ADBI Working Paper Series

BUILDING BACK BETTER IN SMALL ISLAND DEVELOPING STATES IN THE PACIFIC: INITIAL INSIGHTS FROM THE BIND MODEL OF DISASTER RISK MANAGEMENT POLICY OPTIONS IN FIJI

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No. 1290
December 2021

Asian Development Bank Institute

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In this paper, "$" refers to United States dollars.

Suggested citation:

Dunz, N., H. Tanaka, N. Shiiba, J. Mochizuki, and A. Naqvi. 2021. Building Back Better in Small Island Developing States in the Pacific: Initial Insights from the BinD Model of Disaster Risk Management Policy Options in Fiji. ADBI Working Paper 1290. Tokyo: Asian Development Bank Institute. Available at: https://www.adb.org/publications/building-back-better-small-island-developing-states-pacific
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The following projects partially supported this study: Structuralist Macreoconomic Modeling of Disaster Risk and Sustainable Development Goals (Jubiläumsfondsprojekt Nr. 17390) and Distributional Implications of Climate-Related Disasters—A Macroeconomic Assessment (DIoD) (Jubiläumsfondsprojekt Nr. 18654).

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Abstract

Building resilience to disasters continues to pose challenges for developing countries. Historically, small island developing states (SIDS) bordering the Pacific Ocean have suffered from multiple hazards, such as earthquakes, coastal erosion, floods, and cyclones. Population increase, uneven progress in socioeconomic development, and the ongoing environmental degradation, including climate change, have exaggerated their vulnerability to disasters. At the same time, the recent COVID-19 global pandemic has shown that the small, remote, and less-diversified economies of SIDS are particularly prone to additional external shocks. Events such as COVID-19, in combination with disasters resulting from natural hazards, pose additional challenges for resource-constrained economies' recovery. However, the existing literature has rarely evaluated such interactions. This study hence provides initial insights into the interaction of alternative DRM policies in the presence of additional demand-side constraints, which we evaluated through the recently developed binary constrained disaster (BinD) model. Our results indicate that a targeted increase of government spending in times of crisis could be beneficial for the economic recovery of Fiji. However, short-term trade-offs emerged with respect to financing options. Debt-financed recovery allows a faster and less painful recovery but requires quick and preferential access to foreign borrowing. Tax-financed recovery can compensate for short-term foreign borrowing needs but comes at the cost of more detrimental impacts on the GDP and private sector consumption.

Keywords: blue economy, disaster risk reduction, build back better, BinD Model

JEL Classification: C22, Q54, H84

Contents

1. INTRODUCTION

Small island developing states (SIDS) in the Asia and the Pacific region face regular exposure to severe cyclones and flooding. The average annual disaster impact on the GDP is around 8% for SIDS and around 0.1% globally, indicating the high vulnerability of SIDS to climate change and ocean risk (CRED 2020). As a small island country in the Asia and the Pacific, Fiji is prone to hazards, such as cyclones, heavy rain, and flooding, which occur almost annually. Most of the population and infrastructure are located in the ocean's proximity. Combined with socio-economic vulnerability, these disasters result in severe damage to people in Fiji (UNDRR 2019). According to the World Bank (2016), Fiji's coastal protection spending will account for about 1%–3% of its projected GDP every year by 2040. Fiji is most likely to have severe difficulties in funding all its climate-related activities in the future. Tropical cyclone (TC) Harold, a category 4 cyclone, hit Fiji on 8 and 9 April 2020, directly affecting more than 182,500 people (or around 20% of the population).

Due to the compound disaster of tropical cyclones and pandemics, 2020 was a catastrophic year for Fiji's socio-economic status. On 15 April 2020, the Prime Minister declared a state of natural disaster in response to the COVID-19 pandemic, which commenced only 3 days after the declaration of a separate state of natural disaster due to TC Harold on 12 April. The global pandemic and the disaster's external shocks exposed the structural problems that Fiji's economy is facing. Fiji recorded 63 positive cases of COVID-19 in total, 55 of which resulted in a full recovery (Ministry of Health & Medical Services [MHMS], as of 5 March 2020). The UN report "Socio-Economic Impact Assessment of COVID-19 in Fiji" concluded that Fiji's economic recession in 2019 was the largest in the last decade (UNDP 2020). Following the identification of the first confirmed case of coronavirus disease 2019 (COVID-19) in Fiji on 19 March 2020, the Fiji government took preventative measures, including lockdown, travel restrictions, border restrictions, and contact tracing. Although Fiji recorded a small number of cases of COVID-19 compared with other countries in the region, it has hit the industries in Fiji, especially tourism, hard. The forecasted annual GDP growth rate from 2019 was around –20% in 2020 (ADB 2020).

COVID-19 and its interaction with disasters are the focus of recent scientific and policy discourse, with various studies evaluating, for example, how countries have adopted national DRM systems to cope with the emerging pandemic (GFDRR and the World Bank 2020) or how they can effectively address pandemic risk in emergency response operations (Baidya, Maitra, and Bhattacharjee 2020; Ishiwatari et al. 2020). Other studies have examined further pathways to stronger inclusion of civil society during compound crises (Majumdar and DasGupta 2020). At the same time, extensive research on the macroeconomic impacts of COVID-19 and their countermeasures has taken place (Bashir, Benjiang, and Shahzad 2020; Brodeur et al. 2020; Nicola et al. 2020). There are also emergent strands of literature exploring the linkages between COVID-19 recovery stimulus policy and broader climate and sustainable development objectives (Engström et al. 2020; Fargher and Hallegatte 2020; Hepburn et al. 2020; Dunz et al. 2021; Mahul, Monasterolo, and Ranger 2021). However, research analyzing the performance of alternative DRM policy decisions intending to aid the recovery from disasters resulting from natural hazards in terms of their macroeconomic outlook amid COVID-19 remains limited. For instance, Burns, Jooste, and Schwerhoff (2021) compared the performance of four alternative DRM strategies for hurricane damage in Jamaica, specifically adaptation investment, insurance, contingency funds, and debt reduction, assessing the accompanying trade-offs of each policy. Marto, Papageorgiou, and Klyuev (2018) applied a dynamic general equilibrium model to the

case of Cyclone Pam in Vanuatu, comparing different financing channels and pre-disaster adaptation measures with post-disaster growth and debt trajectories. Their findings suggested that ex ante resilience policies can reduce debt distress and recovery costs in the aftermath of a disaster. The recent literature on the economics of disasters has increasingly emphasized the need to tailor DRM and adaptation policy options to the specific and timely contexts of each country while also evaluating key synergies and trade-offs (Hallegatte, Rentschler, and Rozenberg 2020; Yokomatsu et al. 2020).

To fill this important knowledge gap, this paper adopts the "binary constrained disaster model (BinD)," which the International Institute for Applied Systems Analysis (IIASA) developed, and applies it to an analysis of the combined impact of cyclones and COVID-19 in Fiji. The BinD model is a demand-driven macroeconomic model that aims to assess the fiscal and macroeconomic implications of disasters in financially constrained SIDS. Building on the three-gap models of Taylor (1991, 1994) and others, the BinD model describes public sector, private sector, and foreign sector saving constraints, which interact dynamically in an integrated modeling framework. Both aggregate demand and aggregate supply play a fundamental role in the BinD model, depending on which of the two is the constraining factor: limited private and public consumption not allowing profitable use of machinery or limited financial means to purchase machinery to satisfy the foreign and domestic demand (hence, as the name suggests, it indicates the "binary constraints" of supply and demand). The model extends the original gap approach through a dynamic macroeconomic model using parsimonious sets of adjustment mechanisms, and it allows for the combined evaluation of DRM policy and macroeconomic recovery trajectories under alternative demand and supply shock scenarios.

