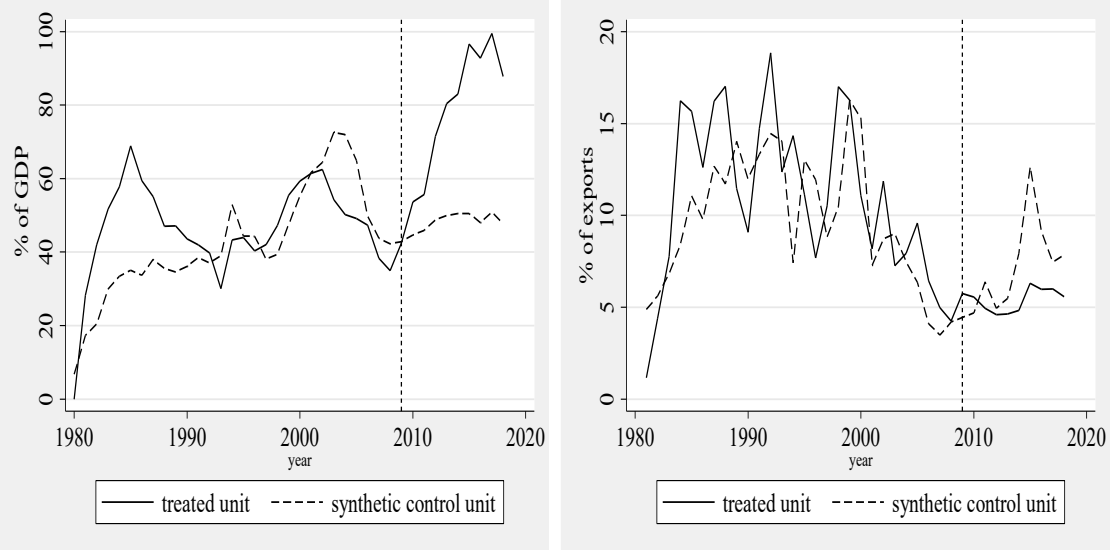
Note: a) Control group: Burundi, Cambodia, St. Lucia, Lesotho, Yemen; RMPSE= 0.98; b) Control group: Burundi, Burkina Faso, Cambodia, St. Lucia; RMSPE=0.4.

iii) Biological disaster: Cabo Verde (2009)

Motivated by the availability of observations over a sufficient pre- and post-disaster time period, the SCM is applied on the Dengue outbreak in Cabe Verde in 2009 which was the largest outbreak the islands had experienced at that time. As shown by the results of the SCM, illustrated in Figure 12, the combination of the biological disaster and the drop in GDP due to the global financial crisis in 2009 caused an explosion of the external debt-to-GDP ratio. In contrast to the control group, debt has drastically increased to almost 100 percent of GDP in 2017. The negative impact of the financial crisis had been more severe for Cabo Verde than for the synthetic control group. Fiscal measures were not successful in boosting GDP growth what was the main cause for the continuous and unsustainable rise in external debt. However, thanks to tourism which accounts for more than 50 percent of total exports, annual debt service, as a percentage of exports, remains relatively low at 6 percent. In addition, nearly 100 percent of the external debt is long-term debt with low interest rates: the average interest of new external debt (public and private debt) is 0.48 percent (2018). Under these conditions, Cabo Verde retains its capability to servicing its debt. However, the current slump in exports, especially of tourism services, in combination with a local health crisis (among SIDS, Cabo Verde has one of the highest number of COVID-19 cases relative to its population), the current crisis will put the country in extremely high risk of debt default.

Figure 12: Cabo Verde 2009 - SCM results, External debt (% of GDP) and total debt service (% of exports)

a) External debt, % of GDP b) Total debt service, % of exports



Note: a) Control group: Fiji, Rwanda, St. Vincent and the Grenadines; RMPSE= 13.96; b) Control group: Fiji, Rwanda; RMPSE= 3.54

Extension to other SVEs and LDCs

SIDS are not the only countries that are vulnerable to disasters and multiple shocks facing difficulties to maintain debt sustainability. Therefore, the regressions reported in Table 3 and Figure 9 are re-estimated extending the country coverage to LDCs and SVEs. The total number of countries increases to 58. Results for the example of the most intense natural disasters are reported in the appendix, Table 10.[60]

The results are strongly in line with those found for the small sample of SIDS, hence, the dummies for different types of disasters and different percentiles are not significant. Past values of debt stock and debt servicing are significantly negatively associated with additional debt in the following period, indicating a similar constraint of SVEs and LDCs in responding to shocks through additional external borrowing. This is supported by the finding that higher real per capita GDP is positively associated with changes in external debt. Economic growth seems to make a country more eligible for additional debt.[61] In light of the need for financing development of LDCs, the seemingly lower credibility to external borrowing should raise concerns. Technically, since reverse causality is not perfectly controlled for, this relationship can be twofold. Higher debt for financing development could also positively impact real per capita GDP.

Higher inflation now seems to increase the external debt-to-GDP ratio for the extended sample. LDCs and SVEs are vulnerable to price fluctuations and macroeconomic instabilities, inflating external debt. Regarding the trade indicators, a positive increase in the terms-of-trade seems to significantly improve debt sustainability, while trade openness remains insignificant. The exchange rate is significant in the large sample for the indicator of debt service-to-exports. A depreciation of the local currency relative to the US-Dollar, indicated by an

[60] The results for each type of natural disaster and at each percentile are available upon request.

[61] Since GDP is also a denominator of the dependent variable, one would even expect a negative correlation, as higher GDP growth would reduce the debt per GDP.

increase in the exchange rate, is associated with a lower price of exports, an increase in exports and hence, a lower ratio of debt service-to-exports.

Static log-linear model

In a dynamic model, a large part of the within-variation in the dependent variable is often captured in the included lag of the dependent variable. This partly causes insignificant results in a relatively small sample. Log-linearization is usually also more robust and yields more significant results. The following robustness check aims to test whether the dummies for natural disasters remain insignificant even in such a simple setting (see equation (3)).

$$\begin{aligned}\ln y_{it} = {} & \beta_0 + \beta_1 Intense\ ND\ dummy_{it-k} + \beta_2 \ln real\ per\ capita\ GDP_{it-1} \\ & + \beta_3 \ln Population_{it-1} + \beta_4 Inflation_{it-1} \\ & + \beta_5 Terms\ of\ Trade_{it-1} + \beta_6 Trade\ openness_{it-1} \\ & + \beta_7 Debt\ reconstruction\ dummy_{it-1} + \beta_8 X_{it-1} + \alpha_i + \gamma_t + \mu_{it}\end{aligned} \quad (3)$$

The results are reported in Table 11 (external debt stock) and Table 12 (debt service) in the appendix. As expected, most variables are significant, at least at the 10-percent level. Real per capita GDP, higher inflation rate, ODA (in % of GDP) and broad money supply (in % of GDP) are significantly positively correlated with external debt (in % of GDP). An increase in real per capita GDP by 1 percent is associated with a 0.4 percentage increase in the external debt-to-GDP ratio. An increase in population, terms of trade growth, trade openness and export diversification are significantly negatively correlated with external debt. For instance, an increase in trade openness (in % of GDP) by 1 percentage point can be associated with a reduction of the debt-to-GDP ratio by 0.36 to 0.5 percentage point. Regarding debt service as a percentage of exports, trade openness and export diversification are the main variables in the specification causing a reduction of the debt service-to-exports ratio through the positive link to exports. An increase in the export diversification index by 1 index point (sample average) could reduce the debt-service-to-exports ratio by 3.7 percentage points. This finding emphasizes the importance of trade and export earnings to reducing the burden of annual debt payment.

