TASK FORCE ON CLIMATE, DEVELOPMENT AND THE INTERNATIONAL MONETARY FUND

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Economic and Fiscal Implications of Climate Change for Vulnerable Countries in Central America and the Caribbean

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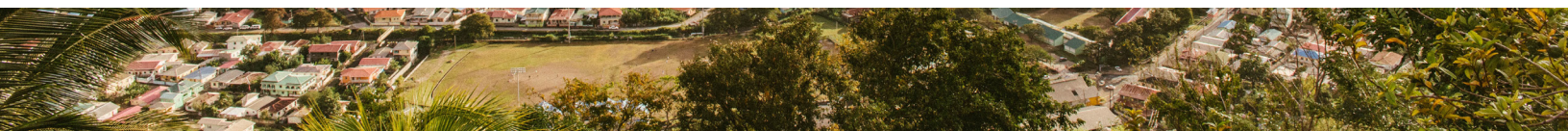

ABSTRACT

Latin America and the Caribbean is highly vulnerable to climate change. To assess the potential impact of climate change on economic growth and fiscal accounts, this paper analyzes six Central American and Caribbean countries: Barbados, Dominican Republic, El Salvador, Guatemala, Honduras and Saint Lucia (CAC6). Members of the group are uniquely vulnerable to changes in climatic conditions due to their geography, high dependence on economic activities that will be heavily impacted by climate change—such as agriculture and tourism—and differing levels of poverty and inequality. Results from macroeconomic modeling suggests that by 2050, the gross domestic product (GDP) of CAC6 countries could be between 9 percent and 12 percent smaller due to climate change and more intense severe weather events, compared to a trend growth counterfactual. Investment needs to compensate for climate change's impact on economic growth are exceptionally large. Annual investment outlays could range from an estimated 5.3 percent of GDP to 10.9 percent of GDP. An investment push in line with submitted Nationally Determined Contributions (NDCs), estimated at 1.8 percent of GDP per year, would limit economic losses but would cause debt dynamics to deteriorate. International financial institutions (IFIs), including the International Monetary Fund (IMF), should play a catalytic role in promoting climate change investment in emerging markets and developing economies. Efforts are needed at the international level to improve access to concessional long-term financing for climate change investment, including for middle income countries, and to establish climate debt relief and restructuring mechanisms. At the same time, it is crucial to provide technical assistance to national governments to improve the management of an ambitious climate change investment push, ensuring coherence between public and private efforts and maximizing synergies with other public sector interventions.

TCD IMF

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Panajachel, Guatemala. Photo by Mathijs Beks via Unsplash

INTRODUCTION

Latin America and the Caribbean is vulnerable to climate change. Rising temperatures and changes in hydrometeorological conditions—with a higher incidence of droughts and heatwaves, greater variability in precipitation levels and patterns—threatens to undercut the underlying determinants of economic growth: reducing labor productivity, agricultural production and contributing to a rapid depreciation of the capital stock. The increasing frequency and severity of extreme climatic events—hurricanes and floods, among others—is exacting a growing toll on the region. The economic structure is also vulnerable, with a high dependence on industries that will be strongly impacted by climate change.

Countries in the region have a reduced fiscal capacity to respond to climate shocks to the economy. Fiscal space is limited after a significant increase in public debt levels in 2020 as countries took unprecedented steps to offset the impact of the COVID-19 pandemic. Countries are pursuing fiscal consolidation measures to put their debt on a sustainable trajectory. In many cases this has resulted in reductions in public investment to cut primary deficits, exacerbating already weak levels of investment in the region.

To assess the potential impact of climate change on economic growth and fiscal accounts, this paper analyzes six Central American and Caribbean countries: Barbados, Dominican Republic, El Salvador, Guatemala, Honduras and Saint Lucia (CAC6). Members of the group are uniquely vulnerable to changes in climatic conditions due to their geography, elevated dependence on economic activities that will be heavily impacted by climate change—such as agriculture and tourism—and differing levels of poverty and inequality.