We adopted a simplified version of the BinD model for Fiji to highlight the initial insights into supply- and demand-side DRM policy responses under alternative macroeconomic conditions. Our results indicated that a targeted increase in government spending in times of crisis could be beneficial for the economic recovery of Fiji. However, short-term trade-offs emerged with respect to financing options. Debt-financed recovery allows faster and less painful recovery but requires quick and preferential access to foreign borrowing. Tax-financed recovery can compensate for short-term foreign borrowing needs but comes at the cost of more detrimental short-term impacts on the GDP and private sector consumption.

The study proceeds as follows: section 2 introduces Fiji's background, economic structure, and vulnerability to disaster; section 3 explains Fiji's disaster risk management; section 4 outlines Fiji's structural vulnerability; section 5 presents the BinD model structure and simulation settings; and section 6 summarizes the key findings of this study, discussing future perspectives.

2. FIJI IN CONTEXT

Fiji is an island nation in the Melanesian region (although the classification of some areas is Polynesian), with an area of about 18,333 square kilometers and a population of approximately 890,000 (ADB 2019a). Fiji has a smaller economy than the upper-middle-income countries in the region, such as Niue, Palau, and the Cook Islands. However, it is a relatively resource-rich country with a large economy and significant political influence in the region. The three primary industries in Fiji are tourism, sugar, and clothing. Fiji's economy has been growing since 2009 with a per capita GNI of $5,890 and a real GDP growth rate of 3.5%, and the average economic growth rate

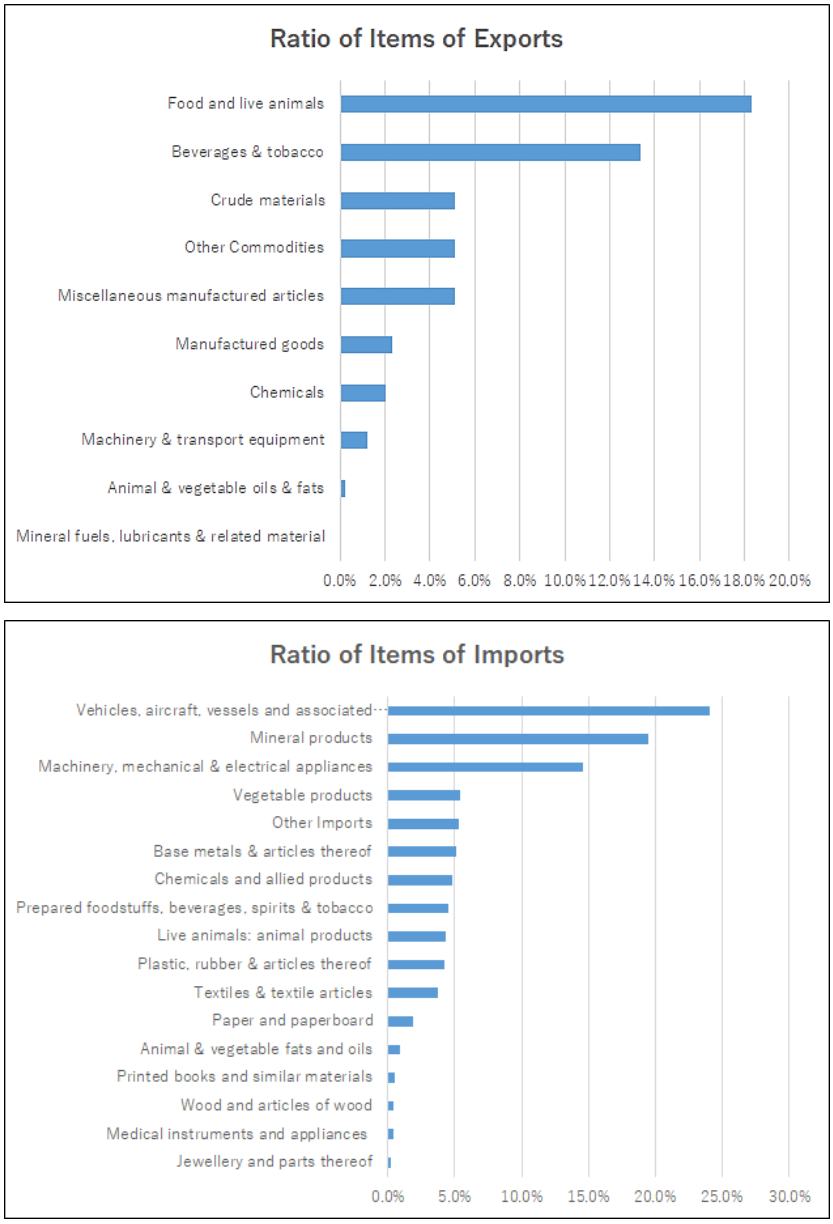
has been relatively stable at 4% since 2011 (IMF 2019). Suva, the capital city, serves as the administrative and cultural center and as a hub for the Asia and Pacific region.

Table 1: Basic Socioeconomic Characteristics of Fiji

Category	Value[1]	References
Population	889,953	World Bank (2020a)
GDP per capita	USD6,176	World Bank (2020a)
Poverty headcount	34%	World Bank (2020a)
Human Development Index	0.743 (ranks 93 out of 189)	UNDP (2020)

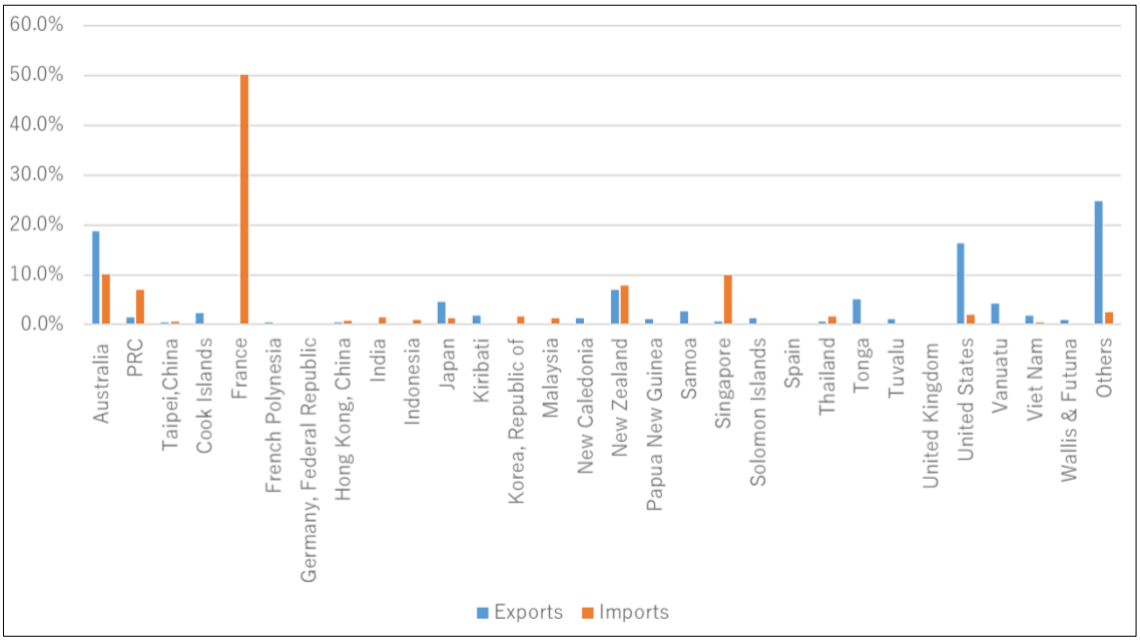
Note: [1] All the values are for 2019 except for headcount poverty, using national poverty lines, for which the latest available estimate is for 2013.