With regards to the research question, none of the dummies capturing severe natural disasters is significant, confirming the statistically weak relationship between a natural disaster and external debt. The findings are largely in line with those found in the literature (e.g. Lee, Zhang and Nguyen, 2018). The insignificance of the coefficient estimates throughout several specifications can be related to: First, in light of already high indebtedness, SIDS may face constraints to access sufficient credit to respond adequately to multiple disasters. The marginal effect on debt and the restrictions to already indebted countries is likely to result in a high welfare loss (Cantelmo et al., 2019). Moreover, limited access to funds risks an increase of economic vulnerability to natural disasters in the future (IPCC, 2012). Second, the insignificance of the coefficient estimates may also be explained by the possibility that expenditures switch from development to reconstruction rather than expanding. Third, the difficulties in measuring and reporting the damage of natural disasters may cause an insufficient response to disasters and a limited recognition of some seemingly silent disasters (such as droughts and biological disasters). Fourth, the, on average, insignificant relationship between disasters and debt may be related to the heterogeneity of SIDS. While it can be observed for some countries that debt increased after a disaster (indicated by the SCM results) this is not the case for all countries. In addition, country-specific characteristics (macroeconomic conditions, past values of debt, trade openness) are main drivers of debt sustainability. For future research, more country-specific analysis is necessary to uncover diverse dynamics of debt sustainability. Fifth, pre-disaster investments in building resilience to external shocks and to climate change adaptation have the potential to improve a country's ability to absorb the damage domestically without the need to increase external debt.

6. Conclusions and policy recommendations

The paper's empirical findings on the relationship between natural disasters and debt sustainability are summarized as follows:

(1) SIDS are the most disaster-prone countries in the world, facing on average an annual damage of 2.1 percent of GDP over the period 1970 to 2018.

(2) Due to small domestic markets, SIDS are highly vulnerable to global economic shocks: During the COVID-19 crisis, SIDS need to expect a drop in the current account balance from averagely -2.7 percent of GDP in 2019 to -13.1 percent of GDP in 2020, mainly due to the drop in tourism.

(3) According to the fixed effects regression results, there is on average no significant relationship between a disaster and increases in external debt across SIDS. This finding is confirmed across different types of disasters. The small and insignificant effect on debt in the aftermath of severe disaster strongly relates to the restrictions of already indebted countries to access adequate funding.

(4) Only for selected case studies, using the Synthetic Control Method, an increase in external debt stock can be strongly associated with the occurrence of a severe natural disaster. SIDS are highly heterogeneous in their exposure to natural disasters, the state of development, the eligibility to concessional financing and their institutional capacity to manage disaster response. Country case studies are necessary to reveal each country's vulnerability to debt increases.

(5) Much of the disaster response had been on a short-term emergency base rather than long-run development planning, especially for the case of biological disasters. Positive examples from Dominica and Samoa reveal that rebuilding efforts have made it possible to achieve economic growth and stronger resilience. This points to the importance of financial resources to rebuild shortly after a natural disaster so that the economy can be strengthened in the long run to meet debt service payments. If sufficient resources are not available when they are needed, countries may end up in a trap where low economic activity and poor competitiveness will cause difficulties to pay external debt, what makes a country even less eligible to access loans in the future.

(6) Debt restructuring has provided important relief only to some disaster-prone countries. For instance, while Dominica received private debt relief in 2004 after a sharp increase in debt in the aftermath of the 1995 storm, Cabo Verde was not eligible after the Dengue outbreak during the financial crisis in 2009 which caused debt to surge to 100 percent of GDP.

(7) The paper's findings reveal that, on average, the external debt-to-GDP and debt service-to-exports, is mainly driven by its past values, by real GDP, terms-of-trade growth and export diversification. Stronger economic growth and diversified exports improve SIDS' capability to manage and repay debt.

Policy recommendations

Policy recommendations are structured along three pillars (1) financial instruments, (2) investing in economic resilience, and (3) improving data collection.

(1) Financial instruments and the role of multilateral institutions

The IPCC (2012) has pointed out that without investment in adaptation and resilience building measures, the increased frequency of natural disasters will negatively impact growth and poverty reduction in the future. Therefore, although it remains important to access a portfolio of post-disaster financing options, pre-disaster financing is crucial to reduce human and physical damage in the first place. Article 4 of the 1992 UN Framework Convention on Climate Change (UNFCCC) obliges developed countries to provide adequate assistance to developing countries that are particularly vulnerable to the impacts of climate change. "These parties include small islands, least developed countries (LDCs), and countries susceptible to desertification"

(Robinson and Dornan, 2017, p.1104). Risk reduction investments supported by international donor and the access to the Green Climate Funds must be facilitated. OECD (2018) reports that current accreditation procedures and application processes exceed SIDS' administrative capacity. A stronger collaboration between traditional and emerging donors could help to reduce transaction costs (e.g. Multi-donor funds in Nauru between Australia and Chinese Taipei) (OECD, 2018). Moreover, agreements between debtor and creditors to reduce a developing country's debt stock or debt servicing in exchange for a commitment to protect nature, so-called "debt-for-nature swaps", could be extended by including climate change resilience building. UNCTAD can assist SIDS and other vulnerable countries in facilitating the dialogue with collaboration partners and in building capacity to access available funds. The international community could help to enhance domestic resource mobilization by supporting diaspora schemes to foster trade and investments; improving efficiency of tax collection[62]; support revenue generation in key domestic sectors (e.g. fisheries, tourism), and using remittances to mitigate financial risks. In 2018, remittances in SIDS made up on average 8.4 percent of GDP, compared to an average of 6.6 percent for developing countries. In order to reap higher benefits from remittances, transaction costs, for instance, must be reduced.