Climate change will negatively impact medium-term growth in CAC6 countries. Results from macroeconomic modelling suggests that by 2050, the gross domestic product (GDP) of CAC6 countries could be between 9 percent and 12 percent smaller due to climate change and more intense severe weather events, compared to a trend growth counterfactual. Per capita GDP would follow a similar trajectory, reinforcing the low levels seen in some CAC6 countries.

The amount of investment needed to compensate for climate change's impact on economic growth are exceptionally large. Annual investment outlays could range from an estimated 5.3 percent of GDP to 10.9 percent of GDP per year, to compensate for the negative effects of climate shocks on GDP growth. This would represent a significant increase in overall investment, which in 2022 averaged 22.1 percent of GDP for the six countries of the group.

An investment push in line with submitted Nationally Determined Contributions (NDCs) would limit economic losses but would cause debt dynamics to deteriorate. For CAC6 countries, investment needs outlined in NDC submissions by the Dominican Republic and Saint Lucia suggest that the investment gaps for meeting mitigation and adaptation goals are lower, although still considerable (between 1.8 percent of GDP and 2.2 percent of GDP per year, respectively). Front-loaded adaptation investments, coupled with mitigation investments, would limit in part the impact of climate change on economic growth. Nevertheless, undertaking these investments could lead to public debt levels of 100 percent of GDP or more by 2050 in Barbados, El Salvador and Saint Lucia, and exceeding 70 percent of GDP in

Honduras. CAC6 countries already face significant debt-related development distress, with interest payments in 2022 equivalent to central government capital expenditure in several members of the group (ECLAC 2023b).

Given the imperative to undertake climate investments, whose magnitude is likely underestimated, it is crucial to reduce financing costs to improve the fiscal viability of these investments. Climate vulnerable countries, such as those of the CAC6, often face higher borrowing costs, particularly if their level of resilience to climate shocks is low (Cevik and Tovar Jalles 2020; Beirne et al. 2020). Front-loaded investments to build resilience would not only support economic growth and development, but also break possible negative feedback loops between climate shocks and higher sovereign borrowing costs. If investments as outlined in the NDCs were financed at concessional terms, defined as one-half of the effective interest rate of public debt for each CAC6 country, debt dynamics would be significantly more favorable. In most cases, public debt levels would stabilize or increase at a much lower rate. As a result, public debt levels in 2050 would be between 9.8 percentage points of GDP and 17.6 percentage points of GDP lower than if NDC investments were financed at current effective interest rates.

International financial institutions (IFIs), including the International Monetary Fund (IMF), should play a catalytic role in promoting climate change investment in emerging markets and developing economies. Efforts are needed at the international level to improve access to concessional long-term financing for climate change investment, including for middle income countries, and to establish climate debt relief and restructuring mechanisms. At the same time, it is crucial to provide technical assistance to national governments to improve the management of an ambitious climate change investment push, ensuring coherence between public and private efforts and maximizing synergies with other public sector interventions.

CLIMATE CONDITIONS ARE DETERIORATING AND COUNTRIES IN THE REGION ARE HIGHLY EXPOSED

CAC6 countries are structurally vulnerable to the impacts of climate change. Geographically, the countries of the group are located in areas that are particularly susceptible to changes in climatic conditions. The location of the Central American isthmus is exceptionally conducive to droughts, floods, heavy rain and landslides (Lazo Vega 2020). Small island developing States (SIDS) in the Caribbean and countries in Central America are in a geographical zone that is frequently impacted by Atlantic hurricane activity. Vastly unequal socio-economic conditions leave a large share of the population vulnerable to climate change. Women, especially those living in poverty, are more vulnerable to the impacts of climate change and experience more significant risks and challenges. As the majority of the world's poor are women, this exacerbates the inequalities they face. Additionally, women's unequal participation in decision-making processes and labor markets further limits their ability to contribute to climate-related planning, policymaking, and implementation (UNFCCC 2022).