Figure 1: Exports and Imports in 2019



Source: Fiji Bureau of Statistics (2020).

Figure 2: Share of Tread by Countries in 2020



Source: Fiji Bureau of Statistics (2020).

Figures 1 and 2 show the breakdown of imports and exports in Fiji. The major exports include food and live animals, beverages, and crude materials. The export destinations are the United States (US), Australia, Japan, New Zealand, and Tonga. The major imports include machinery and transportation equipment, industrial products, foodstuffs, miscellaneous goods, minerals and fuel, and chemicals from France, Singapore, the People's Republic of China (PRC), Australia, New Zealand, and the US. The primary sources of foreign currency are the tourism, sugar, and gold industries. Fiji's tourism industry has developed remarkably in recent years. In the 1960s, the colonial government imposed a limit on the amount of foreign currency that the country could earn through sugar exports and fostered the tourism industry. Tourism reached its first peak in Fiji in the early 1970s, followed by a temporary decline due to the oil crisis. To date, it has experienced stable growth and is arguably the most rapidly growing industry in the country.

In the 1960s, the country focused on import-substituting industrialization, which proved to be ineffective. Its industrial policy has thus shifted toward exports, including the development of the garment industry through the bonded system. Further, it has diversified its primary industries. Nevertheless, Fiji has a long-standing current account deficit (UNCTAD 2018), partly due to steady growth in re-exports as the processing industry is a key part of Fiji's economy. The country also has ample foreign exchange reserves of $1.04 billion (IMF 2019), which have more than doubled over the past 10 years, while remittance inflows (e.g., remittances from overseas) also play a significant role. The government debt constituted 48% of the GDP (ADB 2018) and the external debt equaled 19% of the GDP in 2018 (World Bank 2020b).

Fiji faces the typical development challenges of small island countries, including small domestic markets, geographic remoteness from international markets, and dependence on primary commodities, though Fiji has fared better than its regional peers. Due to these structural challenges and underdeveloped domestic labor markets, many of the countries of Polynesia and Micronesia have a national economy—the so-called MIRAB economy—which relies on foreign aid for state finances and

remittances from overseas migrants. In contrast, Fiji is less dependent on foreign aid than its regional peers (Dornan and Pryke 2017).[1] The World Bank's data show Fiji's low dependence on net official development aid of GNI (2.76%) and relatively high GDP per capita ($6,175) (World Bank 2020b). This could be partly due not only to Fiji's predominant economic status in the region but also to its political situation. Fiji's traditional donors refrained from providing development assistance after the 2006 coup, but they have been likely to improve the relationship with Fiji since the 2014 election (Schmaljohann and Prizzon 2014). Nonetheless, Fiji's aid dependence remains low. At the same time, there is considerable concern that climate change in the coming years could reverse the development gains that it has made in recent decades.

3. FIJI'S CLIMATE AND DISASTER RISK MANAGEMENT

Hydro-meteorological hazards have frequently occurred in Fiji in recent years. According to the EM-DAT database, between 2000 and 2020, Fiji experienced 18 cyclones, with the total estimated economic damage being approximately $800 million (Table 2). The largest damage and losses often result from the destruction of the built environment, including residential, transport, and other infrastructural assets. While considerable uncertainly exists, the recent climate change assessment projected that the cyclone risk in Fiji is increasing due to climate change—estimations have indicated that losses associated with 1-in-50 year cyclones, for example, will by nearly 30% by the end of the century in the worst-case scenario (PCRAFI 2013).

Table 2: Past Hydrometeorological Disasters

Year	Hazards	Event Name	**Total Damage** ('000 USD)
2003	Tropical cyclone	"Ami"	30,000
2004	Tropical cyclone	NA	4,000
2006	Riverine flood	NA	500
2007	Riverine flood	NA	30,000
2007	Flash flood	NA	7,000
2007	Tropical cyclone	"Daman"	652
2008	Tropical cyclone	"Gene"	30,000
2009	Riverine flood	NA	43,247
2009	Tropical cyclone	"Mick"	13,300
2010	Tropical cyclone	"Tomas"	39,427
2012	Riverine flood	NA	17,000
2012	Riverine flood	NA	72,000
2012	Tropical cyclone	"Evan"	8,400
2016	Tropical cyclone	"Winston"	600,000
2018	Tropical cyclone	"Josie"	10,000
2018	Tropical cyclone	"Keni"	50,000
2020	Tropical cyclone	"Yasa"	1,120
2020	Tropical cyclone	"Harold"	13,000

Source: CRED (2020).

[1] The major donors are Australia, New Zealand, Japan, the Republic of Korea, Germany, and the US. Due to pressure from Australia and New Zealand's repeated interference in its internal affairs, Fiji's government has strengthened its relationship with the PRC in recent years.

At the same time, Fiji has made significant progress on climate change and disaster risk management strategies in recent decades. Fiji has adopted its National Disaster Management Plan (1995) and National Disaster Management Act (1998) and is a signatory to the Hyogo Framework for Action (2005–15) and the subsequent Sendai Framework for Disaster Risk Reduction (2015–30). It has also adopted the National Climate Change Policy (2012), and it conducted a Climate Vulnerability Assessment in 2017, identifying priority investment areas. Currently, Fiji is implementing climate and DRM policies within its overall development strategy, the "5-Year and 20-Year National Development Plan," which it released in November 2017 and which sets several economic targets for the next 20 years, including increasing the GDP per capita fourfold, reducing government debt by 35% of the GDP, decreasing unemployment by 4%, and providing universal access to essential social services, including adequate housing, clean and safe water and sanitation, electricity, education, and health care (Ministry of Economy 2017).

4. FIJI'S VULNERABILITY TO MULTIPLE EXTERNAL SHOCKS

Despite progress in disaster risk management, Fiji remains vulnerable to combined external shocks with disaster and non-disaster causes: the global financial crisis and Cyclone Mick in 2009 caused a sharp increase in unemployment (Reserve Bank of Fiji (RBF) 2019a), and the COVID-19 pandemic in early 2020 took a heavy toll on Fiji's economy. The Reserve Bank of Fiji predicted a contraction in tourism revenue of more than 20% in 2020, expecting it to spur unemployment. In addition, repeated incidents of political instability in the country have caused a rapid decline in foreign private investment, for instance in 2006.[2] Such governance risks could amplify Fiji's economic vulnerability in the face of disaster shocks.

Fiji's efforts to build climate and disaster resilience over the next decades therefore hinge on both internal and external circumstances: internally, Fiji must evaluate carefully how alternative disaster and climate policy will fare under its structural rigidity—including the capital import dependence of its major industries, remoteness (i.e., the difficulty of access, especially in rural areas, which hampers poverty and inequity reduction), and less diversified export options, which render it susceptible to external shocks. The external factors that affect Fiji may include non-climate- and climate-related shocks, some of which are likely to worsen in the coming decades (World Economic Forum 2021).

The paragraph below summarizes Fiji's structural challenges, which are especially notable in the light of increasing disaster risk.