Because of the large uncertainties of multiple disasters, ex-ante financing should be a priority. However, previous approaches have mainly focused on ex-post recovery and emergency-based financing. In light of the large damage natural disasters can cause on average every year, a mix of financing options is required. Good experience has been made with countercyclical instruments such as hurricane clauses in debt restructuring (see Grenada) and contingent borrowing. To improve debt sustainability, however, it is strongly recommended to introduce collective action clauses to bond contracts as a general rule to further facilitate negotiations with external bond holders in times of severe shocks. Moreover, the pay-out criteria must be more flexible. For instance, the pandemic catastrophe bonds issued by the World Bank were too restrictive, allowing the death toll in the DRC to increase until the total insurance amount was paid out. Similarly, some of the criteria to access the Catastrophe Containment and Relief fund (e.g. damage must be higher than 100 percent of GDP to access the fund) are inadequate in light of an increasing frequency of multiple disasters.

Transferring risk through insurance and re-insurance (e.g. CCRIF and PCRAFI) has shown first success and can be further exploited. Due to the limited international attention to some seemingly quite natural disasters such as droughts and biological disasters, a general rule to include market insurance to debt should be applied to share costs of such disasters. The international community could help countries to obtain insurance contracts against natural disaster from the private sector at reasonable premiums. The InsuResilience Global Partnership on Climate Risk Insurance could be an opportunity for strengthening public-private partnership in the future in risk transferring. Moreover, green and blue bonds created to fund projects that have a potentially positive environmental impact still remain underrepresented.

Finally, access to financing at concessional terms should be extended to countries when they are exposed to external shocks such as a natural disasters or global economic downturn.[63] Moreover, existing resources must be used more efficiently and catalytically to attract private and public investments (OECD, 2018). The debt sustainability analysis of the IMF remains critical to whether a country is eligible for debt restructuring. At the same time, the rating of debt sustainability tends to be underestimated, often downplays the risk for destabilizing and the need for restructuring (Guzman and Freyman, 2015). In order to mobilize investment especially at the beginning of the development path, and still be sustainable in the long-run, debt ratios should be allowed to increase.

(2) Investing in economic resilience

The results highlight the important role of trade openness and export diversification in lowering the annual debt service payment burden, relative to export earnings. Trade resilience and preventing trade disruptions should

[62] For instance, Australia provided technical assistance to Kiribati to support implementation of value added tax (VAT), and supported Vanuatu to identify potential new sources of revenue.

[63] Countries with access to concessional loans have been able to maintain debt sustainability (see examples of Samoa in the 1990s and Vanuatu). In contrast, SIDS with higher per capita GDP have no access to concessional funding but are also strongly vulnerable to natural disasters and bear high costs of reconstruction.

play an important role to research and policy makers. Attracting FDI is another important mechanism. After a natural disaster, a group of new firms is likely to emerge, and providing appropriate help to these firms could potentially contribute to a stronger economy. If such assistance is provided, natural disasters could impact trade positively through demand, technology upgrading, and generating import demand.[64]

Potential avenues to build greater resilience include a more sustainable use of the oceans, foster biodiversity and invest in green technology to reduce energy and water consumption (OECD, 2018). The blue economy provides a potential through offshore wind energy, fish processing and marine aquaculture. Marine organism could also provide resources for pharmaceutical sectors (OECD, 2018).

Regional approaches already help to distribute risks and costs of natural disaster but can further be strengthened in sharing best practices and regulating standards to regional disaster responses (e.g. the Caribbean Disaster Emergency Management Agency).[65] A key role in getting ready in advance for future risks of multiple shocks play science, technology, and innovation. In times of increasing remoteness, digital technologies can extend access to education and health services, connect communities, and enable early warning systems.[66]

(3) Improving data collection

Incomplete data on the costs of natural disasters is likely to cause a downward bias of the obtained empirical results. Some higher-order impacts from natural disasters are hardly measured, i.e. resources pulled away from usual production processes to recover from natural disasters. While the damage from storms and earthquakes can be measured in monetary terms due to the direct loss of physical capital, many other natural disasters, such as droughts, are silent, do not receive sufficient international attention, and are often not covered in sophisticated financing instruments. There needs to be a harmonized and advanced measurement of all kinds of natural disasters, especially those where people are affected through malnutrition and increasing poverty due the loss of agriculture output. Such data limitations cause uncertainties which is why the findings must be treated with caution. Moreover, policy makers should not rely on highly uncertain projections on long-run debt but rather accumulate domestic resources and maximize the revenue side by addressing leakages (e.g. financial leakages), including better data management. National statistical systems to improve the measurement of natural disasters' impact remain a challenge for many developing countries, also for SIDS. Valuable regional co-operations include the Caribbean Community (CARICOM), and the Pacific Community for the Pacific.

Another element that could not be analyzed in this paper due to data availability constraints is the unequal impact of natural disasters on gender and income groups. Poor and remote households often do not access insurance and credit and may also have insufficient access to recovery programs and public funds to rebuild houses (IMF, 2016). Inequalities in exposure and sensitivity to risk affect women and girls more strongly causing higher death rates of females (Neumayer and Plümper, 2007).

Moreover, data on debt indicators is also not complete for SIDS what challenges an assessment of debt vulnerability to multiple disasters. For instance, one third of low-income countries do not report publicly guaranteed debt of state-owned enterprises and less than 10 percent report debt of public enterprises.[67]

The paper also brings some attention to a potentially misleading grouping of countries into small, islands and developing states. First, SIDS are very heterogenous in their per capita GDP and their vulnerability to natural disasters. Second, a lot of attention has been brought to SIDS in the media, but many other vulnerable countries, also islands or small countries should be equally recognized to mobilize funds. Compared to other small

[64] For instance, a study by Brata, de Groot and Zant (2018) suggests that the 2006 earthquake in Indonesia had a "cleaning effect" of the manufacturing sector, forcing out unproductive firms and opening firms for new firms.

[65] See IMF (2016) for examples in the Pacific.

[66] https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2373

[67] https://blogs.imf.org/2018/03/22/managing-debt-vulnerabilities-in-low-income-and-developing-countries/

developing countries and LDCs, SIDS do not seem to perform worse with similar challenges to adapt to climate change and other external shocks. As argued in the literature, social networks and community-based adaptation[68] to risk is particularly high in SIDS (e.g. Petzold and Magnan, 2019). SIDS have the highest level of official development aid (ODA), relative to their GDP, compared to other developing countries (Robinson and Dornan, 2017). Regarding only SIDS LDCs, ODA was 15.9 percent of GDP in 2018, compared to 10.3 percent in non-SIDS LDCs. Robinson and Dornan (2017) empirically assess the determinants of adaptation financing commitments to SIDS and found that adaptation funds are positively correlated with population size, governance quality, and a SIDS dummy. The Alliance of Small Island States (AOSIS)[69] helps to increase international attention to SIDS but the public tends to neglect the diversity of countries. Among SIDS, comparably less attention in academic research has been given to Cabo Verde, Guinea-Bissau and Sao Tome and Principe (Petzold and Magnan, 2019).

[68] Klöck and Nunn (2019), for instance, reflect on communities' responses to extreme environmental conditions in storing food and preparing houses/gardens for high wind seasons.