The impact of rising temperatures on climatic conditions in CAC6 countries is already apparent. Since the 1980s there has been an increase in extreme high temperature events

and a reduction in extreme low temperatures (Castellanos and others 2022). Precipitation patterns are exhibiting higher variability, with a higher number of dry days and extreme rainfall in some areas. Drought conditions have become more widespread. In Central America, 38.8 percent more land area was affected by an extreme drought of at least 1 month—or 6.1 percent for droughts of at least 6 months—in 2010-2019 compared to 1950-1959 (Romanello et al. 2021). Sea levels in the Caribbean have risen at a rate of 3.6mm/year between 1993-2020, which is slightly higher than the global average of 3.3mm/year and the surface temperature of the Caribbean Sea reached a record high in 2020, exceeding the previous highest anomaly value of +0.78°C recorded in 2010 and registering at +0.87°C above the 1981-2010 average (WMO 2022).

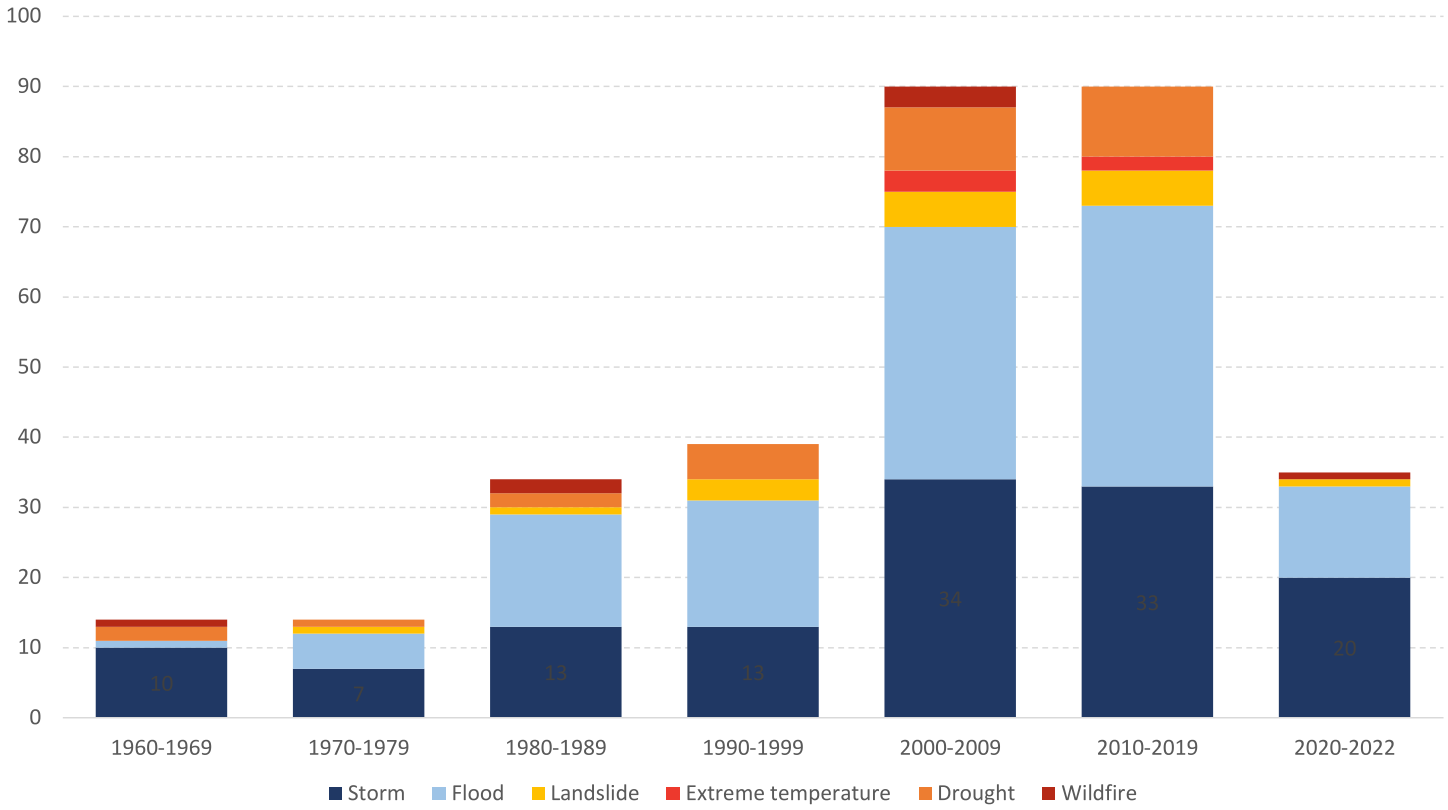
Models suggest that the effects of climate change will intensify in CAC6 by the end of the century. Temperatures are projected to continue to rise throughout Central America, with a significant increase in extreme heat stress and longer periods of dangerous heat under some warming scenarios (Ranasinghe and others 2021). As a corollary, periods of extreme low temperatures are likely to progressively decline. Current models point to higher aridity, and the potential for an increase in agricultural and ecological drought conditions. Fluctuations in precipitation levels caused by the El Niño–Southern Oscillation (ENSO) and climate change are likely to aggravate already high levels of vulnerability to landslides. While tropical cyclones are projected to decrease in number, they are expected to become intense, with an acceleration in the intensification rate already apparent for the period 1982-2017 (Bloemendaal et al. 2022; Bhatia et al. 2020). Sea levels in Central America and the Caribbean will continue to trend higher, with an increase in coastal flooding and erosion. However, these climate forecasts are likely understating the potential changes that will occur in CAC6 countries, reflecting the existence of potential tipping points and cascading effects that are difficult or even impossible to model (Kemp et al. 2022).