[2] The prolonged political instability resulting from a series of coups has indeed led Fiji onto a lower growth path, and the accumulated effect is increasing (Fletcher and Morakabati 2008).

Alley (2001) analyzed the coup of 2000 and determined that it caused severe economic damage to Fiji compared with the coup of 1987. It produced not only economic shocks, such as a loss of existing trade concessions and disruptions to trade and services, but also political shocks, including the diplomatic isolation of Fiji. In addition, Fiji, as a hub of intergovernmental activity, risked the loss of generous sugar, tuna, and garment export subsidies and benefits in the European Union market. Exports of garment manufacturing, tourism, and aviation faced longer-term damage due to the coup of 2000.

4.1 Industrial Structure, Including Import and Export Rigidities

As with many small island states, Fiji's less-diversified and externally dependent industrial structure is vulnerable to numerous external shocks, with disaster and non-disaster causes. As the background section established, Fiji's economy is highly dependent on capital goods imports (e.g., manufactured goods, machinery, and transport equipment) and petroleum products; these render the economy vulnerable in the case of extended supply and price shocks of these goods in the global market.

Regarding exports, Fiji is strongly dependent on tourism. Fiji's tourism receipt as a share of its total exports reached approximately 50.9% in 2019 (UNWTO 2019). However, the tourism sector is prone to extensive volatility, as the COVID-19 pandemic has recently demonstrated. Further, its exports are predominantly unrefined commodities, such as sugar, gold, and timber, for which it loses ground in market shares.

For instance, Fiji's traditional sugar industry's performance has deteriorated for decades due to the challenges of economic, political, and disaster-related shocks. Fiji's traditional sugar industry is lacking in modernization, which is gradually eroding its international competitiveness as problems such as aging machinery are beginning to emerge (Reddy 2003). The Fiji government has tried to rescue the Fijian Sugar Corporation (FSC), the biggest public sugar company in Fiji, by supporting the purchase of new farming machine; however, its performance has hardly recovered because of its vulnerability to domestic and external shocks (Sami 2020). Guaranteeing the sugar industry's borrowing from domestic and foreign resources would be expensive and would face impediments. The installation of more modern machines to overcome such modernization issues would be more costly and impractical, especially when a disaster occurs, due to the limited foreign exchange and a lack of domestic demand. We explore these aspects in more detail in the following section.

4.2 The Lack of Redundancy in Critical Infrastructure, Financial Preparedness, and Technical Capacities

The lack of redundancy of critical infrastructure and facilities—most of which are, for convenience and strategic reasons, located along the coasts—renders SIDS especially vulnerable to the physical disruption of coastal hazards, and Fiji is no exception. The occurrence of hazards such as coastal storm surge, which climate change exacerbates, may destroy critical port and airport infrastructure and disrupt trade. At the same time, hazards may directly damage the local production of critical goods, hampering the country's ability to substitute these goods domestically.

When one road is damaged, for example, the lack of redundancy means that taking an alternative route is not an option, leading to significant disruption of the transportation of goods and services and even reducing the productivity of other assets, such as factories (Hallegatte, Rentschler, and Rozenberg 2019). Evaluating aspects such as road traffic, the level of redundancy, and hazard exposure, the recent transport sector criticality analysis that Fiji conducted identified, for instance, areas for priority investment. In Vanua Levu, the analysis indicated that the most critical roads are the Natewa west coast road and the Bucalevu, Nabouwalu Batiri Village, and Navolu roads. In Viti Levu, the report showed that King's Road and Queen's Road are critical. Regarding bridges and culverts, important nodes include Kings Road (including the Vunato and Laqere bridges, the Thomson Nabukalou bridge, the Sawani bridge, the Draiba bridge, and the Laqere crossing) in Viti Levu and Savudrodro Road, Nayarabale Road, and Bucalevu Road in Vanua Levu (Government of Fiji 2017). The destruction of

any of these choke points could have significant implications for the country's economic activities and emergency response logistics.

The general lack of redundancy in small island economies applies not only to infrastructure but also to the necessary financial and technical capacities to manage complex reconstruction projects and to repair and maintain specialized facilities. According to the recent study that the International Bank for Reconstruction and Development conducted, $1.6 million of the national budget is available for disaster risk financing and insurance instruments in Fiji as of 2015 (World Bank 2015). However, probabilistic assessment of these financing resources vis-à-vis the reconstruction financing needs of major hazards shows that the response, recovery, and reconstruction needs are likely to exceed Fiji's resource availability in any given year with a 60% probability (PCRAFI 2015).[3] The planning and execution of reconstruction projects will involve complex handling of multi-currency grants and loans. Furthermore, the rebuilding of specialized facilities (port infrastructure, etc.) requires skills that may not be readily available. These additional operational bottlenecks are likely to delay the implementation of recovery and reconstruction projects, leading to increased adverse impacts on the economy.

4.3 Social Vulnerability, Including Poverty and Inequity

According to the UNDP (2020), 24.2% of the population in Fiji still lived below the national poverty line of 7.1 FJD per day before COVID-19, of which more than 60% lived in rural areas. Relative to its regional peers, Fiji's residential building stocks are relatively resilient to disasters, but some disparity remains: nationally, approximately 40% of houses are made of concrete/masonry, while 58% are timber framed with wood or tin/iron cladding. Local bure housing is evident in areas such as the Northern Division (10%) and Eastern Division (7%). Among the areas of informal settlements, 10% of housing is made of concrete, the remainder consisting of timber, iron/tin, and other recycled materials (Government of Fiji 2017). Providing safe housing and adequate preparedness, including access to warnings and evacuation shelters in these areas of heightened vulnerability, remains a policy priority for Fiji.

The recent microeconomic analysis showed that natural hazards place a significant burden on households: cyclones and floods on average push 25,700 people into poverty each year, while 100-year cyclone, fluvial, and pluvial flood events may force approximately 5.7%, 12.5%, and 7.8% of the total population into poverty. These figures are likely to increase (100-year cyclone: 5.7% in 2050, 5.7% in 2100; fluvial floods: 14.8% in 2050, 15.7% in 2100; and pluvial floods: 10.5% and 12.8%) (Government of Fiji 2017). To provide adequate social protection, especially for the vulnerable population, the Government of Fiji has been strengthening its social protection schemes: the social protection budget of the Ministry of Women, Children, and Poverty Alleviation has increased to $23 million, and it needs an estimated additional $1.96 million annually to scale up social protection under climate change (ibid.).

As we will describe below, Fiji faces a number of competing DRM policy needs, including the need for timely recovery of its critical infrastructure bottlenecks, the need to include resilience building (e.g., enhancing the structural safety of the built environment) in post-disaster reconstruction operations, and the provision of sufficient livelihood support for those susceptible to poverty, to name a few. All of these DRM

[3] See, for example, Mochizuki, Hallwright, and Handmer (2019) for a discussion on implementation constraints in post-disaster operation.

policy options must receive financing within the structural rigidity of Fiji's economy, as we will discuss below. As observations in the past few years have indicated, the rebuilding of Fiji's fiscal space remains a major policy priority as the country faces the deterioration of its current account deficit due to rising imports, appreciation of the real exchange rate, and expansionary spending following an election year (IMF 2020a).