[69] Member countries include from the Caribbean - Antigua and Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago – the Pacifics – Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Vanuatu – and African, Indian, and South China Seas – Cabo Verde, Comoros, Guinea-Bissau, Maldives, Mauritius, Sao Tome and Principe, Seychelles, Singapore

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Appendix

Table 4: Country list and group classification

SIDS	LDCs	SVEs
Antigua and Barbuda	Afghanistan	Antigua and Barbuda
Bahamas	Angola	Bahamas
Bahrain	Bangladesh	Barbados
Barbados	Benin	Belize
Belize	Bhutan	Bolivia (Plurinational State of)
Cabo Verde	Burkina Faso	Cuba
Comoros	Burundi	Dominica
Cuba	Cambodia	Dominican Republic
Dominica	Central African Republic	Ecuador
Dominican Republic	Chad	El Salvador
Fiji	Comoros	Fiji
Grenada	Democratic Republic of the Congo	Grenada
Guinea-Bissau	Djibouti	Guatemala
Guyana	Eritrea	Honduras
Haiti	Ethiopia	Jamaica
Jamaica	Gambia	Mauritania
Kiribati	Guinea	Nicaragua
Maldives	Guinea-Bissau	Panama
Marshall Islands	Haiti	Papua New Guinea
Mauritius	Kiribati	Saint Kitts and Nevis
Micronesia (Federated States of)	Lao People's Democratic Republic	Saint Lucia
Nauru	Lesotho	Saint Vincent and the Grenadines
Palau	Liberia	Samoa
Papua New Guinea	Madagascar	Seychelles
Saint Kitts and Nevis	Malawi	Sri Lanka
Saint Lucia	Mali	Tonga
Saint Vincent and the Grenadines	Mauritania	Trinidad and Tobago
Samoa	Mozambique	Antigua and Barbuda
Sao Tome and Principe	Myanmar	Bahamas
Seychelles	Nepal	Barbados
Singapore	Niger	Belize
Solomon Islands	Rwanda	Bolivia (Plurinational State of)
Suriname	Sao Tome and Principe	Cuba
Timor-Leste	Senegal	Dominica
Tonga	Sierra Leone	Dominican Republic
Trinidad and Tobago	Solomon Islands	Ecuador
Tuvalu	Somalia	El Salvador
Vanuatu	South Sudan	Fiji
	Sudan	Grenada
	Timor-Leste	Guatemala
	Togo	Honduras
	Tuvalu	Jamaica
	Uganda	Mauritania
	United Republic of Tanzania	Nicaragua
	Vanuatu	Panama
	Yemen	Papua New Guinea
	Zambia	Saint Kitts and Nevis
		Saint Lucia
		Saint Vincent and the Grenadines
		Samoa
		Seychelles
		Sri Lanka
		Tonga
		Trinidad and Tobago

Table 5: Worst natural disasters (>75-percentile) in SIDS, damage in % of GDP, 1970 - 2018

	Country	Year	Region	Type/Name of natural disaster	Total damage, in % of GDP	Deaths	Affected	Cumulated damage (% of GDP) over 1970 - 2018
1	Dominica	2017	Caribbean	Storm	280.09	64	71293	538.94
2	Samoa	1991	Polynesia	Storm	221.34	13	85000	488.77
3	Samoa	1990	Polynesia	Storm	159.03	8	170000	488.77
4	Grenada	2004	Caribbean	Storm	148.38	39	60000	154.30
5	Vanuatu	1985	Melanesia	Storm	139.86	9	117500	222.57
6	Haiti	2010	Caribbean	Earthquake	120.79	229549	4314226	262.46
7	Saint Kitts and Nevis	1998	Caribbean	Storm	104.37	5	10000	203.63
8	Dominica	2015	Caribbean	Storm	89.29	30	28000	538.94
9	Dominica	1979	Caribbean	Storm	81.16	40	70000	538.94
10	Dominica	1995	Caribbean	Storm	71.03	2	0	538.94
11	Saint Kitts and Nevis	1995	Caribbean	Storm	62.84	0	1800	203.63
12	Antigua and Barbuda	1995	Caribbean	Storm	60.63	2	0	110.73
13	Vanuatu	2015	Melanesia	Storm	59.16	11	188000	222.57
14	Saint Lucia	1980	Caribbean	Storm	56.97	9	70000	61.45
15	Samoa	1983	Polynesia	Storm, Wildfire	56.54	0	2000	488.77
16	Guyana	2005	Central America	Flood	56.38	34	274774	72.56
17	Maldives	2004	Southern Asia	Storm	38.32	102	12000	54.84
18	Tonga	1982	Polynesia	Storm	35.93	7	100000	83.85
19	Belize	2000	Storm		33.34	14	62000	273.56
20	Haiti	1980	Caribbean	Storm	28.90	220	1268000	262.46
21	Belize	2001	Storm		28.67	30	20000	273.56
22	Tonga	2001	Polynesia	Storm	28.30	0	16500	83.85
23	Haiti	2016	Caribbean	Flood, Storm	26.17	599	5801040	262.46
24	Jamaica	1988	Caribbean	Storm	26.13	49	810000	49.08
25	Saint Kitts and Nevis	1989	Caribbean	Storm	23.89	1	0	203.63
26	Samoa	2009	Polynesia	Earthquake	21.21	148	5274	488.77
27	Saint Vincent and the Grenadines	1980	Caribbean	Storm	19.80	0	20000	76.90
28	Vanuatu	1987	Melanesia	Storm	19.11	48	48000	222.57
29	Antigua and Barbuda	1989	Caribbean	Storm	18.23	2	7500	110.73
30	Samoa	2012	Polynesia	Storm	17.49	12	12703	488.77
31	Bahamas	2004	Caribbean	Storm	17.12	12	9000	46.69
32	Antigua and Barbuda	2017	Caribbean	Storm	17.03	1	0	110.73
33	Saint Vincent and the Grenadines	2013	Caribbean	Flood	14.97	12	16885	76.90
34	Mauritius	1979	Eastern Africa	Storm	14.45	5	100000	26.17
35	Antigua and Barbuda	1998	Caribbean	Storm	13.74	2	0	110.73
36	Samoa	1989	Polynesia	Storm	12.61	0	0	488.77
37	Maldives	1991	Southern Asia	Storm	12.27	0	0	54.84
38	Fiji	2016	Melanesia	Storm	12.17	47	545414	57.73
39	Comoros	1983	Eastern Africa	Storm	12.00	33	30000	19.53
40	Guyana	2006	Central America	Flood	11.587615	0	35000	72.560219
41	Dominica	1989	Caribbean	Storm	10.80	0	710	538.94
42	Saint Kitts and Nevis	1999	Caribbean	Storm	10.18	0	1080	203.63

43	Solomon Islands	1986	Melanesia	Storm	9.49	101	90000	12.07
44	Dominican Republic	1998	Caribbean	Storm	9.14	347	855000	22.71
45	Jamaica	2004	Caribbean	Storm	8.82	16	350120	49.08
46	Cuba	1998	Central America	Storm, Drought	8.47	6	967000	33.32
47	Bahamas	1992	Caribbean	Storm	8.04	4	0	46.69

Source: Author's calculation based on EMDAT data.

Table 6: Worst natural disasters (>75-percentile) in SIDS countries, affected population, 1970 - 2018

	Country	Region	Year	Type of natural disaster	Total affected people, in % of population	Deaths	Total affected
1	Antigua and Barbuda	Caribbean	1983	Storm	121.38	0	75000
2	Tonga	Polynesia	1982	Storm	106.79	7	100000
3	St. Lucia	Caribbean	2010	Storm	105.12	14	183000
4	Samoa	Polynesia	1990	Storm	104.42	8	170000
5	Kiribati	Micronesia	1999	Drought	101.24	0	84000
6	Dominica	Caribbean	2017	Storm	99.77	64	71293
7	Dominica	Caribbean	1979	Storm	93.39	40	70000
8	Mauritius	Eastern Africa	1975	Storm	92.62	9	826199
9	Sao Tome and Principe	Middle Africa	1983	Drought	92.02	0	93000
10	Micronesia	Micronesia	2016	Drought	90.73	0	100000
11	Vanuatu	Melanesia	1985	Storm	90.40	9	117500
12	Cuba	Central America	2017	Storm	88.18	10	10000000
13	Tonga	Polynesia	2018	Storm	84.30	0	87000
14	Guyana	Latin America	1997	Drought	80.10	0	607200
15	Vanuatu	Melanesia	2015	Storm	69.34	11	188000
16	Fiji	Melanesia	2016	Storm	62.52	47	545414
17	St. Lucia	Caribbean	1980	Storm	59.41	9	70000
18	Grenada	Caribbean	2004	Storm	57.50	39	60000
19	Haiti	Caribbean	2016	Storm, Flood	53.35	599	5801040
20	Belize	Central America	1974	Storm	53.31	0	70000
21	Cuba	Caribbean	2001	Storm	52.84	5	5900012
22	Samoa	Polynesia	1991	Storm	51.83	13	85000
23	Comoros	Eastern Africa	2005	Volcanic activity	46.66	1	285358
24	Tuvalu	Polynesia	2015	Storm	41.56	0	4613
25	Dominica	Caribbean	2015	Storm	39.34	30	28000
26	Haiti	Caribbean	2010	Earthquake	37.55	229549	4314226
27	Guyana	Central America	2005	Flood	36.82	34	274774
28	Marshall Islands (the)	Micronesia	2015	Drought	36.56	0	21000
29	Fiji	Melanesia	1983	Storm and Drought	35.32	9	242132
30	Vanuatu	Melanesia	1987	Storm	35.27	48	48000
31	Jamaica	Caribbean	1988	Storm (and Flood)	33.90	49	810000
32	Fiji	Melanesia	1998	Drought	32.93	0	263455
33	Solomon Islands	Melanesia	1986	Storm	32.28	101	90000
34	Papua New Guinea	Melanesia	2015	Drought, Flood, Storm	31.44	24	2549199
35	Fiji	Melanesia	1986	Flood	30.34	20	218000
36	Antigua and Barbuda	Caribbean	2008	Storm	30.21	0	25800
37	Dominican Republic	Caribbean	2016	Storm	26.85	15	2792000
38	Vanuatu	Melanesia	2004	Storm	26.45	2	54000
39	Solomon Islands	Melanesia	1993	Storm	26.07	4	88500
40	Belize	Central America	1998	Storm	26.05	9	60000
41	Guyana	Central America	2015	Flood	25.93	0	199000

42	Belize	Central America	2000	Storm	25.06	14	62570
43	Saint Kitts and Nevis	Caribbean	1998	Storm	23.14	5	10000
44	Cuba	Central America	2005	Storm	23.08	20	2600000
45	St. Vincent and the Grenadines	Caribbean	2016	Flood	22.84	0	25000
46	Jamaica	Caribbean	1991	Flood	22.55	15	550000
47	Fiji	Melanesia	1972	Storm	22.11	3	120000
48	Dominican Republic	Caribbean	1979	Flood	21.17	1432	1201000
49	Fiji	Melanesia	2018	Storm	20.28	7	179200
50	St. Vincent and the Grenadines	Caribbean	1979	Volcanic activity	20.07	2	20000
51	St. Vincent and the Grenadines	Caribbean	1980	Storm	19.89	0	20000
52	Fiji	Melanesia	1993	Storm	19.87	21	150000
53	Haiti	Caribbean	1994	Storm	19.73	1122	1587000
54	Dominican Republic	Caribbean	1988	Flood	17.36	0	1191150
55	Fiji	Melanesia	1985	Storm	17.14	32	122000
56	Tonga	Polynesia	2001	Storm	16.75	0	16500
57	Tonga	Polynesia	1977	Storm and Earthquake	16.62	1	15000
59	Belize	Central America	2008	Flood, Storm	15.64	8	48000
60	St. Vincent and the Grenadines	Caribbean	2013	Flood	15.54	12	16885
61	St. Lucia	Caribbean	2016	Storm	13.89	0	25000
62	Dominica	Caribbean	1984	Storm	13.54	2	10000
63	Vanuatu	Melanesia	2011	Storm	13.19	0	32000
64	Jamaica	Caribbean	2004	Storm	12.85	16	350120
65	Solomon Islands	Melanesia	1982	Storm	12.17	0	30000
66	Antigua and Barbuda	Caribbean	1989	Storm	12.10	2	7500
67	Tuvalu	Polynesia	1972	Storm	12.09	6	700
68	St. Lucia	Caribbean	2013	Flood	11.26	6	19984
69	Marshall Islands (the)	Micronesia	2013	Drought	11.21	0	6384
70	Trinidad and Tobago	Caribbean	2018	Flood	10.79	0	150000
71	Dominica	Caribbean	2007	Storm	10.59	2	7500
72	Mauritius	Eastern Africa	1979	Storm	10.53	5	100000
73	Dominican Republic	Caribbean	1998	Storm	10.41	347	855000
74	Comoros	Eastern Africa	1985	Storm	9.85	2	35000
75	Timor-Leste	South-eastern Asia	2016	Drought	9.84	0	120000
76	Jamaica	Caribbean	1979	Flood	9.38	44	200000

Source: Author's calculation based on EMDAT data.