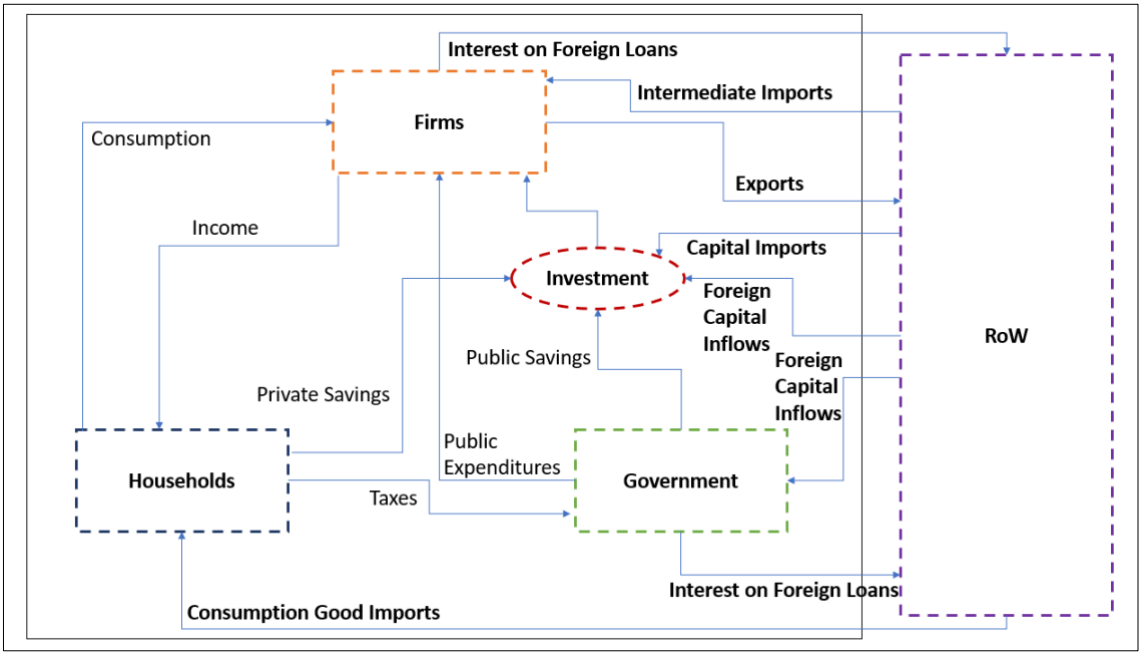
5. METHODOLOGY

This section investigates how these DRM policy options interact in the face of the acute demand-side constraints resulting from the additional external shock of COVID-19. To provide initial insights, we adopted the simplified version of the BinD model to conduct an analysis of Fiji's disaster response scenario.[4]

5.1 BinD Model Structure[5]

The BinD model builds on the three-gap model approach (Bacha 1990; Taylor 1991, 1994), which analyzes the interactive economic constraints of fiscal, private, and foreign savings. The BinD model addresses the shortcomings of the original general three-gap model by capturing the dynamic change of macroeconomic indicators and considering additional supply-side constraints. Figure 3 shows the flows within the BinD model.

Figure 3: BinD Model Flow Framework



Source: Dunz, Naqvi, and Mochizuki 2020.

[4] While distributional aspects are important structural characteristics of Fiji's economy, as section 4 reviewed, the simplified version of the BinD model primarily incorporates rigidities of import and export dependency, the lack of redundant production capacity, and general discussions of the trade-off between consumption and investment spending. The DIoD Project, with funding from the Austrian National Bank, is currently studying the incorporation of distributional aspects.

[5] A full description of the model is available from the IIASA research group on request.

5.1.1 Investment and Capacity Utilization

In line with the three-gap model of Taylor (1991, 1994), the BinD model assumes that Fiji's economy is demand driven—that is, it operates below its full capacity in normal times. Foreign demand in the form of exports, investment, and public and private consumption drive the formation of the output and GDP. In normal times, firms invest to satisfy the demand and expand the physical capital stock of the economy. The available financial means, however, constrain the capital formation since SIDS' access to capital markets is often limited. The BinD model hence assumes that it is possible to determine an economy's actual output in one of two possible ways: (i) the aggregate demand (i.e., specified endogenously by simultaneously solving government, private consumption, investment, and import functions [6]), representing a demand-side constraint, and (ii) the employed capacity (which the level of capital and the fixed capital to output ratio indicate), representing a supply-side constraint.

The economy's production capacity (i.e., supply-side constraint) updates dynamically based on the level of actual investment (i.e., the level of realized investment in each time step)[7] considering both the target investment and the available savings.[8]

5.1.2 Fiscal, Foreign, and Savings Constraints

Building on the original three-gap model logic, the assumption is that an economy faces savings, foreign, and fiscal gaps (or constraints). First, we assumed that Fiji's economy confronts a savings gap—i.e., the government, private, and foreign savings determine the economy's available savings in each period. An excess (or shortfall) of private spending (i.e., private consumption and private investment) over private income (total real output plus foreign private transfer minus tax) establishes private (dis)savings.

Second, we assumed that an economy faces a foreign exchange gap—Fiji's economy may not sustain a high level of balance of payment deficit. The current account balance in each period determines foreign (dis)savings. Based on the key structural features of Fiji's economy, as the previous sections discussed, we assumed that capital imports are an important structural element of a productive economy. In normal times, for each additional unit of productive capital, a fixed share of capital imports (calibrated for the base year) is necessary. In disaster terms, a country needs additional capital imports to implement the reconstruction of built environments, such as houses, infrastructure, and production facilities. Given the constraints on foreign exchange, an economy faces a trade-off between consumption imports, which raise the effective demand, or capital imports, which raise the supply capacity.

Third, we assumed that an economy faces a fiscal gap—the Fiji government may not sustain a high level of fiscal deficit. It is possible to calculate government (dis)savings as an excess (or shortfall) of government spending (e.g., government consumption and public investment) over government revenue (including direct taxes). We assumed that public investment crowds in private investment and hence plays a significant role in enhancing the production capacity. However, given the presence of a fiscal gap, public investment also competes with government consumption, having demand-side

[6] This version of the model assumes that exports are exogenous.

[7] This version of the model simulates the economy's growth path monthly.

[8] Note that the model currently only captures human-made capital stock and respective investment. Natural capital is, however, an important source of revenue and wealth in many small island states (Lange, Wodon, and Carey 2018), which could future versions of the BinD model could include.

implications. In summary, these inter-related demand- and supply-side factors jointly determine the Fiji economy's pre- and post-disaster growth trajectories.

The model consists of two kinds of path-dependent stocks, domestically produced and imported capital stock as well as foreign debt. Further, the model introduces supply-side constraints into a demand-driven model, a methodological and conceptual avenue that has been receiving increasing attention in the structuralist literature but is still relatively unexplored. The aggregate demand drives the output. Since there is restricted access to capital markets, however, the supply side can also constrain the output due to a lack of available saving for sufficient capital formation. Thereby, we incorporate the original three-gap features of necessary capital goods and intermediate goods imports for production capacity build-up and output formation, respectively, while public infrastructure investment is a necessary condition for mobilizing private investment. As such, the model highlights the trade-offs and the underlying allocative choice problem for constrained financial means that become prevalent in the case of an extreme weather shock. The dynamic set-up with a private sector, government, and foreign account allows us to identify the interacting feedback effects of the distinct constraining factors in a post-disaster situation.

5.2 Calibration and Scenario Development

5.2.1 Calibration

We calibrated the above conceptual model to Fiji's macroeconomic data with a base year of 2017. We took the data from the Fiji Bureau of Statistics (FBS 2020), the Reserve Bank of Fiji (RBF 2017), the IMF article VI consultation reports (IMF 2020b), the World Development Indicators and other databanks available from the World Bank (World Bank 2020c), and the Penn World Table (PWT 2020).