Table 7: Debt indicators, 2018, SIDS

Country	LDC Status	Debt restructu-ring	Real per capita GDP in US$	External debt, in % of current GDP	PV of external debt, in % of current GDP	External debt, in % of exports	Total debt service, in % of exports	Risk of Debt distress according to IMF DSA	Concessional debt, in % of ext. debt	Long-term debt, in % of total ext. debt	PPG, in % of total ext. debt	Private creditor bonds, % of total PPG debt	Avg. interest on new ext. debt, public and private (%)	Currency composition of PPG debt, U.S. dollars (%)
Antigua and Barbuda	No	2010 (2), 2008 (3)	15134	35.00		73.60	8.40	High						
Bahamas	No		27261	25.50		74.10	9.10	Moderate						
Barbados	No	2018/19	16018	32.60		79.50		Moderate						
Belize	No	2007 (4), 2013 (3), 2017	4248	73.75	69.33	126.98	10.14	High						
Cabo Verde	Grad. 2007		3759	87.79	78.13	173.62	5.57	High	44.29	99.18	99.19	0.00	0.48	25.74
Comoros	Yes	HIPC; 2009 (2), 2010 (2)	1401	16.23	8.09	125.37	1.92	Moderate	85.29	87.71	87.70	0.00	1.00	45.00
Dominica	No	2004 (3)	6694	50.67	47.42	161.81	16.54	High	18.53	87.28	87.29	10.47	0.75	63.60
Dominican Republic	No	1985 (2), 1991 (2), 2004 (2), 2005 (2,3)	7697	39.63	29.03	163.85	15.07	High	1.25	92.9	69.3	69.4	6.6	93.92
Fiji	No		4795	15.38	12.42	31.29	1.95	Moderate	0.13	83.81	83.78	28.03	3.05	67.91
Grenada	No	2006 (2), 2005 (3), 2013 (3) 2015 (3)	9096	54.38	41.09	97.44	8.44	In debt distress	28.55	75.76	75.76	22.21	0.78	94.89
Guinea-Bissau	Yes	1987 (2), 1989 (2), 1995 (2), 2001 (2), 2010 (2), 2011 (2)	622	28.85	16.84	81.54	1.90	Moderate						
Guyana	No	HIPC, 1989 (2), 1990 (2), 1993 (2), 1996 (2), 1999 (2), 2004 (2)	3992	41.48	29.51	99.72	4.97	Moderate						
Haiti	Yes	HIPC, 1995 (2), 2006 (2), 2009 (2)	730	22.91	15.74	119.70	1.16	High						

Jamaica	No	1984 (2), 1985 (2), 1987 (2), 1988 (2), 1990 (2), 1991 (2), 1993 (2), 2010 (4), 2013 (4)	4855	103.77	88.52	268.22	20.44	High	0.51	81.19	59.91	62.06	3.41	97.84
Kiribati	Yes		1762	23.00	11.40		6.00	High						
Maldives	Grad. (2011)		8033	43.78	22.18	63.03	9.23	High	12.83	88.24	85.89	17.47	5.52	73.79
Marshall Islands	No		3066	37.70	31.50	106.70	10.70	High						
Mauritius	No		10578	78.81	10.05	81.06	23.25	Moderate	0.35	56.02	12.76	0.00	1.23	37.22
Micronesia	No		2728	20.30	18.70		6.40	High						
Nauru	No		10910	30.60		117.70	5.60	High						
Palau	No		12260	30.80		64.40	5.80	Moderate						
Papua New Guinea	No		2416	75.40	9.26	166.45	26.11	Moderate						
Saint Kitts and Nevis	No	2012 (2,3)	16942	18.50		54.30	5.50	Low						
Saint Lucia	No		8485	32.04	28.58	49.12	3.90	Moderate	16.58	81.17	81.16	51.41	1.83	95.97
Saint Vincent and the Grenadines	No	2007 (2)	6852	40.45	36.94	101.63	12.29	High	24.19	94.52	94.52	2.94	0.75	92.77
Samoa	Grad. 2014		3748	52.10	42.43	137.20	9.77	High	61.47	94.32	94.32	0.00	0.00	26.56
Sao Tome and Principe	Yes	HIPC; 2000 (2), 2005 (2), 2007 (2)	1297	59.11	52.04	242.87	4.52	In debt distress	70.21	89.36	89.38	0.00	0.00	49.18
Seychelles		2009 (2), 2015 (2), 2010 (3)	14385	100.10		97.80		High						
Solomon Islands	Yes	2010 (3)	1482	27.84	5.81	53.83	5.61	Moderate	19.08	84.52	24.72	0.00	0.75	69.56
Suriname	No	2009 (2)	8040	102.3		153.8		High						
Timor-Leste	Yes		2759	6.12	4.02	15.68	0.32	Low	13.54	91.56	91.52	0.00	2.60	90.87
Tonga			4054	41.90	34.72	122.51	7.23	High	36.92	95.15	95.12	0.00	0.00	25.47
Trinidad and Tobago		1989 (2), 1990 (2)	15161	15.00				Low						
Tuvalu	Yes		3636	37.00	45.00	320.60		High						
Vanuatu	Grad. 2020		2875	43.99	44.20	96.20	8.00	Moderate	36.29	78.01	78.02	0.00	2.00	23.68

Table 8: Variables, descriptive statistics, Extended sample (SIDS, SVE and LDCs), 1980-2018

	Obs	Mean	Std. Dev.	Min	Max	Estimation
Total external debt, % of GDP	2,232	67.35	71.62	0	1087.40	
Total debt service, % of exports	2,060	14.56	13.87	0.0082	156.85	
Control variables						
Real per capita GDP	2,236	1836.4	1837.39	164.19	10578.62	FE
Real GDP growth	2,386	3.77	5.60	-50.24	64.08	FE, SCM
Government expenditures, % of GDP	2,341	0.15	0.07	0.019	0.92	SCM
Openness, % of GDP	2,341	0.71	0.34	0.035	2.90	FE, SCM
Population density	2,387	1.28E+02	1.97E+02	1.539	1.72E+03	SCM
Population size	2,387	1.13E+07	1.99E+07	69650	1.61E+08	FE, SCM
Agriculture value added, % of GDP	2,341	0.24	0.13	0.0149	0.83	SCM
Inflation, % change	1,849	35.56	628.46	-60.49	23773.13	FE
Terms of trade growth	1,885	0.007	0.15	-0.622	3.49	FE
Debt restructuring dummy	2,394	0.070	0.25	0	1	FE, SCM
Export diversification index	1,504	0.75	0.07	0.454	0.91	FE
Net ODA, % of GDP	2,188	10.90	10.50	-2.627	94.94	FE
Concessional debt, % of external debt	2,394	3.89E+01	2.66E+01	0	1.00E+02	SCM
Broad money, % of GDP	2,148	36.99	23.92	2.86E+00	150.68	FE
Exchange rate, LCU/US-Dollar	2,349	399.33	1175.24	1.46E-11	11786.8	FE

Note: “Obs” observations, “Std. Dev.” Standard Deviation.

Table 9: GDP growth rate and current account balance, 2016-2021, by SIDS

	Growth rate of GDP (constant prices)						Current account balance, % of GDP					
	2016	2017	2018	2019*	2020*	2021*	2016	2017	2018	2019*	2020*	2021*
Antigua and Barbuda	5.498	3.144	6.95	3.351	-17.273	4.701	-2.428	-7.834	-13.682	-6.507	-22.035	-24.705
The Bahamas	1.444	3.116	3.026	1.218	-14.784	4.592	-5.958	-12.083	-11.422	0.616	-17.546	-15.932
Barbados	2.485	0.478	-0.583	-0.098	-11.6	7.4	-4.26	-3.788	-3.96	-3.102	-11.088	-6.807
Belize	0.104	1.863	2.079	-1.99	-16	8	-9.208	-8.605	-8.059	-9.64	-15.287	-11.38
Cabo Verde	4.706	3.702	4.531	5.668	-6.771	4.481	-3.828	-7.844	-5.223	0.297	-15.162	-10.048
Comoros	3.457	4.177	3.639	1.866	-1.818	2.9	-4.349	-2.132	-2.752	-3.806	-2.125	-1.48
Dominica	2.522	-9.53	0.533	8.386	-8.782	3.269	-7.68	-8.832	-44.592	-27.153	-27.781	-26.307
Dominican Republic	6.659	4.667	6.983	5.052	-5.987	3.996	-1.075	-0.166	-1.354	-1.353	-6.038	-4.486
Fiji	2.51	5.426	3.526	-1.3	-21	11.5	-3.627	-6.72	-8.489	-12.889	-15.3	-12.1
Grenada	3.74	4.439	4.141	2.992	-11.779	3.049	-11.049	-14.435	-15.922	-15.826	-25.285	-24.931
Guinea-Bissau	5.307	4.789	3.358	4.5	-2.9	3	1.358	0.263	-3.598	-8.53	-12.118	-4.229
Guyana	3.807	3.734	4.441	5.353	26.205	8.12	1.453	-4.887	-29.158	-33.901	-21.972	-16.227
Haiti	1.453	1.173	1.484	-1.197	-4	1.2	-0.893	-0.998	-3.86	-1.412	-2.471	-0.42
Jamaica	1.499	0.687	1.886	0.899	-8.564	3.635	-0.308	-2.688	-1.56	-2.005	-5.213	-7.237
Kiribati	5.13	0.897	2.313	2.297	-1.1	2.954	10.77	37.627	38.742	32.047	-1.574	2.812
Maldives	6.338	6.804	6.889	5.657	-18.562	12.696	-23.638	-21.701	-26.399	-25.995	-31.819	-17.043
Marshall Islands	1.307	4.057	3.625	5.309	-4.5	-0.9	16.134	7.529	6.516	8.035	1.58	1.246
Mauritius	3.838	3.814	3.76	3.015	-14.2	9.9	-4.017	-4.617	-3.916	-5.423	-13.256	-10.711
Micronesia	0.9	2.682	0.212	1.2	-3.778	1.187	7.155	10.279	21.04	15.965	1.584	3.452
Nauru	3.02	-5.496	5.703	0.959	0.706	1.25	2.034	12.666	-4.585	10.54	4.172	3.371
Palau	-0.444	-1.972	5.815	-1.769	-11.4	-7.4	-13.448	-18.709	-15.163	-26.619	-32.722	-35.379
Papua New Guinea	4.078	3.538	-0.85	4.933	-3.276	1.187	29.365	29.891	26.246	22.155	14.728	18.869
Samoa	8.054	1.016	-2.168	3.549	-4.997	-1.519	-4.468	-1.993	0.818	2.282	-7.084	-6.997
São Tomé and Príncipe	4.172	3.871	3.028	1.302	-6.5	3	-6.076	-13.233	-12.288	-12.483	-16.985	-11.707
Seychelles	4.563	4.376	3.754	3.901	-13.778	4.172	-20.571	-20.105	-17.939	-16.67	-28.335	-25.655
Solomon Islands	5.873	5.347	3.943	1.193	-4.993	4.465	-3.531	-4.31	-3.016	-9.635	-11.323	-16.376
St. Kitts and Nevis	2.828	-1.978	2.924	2.842	-18.65	8	-12.731	-11.206	-5.738	-2.095	-21.01	-19.993
St. Lucia	3.762	3.489	2.639	1.729	-16.897	7.206	-6.518	-0.965	2.169	5.29	-16.797	-9.257
St. Vincent and the Grenadines	1.897	1	2.163	0.4	-6.989	3.679	-13.878	-11.606	-11.989	-9.967	-18.732	-16.94
Suriname	-5.56	1.762	2.58	0.268	-13.08	1.49	-5.129	1.894	-3.406	-11.095	-7.994	-6.161

Timor-Leste	3.551	-3.799	-0.78	3.1	-6.8	4	-32.879	-21.09	-12.189	8.209	-13.726	-27.555
Tonga	6.571	3.322	0.302	0.732	-2.539	-3.546	-6.487	-6.383	-5.572	-4.778	-4.649	-17.505
Trinidad and Tobago	-6.296	-2.312	-0.245	-0.002	-5.645	2.632	-4.394	5.322	5.756	4.846	-3.308	1.461
Tuvalu	5.885	4.6	3.662	6	-0.517	2.985	21.454	23.997	7.104	12.427	17.009	-10.998
Vanuatu	3.467	4.418	2.9	3.265	-8.286	4.281	0.756	-6.388	9.438	13.086	-0.306	-1.561

Source: IMF World Economic Outlook. Note: * 2019, 2020 and 2021 are estimated and projected values.