5.2.2 Simulating Disasters and DRM Policies

Disasters may affect an economy thorough several channels, including the physical destruction of infrastructure, productive capital, and outputs, a reduction in sales revenue due to destruction, facility closure, temporary absence of labor or a decline in customer demands, and increased government spending on response, recovery, and reconstruction efforts. Those channels may also have implications for the country's trade balances and so on. For example, the post-disaster needs assessment of Cyclone Winston in 2016 revealed strong macroeconomic and fiscal impacts (Government of Fiji 2016), such as:

- A reduction in economic growth to 1.3% in 2016 compared with the projected 3.8% in the pre-cyclone time;
- The inter-industry impacts noted include lower sugar production, affecting the manufacturing subsector, and water and electricity supply disruption, affecting manufacturing and commerce activities;
- A decline of 1.2% in the total exports in 2016 compared with the pre-cyclone projection of over 17% growth (primarily a decline in commodity outputs, with minimal effects on the tourism sector.
- Higher imports (10% as opposed to the projected 7% pre-cyclone) with an inflow of capital for reconstruction (primarily in the housing, telecommunication, and transport sectors). Increased food imports to offset local production losses.

- Budget reallocation to finance disaster relief and early recovery activities, while projections indicate that value added tax (VAT) collections are likely to decline by approximately $30.3 million.

5.2.3 Policy and Shock Scenarios

To prepare for these potential shocks, the Fiji government has invested in a DRM policy, as section 3 reviewed. Fiji's current resource availability to respond to and recover from disasters includes, but is not limited to (ADB 2019b):

- A contingency budget fund;
- Line agency budgets for the Ministry of Disaster Management and Meteorology Services;
- Post-event budget reallocation;
- International external assistance, including official donor assistance and remittances.

Fiji is also a member of the Asia and Pacific Catastrophe Risk Insurance Company, and discussions are currently taking place to increase the access to financing through instruments such as the World Bank CATDDO.[9]

The BinD model could assess many of these disaster impact transmission channels and policy options, and this is the subject of ongoing research. Here, we will focus on a selected set of disaster shocks for this initial assessment and respective government disaster recovery policies.[10]

We designed three scenarios to allow us to compare the effectiveness of government response measures given different financing options with a situation of no policy response (SC1) and no shock (BAU) (Table 3). First, we simulated a strong cyclone that destroys 10% of Fiji's productive capital stock. Second, we simulated a (moderate) impact of COVID-19 with a drop in exports of 15% (Economist Intelligence Unit 2021). To stimulate the recovery, the government increases public investment by 20% in both policy scenarios (SC2 and SC3). In SC1 and SC2, we assumed fast access to international capital markets and multilateral lending to finance additional public investment expenditures. In SC3, we assumed that the government will increase income taxes by 4 percentage points to finance the additional public investment expenditures. We designed all the scenarios to be budget and debt neutral in the long run, when Fiji's economy returns to its steady state.

[9] http://documents1.worldbank.org/curated/en/913071603238067503/text/Concept-Program-Information-Document-PID-Fiji-First-Recovery-and-Resilience-Development-Policy-Operation-with-a-Cat-DDO-P173558.txt.

[10] Note that the current model version does not distinguish between different types of capital stock that could be, for instance, more or less resilient to extreme weather events. As such, we assessed post-disaster recovery policies only with respect to the overall economic and financial position recovery, leaving increasing resilience to future events as an avenue for further research and model development.

Table 3: Cyclone Shock and Response Policy Simulation Scenarios

Scenario	Cyclone Only	Cyclone Plus COVID
BAU	• No disaster shock and no policy implemented (representing the benchmark)	
SC1: shock only	• A cyclone destroys 10% of capital stock • No policy response	• A cyclone destroys 10% of capital stock • A 15% export shock (e.g., tourism) due to COVID-19 • Access to foreign capital markets but no policy response
SC2: a debt-financed increase in public investment	• A cyclone destroys 10% of capital stock • The government reacts by increasing public investment expenditures, which it finances through foreign debt	• A cyclone destroys 10% of capital stock • A 15% export shock (e.g., tourism) due to COVID-19 • The government reacts by increasing public investment expenditures, which it finances through foreign debt
SC3: a tax-financed increase in public investment	• A cyclone destroys 10% of capital stock • The government reacts by increasing public investment expenditures, which it finances through tax	• A cyclone destroys 10% of capital stock • A 15% export shock (e.g., tourism) due to COVID-19 • The government reacts by increasing public investment expenditures, which it finances through tax

6. RESULTS

Figure 4 presents the dynamics of Fiji's real GDP under alternative simulation scenarios. The same cyclone shock hits all the scenarios, with or without an additional COVID-19-related shock to exports. The destruction of capital stock leads to an initial drop in the real GDP of approximately 5.4% in the case of a cyclone shock only. The destroyed production capacity impedes firms' ability to meet the aggregate demand in the immediate aftermath, reducing the output, private consumption, and GDP. The destruction of capital stock plus an export shock due to COVID-19 reduce the real GDP by approximately 10% initially. The shock in exports dampens the aggregate demand, delaying firms' rebuilding efforts (Figure 5, right-hand side). For both scenarios, with and without an additional COVID-19 shock, the debt-financed increase in government investment reduces the immediate shocks in terms of the GDP and achieves a faster recovery. The tax-financed increase in public investment leads to an initial worsening of the GDP trajectory, followed by a lagged increase in output that is apparent 2 years after the initial shock.

A reduction in private consumption due to higher tax payments may explain part of this time lag in the GDP recovery with a tax finance increase in government investment (Figure 5). Further, decreased public spending (Figure 9) lowers the aggregate demand. While the government increases public investment by the same level as in the debt-financed scenario, it has to cut general public expenditures and reduce its budget deficit (Figure 8). The reasons are twofold. First, the government cannot access foreign borrowing, which would otherwise allow it to bridge financing gaps in the short run. Second, the negative impact on GDP further reduces the overall tax base, which a higher tax rate cannot fully compensate for in the immediate aftermath of a disaster shock. Reduced private consumption and public spending both dampen the aggregate demand and thus lead to a subsequent decline in demand-driven private capital investment (Figure 6) in SC3. The debt-financed increase in government investment, on the other hand, requires a temporary increase in foreign lending (Figure 7), and the government needs to run a higher government budget deficit (Figure 8) but achieves a faster recovery of capital stock without dampening private consumption (Figure 6).

Figure 4: Real GDP Recovery Trends
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)

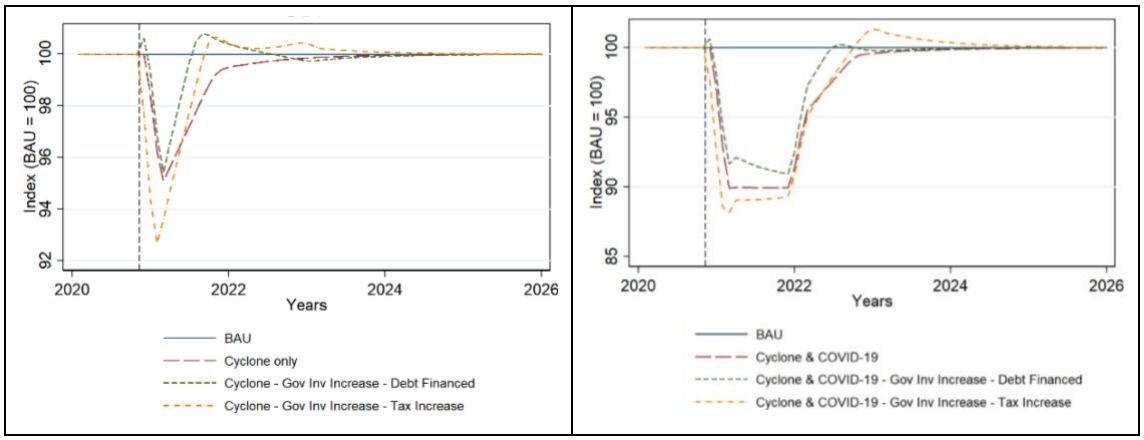


Figure 5: Private Consumption Recovery Trend
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)

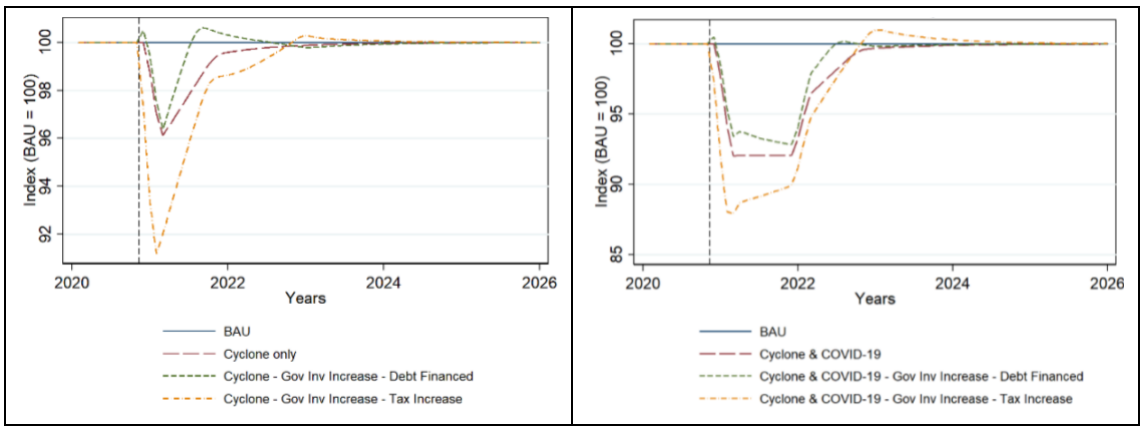
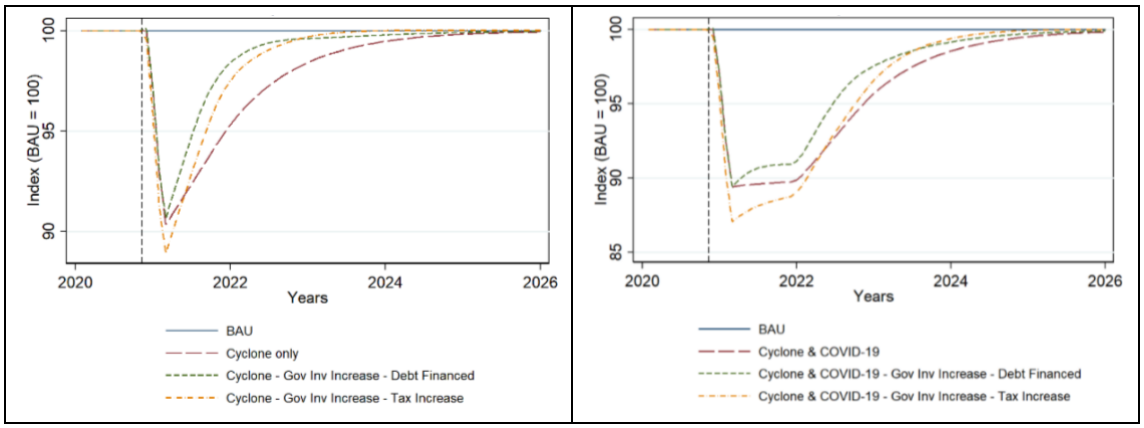


Figure 6: Capital Stock Recovery Trend
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)



As we outlined above, Fiji is a small island economy that shows a high propensity to import goods. To rebuild its infrastructure and production capacity, Fiji must import large amounts of machinery and similar capital goods, which increase the current account deficit. The current account deficit as well as the emerging gap between domestic savings and investment needs lead to a large increase in foreign debt in the no-policy scenario (Figure 7). The additional public investment in the debt-financed scenario (SC1 and SC2) further drives up the foreign debt levels before returning to the same steady-state levels for all the scenarios in the long run. In contrast, increasing tax-financed investment (SC3) and reducing the budget deficit (Figure 9) only result in a marginal increase in foreign debt. When COVID-19 additionally hits Fiji's economy, the foreign debt to GDP ratio initially increases due to the denominator effect, producing a lower GDP. When the exports and aggregate demand recover, rebuilding efforts start, driving up foreign debt, as we explained above, except in the tax-financed policy scenario (Figure 7, right-hand side). The government's additional public investment expenditures (SC2) promote faster private capacity employment (Figure 6, right-hand side), thereby stimulating the GDP and lowering the foreign debt requirements.

Figure 7: Foreign Debt Trajectory
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)

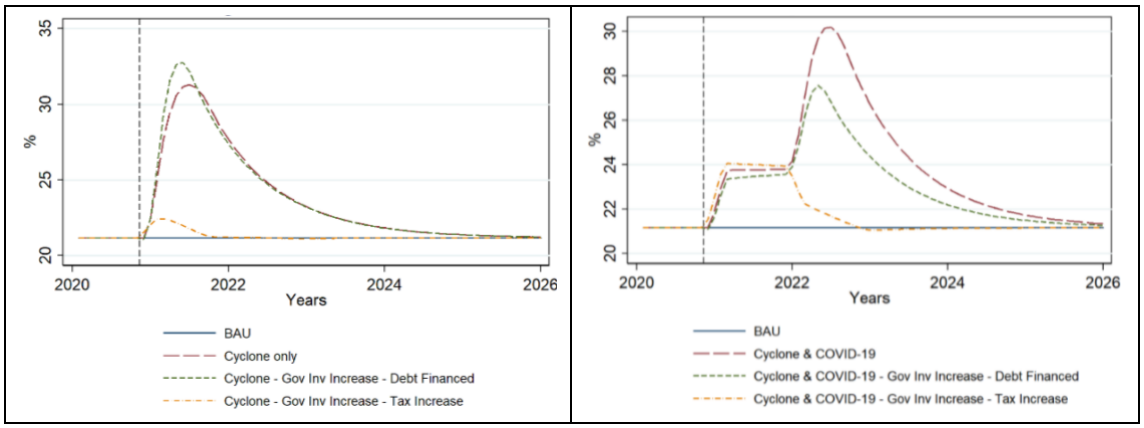


Figure 8: Budget Deficit to GDP Trend
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)