Table 10: Fixed effects regression - Extended sample including SVE and LDCs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable :	Change in (% of GDP) total external debt					Change in (% of exports) total debt service				
L. External debt, % of GDP	-0.127***	-0.119***	-0.111***	-0.127***	-0.129***					
	(0.0119)	(0.0123)	(0.0117)	(0.0139)	(0.0121)					
L.Debt sevice, % of exports						-0.429***	-0.463***	-0.437***	-0.513***	-0.438***
						(0.0244)	(0.0263)	(0.0248)	(0.0302)	(0.0249)
L. ND-dummy > 95 percentile	-2.416	-2.310	-2.227	-2.897	-2.655	0.468	0.692	0.475	-0.403	0.424
	(2.544)	(2.514)	(2.493)	(3.031)	(2.601)	(1.416)	(1.388)	(1.424)	(1.633)	(1.445)
L.(log) real per capita GDP	10.40***	9.620***	9.570***	18.08***	9.588***	-0.516	1.258	-1.126	1.756	-0.369
	(2.384)	(2.664)	(2.389)	(3.975)	(2.567)	(1.361)	(1.509)	(1.420)	(2.058)	(1.375)
L.(log) population	-3.980	-4.284	-2.472	-2.500	-4.186	-11.26***	-13.35***	-12.16***	-15.98***	-10.59***
	(5.418)	(5.410)	(5.273)	(7.998)	(5.474)	(3.157)	(3.136)	(3.233)	(4.442)	(3.197)
L. Inflation rate (CPI)	0.00235***	0.00227***	0.00221***	-0.00752	0.00234***	-0.000745	-0.000558	-0.000698	0.0206	-0.000796
	(0.000571)	(0.000575)	(0.000547)	(0.0177)	(0.000576)	(0.000700)	(0.000687)	(0.000708)	(0.0326)	(0.000702)
L. Terms-of-trade growth	-5.990**	-5.289**	-2.790	-5.305*	-5.936**	-1.807	-1.213	-1.833	-2.414	-1.873
	(2.639)	(2.619)	(2.541)	(3.191)	(2.660)	(1.467)	(1.448)	(1.477)	(1.707)	(1.475)
L. Trade openness (% of GDP)	-1.924	-2.098	-3.487	1.707	-2.168	0.244	0.363	0.181	4.637***	0.0147
	(2.489)	(2.542)	(2.435)	(3.091)	(2.533)	(1.456)	(1.467)	(1.513)	(1.721)	(1.474)
Debt restructuring dummy	-5.397***	-5.296***	-7.849***	-5.620***	-5.347***	-1.356	-1.126	-1.336	-0.406	-1.094
	(1.756)	(1.758)	(1.714)	(1.891)	(1.773)	(1.039)	(1.032)	(1.053)	(1.048)	(1.049)
L.Net ODA (% of GNI)		-0.136**					-0.0182			
		(0.0678)					(0.0400)			
L.broadmoney (% of GDP)			0.00113					0.0132		
			(0.0466)					(0.0272)		
L. Export diversification index				-10.53					-9.539	
				(10.82)					(5.926)	
L. (log) exchange rate (LCU/$US)					-0.158					-0.492**
					(0.207)					(0.228)
Observations	1,467	1,449	1,424	1,105	1,447	1,373	1,351	1,343	1,022	1,355
R-squared	0.233	0.230	0.235	0.212	0.233	0.255	0.273	0.261	0.299	0.259
Number of country_id	58	58	58	58	58	58	58	58	57	58

Note: Standard errors in parentheses; Country- and year-fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 11: Fixed effects regression - Log linear static model (external debt)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable				ln External debt (in % of GDP)			
L. ND-dummy > 95 percentile	-0.171	-0.148	-0.177	-0.0788	-0.173		
	(0.152)	(0.146)	(0.148)	(0.147)	(0.152)		
L. ND-dummy > 85 percentile						0.00839	
						(0.0857)	
L. ND-dummy > 75 percentile							-0.0730
							(0.0711)
L.(log) real per capita GDP	0.363***	0.558***	0.243*	0.273	0.341**	0.360***	0.373***
	(0.134)	(0.150)	(0.143)	(0.279)	(0.136)	(0.135)	(0.135)
L.(log) population	-0.837***	-0.668**	-0.698**	-2.497***	-0.768**	-0.813***	-0.824***
	(0.300)	(0.290)	(0.293)	(0.401)	(0.308)	(0.300)	(0.300)
L. Inflation rate (CPI)	0.0122***	0.0135***	0.0124***	-0.00074	0.0125***	0.0120***	0.0123***
	(0.00410)	(0.00392)	(0.00399)	(0.00515)	(0.00411)	(0.00411)	(0.00410)
L. Terms-of-trade growth	-0.293	-0.218	-0.239	-0.0616	-0.307	-0.246	-0.243
	(0.243)	(0.233)	(0.236)	(0.283)	(0.244)	(0.240)	(0.240)
L. Trade openness (% of GDP)	-0.326*	-0.501***	-0.575***	0.0824	-0.394**	-0.335*	-0.340*
	(0.181)	(0.177)	(0.183)	(0.207)	(0.194)	(0.181)	(0.181)
Debt restructuring dummy	0.0888	0.0934	0.106	0.0940	0.0874	0.0766	0.0844
	(0.108)	(0.103)	(0.104)	(0.0987)	(0.108)	(0.108)	(0.108)
L.Net ODA (% of GNI)		0.00992***					
		(0.00350)					
L.broadmoney (% of GDP)			0.0046*				
			(0.00276)				
L. Export diversification index				-1.053*			
				(0.554)			
L. (log) exchange rate (LCU/$US)					-0.0693		
					(0.0699)		
Observations	334	332	332	281	334	334	334
R-squared	0.236	0.286	0.272	0.295	0.239	0.232	0.235
Number of countries	16	16	16	16	16	16	16

Note: Standard errors in parentheses; Country- and year-fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Fixed effects regression - Log linear static model (debt service)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	ln Debt service (% of exports)						
L. ND-dummy > 95 percentile	0.0537	0.0997	0.101	0.0422	0.0565		
	(0.249)	(0.243)	(0.246)	(0.242)	(0.250)		
L. ND-dummy > 85 percentile						0.175	
						(0.140)	
L. ND-dummy > 75 percentile							-0.111
							(0.116)
L.(log) real per capita GDP	-0.106	-0.00919	-0.235	-0.497	-0.0835	-0.132	-0.0904
	(0.216)	(0.251)	(0.237)	(0.408)	(0.220)	(0.217)	(0.217)
L.(log) population	-0.906*	-0.677	-0.829*	-2.046***	-0.975*	-0.912*	-0.923*
	(0.495)	(0.489)	(0.492)	(0.676)	(0.510)	(0.493)	(0.494)
L. Inflation rate (CPI)	0.00935	0.00921	0.00889	-0.00235	0.00909	0.00898	0.00972
	(0.00660)	(0.00653)	(0.00664)	(0.00823)	(0.00662)	(0.00658)	(0.00659)
L. Terms-of-trade growth	-0.305	-0.272	-0.248	-0.0840	-0.299	-0.305	-0.321
	(0.413)	(0.404)	(0.408)	(0.492)	(0.414)	(0.406)	(0.406)
L. Trade openness (% of GDP)	-1.085***	-1.402***	-1.413***	-0.0307	-1.019***	-1.066***	-1.089***
	(0.291)	(0.296)	(0.306)	(0.332)	(0.312)	(0.290)	(0.290)
Debt restructuring dummy	0.172	0.123	0.128	0.131	0.172	0.165	0.185
	(0.171)	(0.172)	(0.173)	(0.157)	(0.172)	(0.170)	(0.171)
L.Net ODA (% of GNI)		0.00995*					
		(0.00584)					
L.broadmoney (% of GDP)			-0.00035				
			(0.00461)				
L. Export diversification index				-3.593***			
				(0.890)			
L. (log) exchange rate (LCU/$US)					0.0667		
					(0.116)		
Observations	331	328	327	278	331	331	331
R-squared	0.196	0.235	0.227	0.204	0.197	0.201	0.199
Number of countries	16	16	16	16	16	16	16

Note: Standard errors in parentheses; Country- and year-fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1