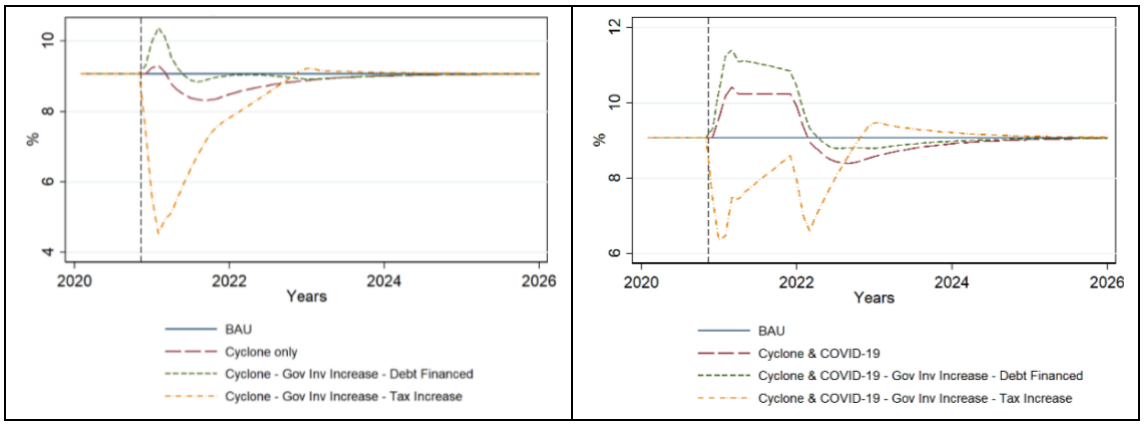
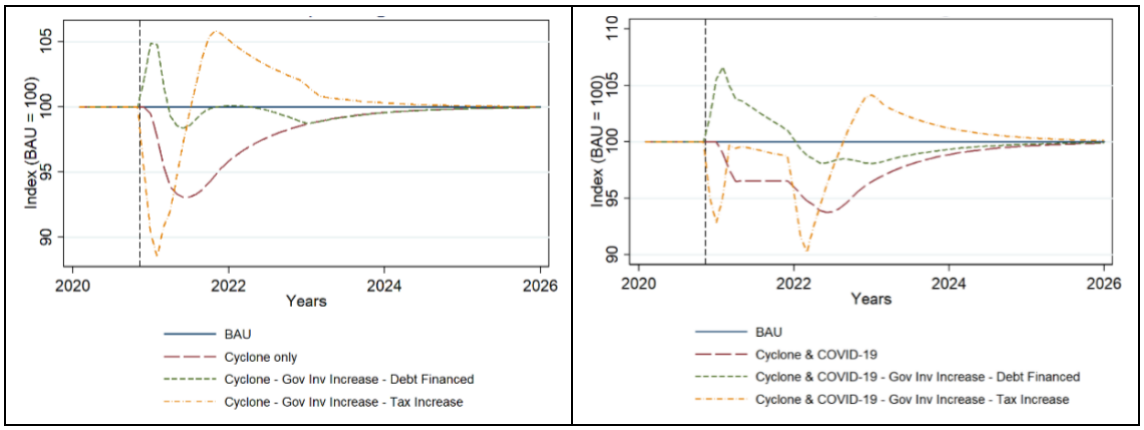


Figure 9: Public Spending Trajectory
(Left: Cyclone Shock Only; Right: Cyclone and COVID-19)



The public spending trajectory (Figure 9) provides an explanation for the long-run adjustment path back to the steady state for all the scenarios. In the case of no policy measures (SC1), the reduced tax base from the lower GDP as well as interest payments for the additional foreign debt necessary to close the saving and investment gap reduce public spending until the government has repaid all the foreign debt. When debt finances additional public investment, the government spending increase outweighs the tax base effect, stimulating the recovery (Figures 4 and 6). Over time, the government phases out the public investment stimulus and the interest payments for the additional foreign debt lower public spending for a while. The recovery allows the country to spread the financial burden of the disaster over a longer time span, then returning to the steady-state foreign debt and GDP levels. The tax-financed public investment stimulus (SC3) shows a diverging trajectory. Initially, the lower tax base and accompanying lower government spending outweigh the investment stimulus, leading to the most detrimental GDP and capacity impacts. In the medium run after the disaster, when the economy begins to recover, the higher tax rate and the missing interest payments for foreign debt generate larger fiscal space, driving up public spending. This explains the catching-up effect in the medium run for the GDP and capital stock recovery. Since higher GDP and income also drive consumption, intermediate and capital imports and the counterbalancing GDP increase, and all the scenarios return to their long-run steady-state values.

Our results indicate that a targeted increase of government spending in times of crisis could be beneficial for the economic recovery of Fiji, especially when foreign debt finances it instead of tax increases. This solution, however, involves important trade-offs. Fiji is a small island economy that must import 70% of investment goods, such as machines, from abroad. Efforts to speed up the reconstruction of the destroyed capital stock would therefore require large capital goods imports, leading to an increased current account deficit. This needs financing either via foreign borrowing or via domestic tax increases in our model simulations. Debt-financed recovery with targeted public investment allows faster and less painful recovery but requires quick and preferential access to foreign borrowing. Tax-financed recovery can satisfy short-term foreign borrowing needs but comes at the cost of more detrimental impacts on the GDP and private sector consumption in the direct aftermath of a disaster.

7. CONCLUSION

To build economic resilience against disasters, one must address appropriately the trade-offs associated with alternative recovery policy options for a small island economy such as Fiji. Reviewing the hazard profile, climate, and DRM policy frameworks and the structural vulnerabilities associated with Fiji's economy, such as trade dependency and access to foreign borrowing, this article has developed and calibrated a demand-driven binary constrained disaster (BinD) model, incorporating the three gaps of fiscal, foreign, and savings constraints. The BinD model assessed post-disaster response and recovery options against cyclone and COVID-19 impacts under alternative financing options of debt- and tax-financed increases in government investment.

As our analysis has demonstrated, efforts to restore disaster-affected infrastructure, buildings, and livelihoods as swiftly as possible may in fact compete with other development objectives, such as quickly restoring an adequate level of consumption, especially for the most vulnerable population. The simulation results indicated that a cyclone-only shock (resulting in 10% destruction of capital stock) leads to an initial drop in the real GDP of approximately 5.4%, while the same magnitude of destruction of capital stock under an additional export shock of COVID-19 reduces the real GDP by approximately 10%. A debt-financed increase in government investment requires a temporary higher foreign lending and government budget deficit while achieving a faster recovery of capital stock without dampening private consumption. A tax-financed increase in government investment, on the other hand, will hamper the aggregate demand; thus, capital investment and the overall macroeconomic recovery, as the GDP trajectory indicated, will perform poorly compared with the no-policy and debt-financed scenarios. This highlights the crucial role that the domestic demand plays in facilitating a swift economic recovery, especially with significant curtailment of the foreign demand, such as in the case of COVID-19.

Our initial assessment indicated the importance of quick and preferential access to foreign borrowing in line with the Fijian Government's current engagement to access donor financing, for instance through a contingent credit arrangement. At the same time, the government must design credible recovery and debt repayment plans to allow for long-run sustainability of debt in the country. While our analysis provided initial insights into the potential trade-offs associated with post-disaster recovery policies under demand-side constraints, additional knowledge gaps remain. They include, but are not limited to, the impact of alternative recovery-financing options and their distributional implications and the performance of debt- and tax-financed recovery options in comparison with other financing options, such as sovereign insurance and reserve funds. Further, it is necessary to explore an evaluation of ex post versus ex ante policy options, including adaptation policy. Finally, the analysis of long-run impacts of disasters, that is, how persistent changes in economic and financing conditions may drive long-run growth trajectories, is highly relevant, especially with the increased frequency and intensity of disaster occurrence due to climate change.

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