Severe weather events, with large humanitarian and economic costs, have become more common. A changing climate has been accompanied by a rise in the disasters caused by severe weather events in CAC6 countries (Figure 1). The number of disasters per decade more than doubled from the 2000s onward, compared to the period between the 1960s and the 1980s. More recently, there were 35 disasters between 2020 and 2022, equivalent to the total number of events for each decade prior to the 2000s. Extreme flooding episodes caused by heavy rains were common in CAC6 countries over the period, with particularly large-scale events occurring in 2016 in the Dominican Republic—impacting 2.8 million people—and in Guatemala during 2022, which affected 2.9 million people.[1] Countries of the group also were impacted by a series of major storms that caused catastrophic damage, including Hurricane Eta in 2020, whose affects were borne by millions of people in Honduras—45 percent of the population, or 4.6 million people—and Guatemala—14 percent of the population, or 2.4 million people.[2] The economic costs of these events, and their potential to disrupt economic development, can be very significant. The estimated cost of lost output from the 30 most lethal storms in the region is about 2 percent of GDP, with no evidence of

[1] Centre for Research on the Epidemiology of Disasters (CRED), EM-DAT International Disaster Database [online] http://www.emdat.be.

[2] Ibid.

FIGURE 1 CAC6: Meteorological, Hydrological and Climatological Disasters, by Decade, 1960-2022 (Count)



Source: Authors' elaboration on figures from EM-DAT, CRED / UCLouvain, Brussels, Belgium, available online at: http://www.emdat.be.

the losses ever being recovered (Cavallo and Hoffmann 2020). In Honduras, Hurricanes Eta and Iota were estimated to have caused damages equivalent to 8.9 percent of GDP in 2020 (BID-CEPAL 2021).

ECONOMIC STRUCTURES ARE VULNERABLE TO CLIMATE SHOCKS AND THERE IS LITTLE FISCAL POLICY SPACE TO RESPOND

Vulnerable Economic Structures

Climate change represents a permanent shock to the productive structure of CAC6 countries. The emerging and future impacts of a changing climate will cause significant dislocations in many economic sectors with potentially negative implications for economic development. For the countries of the CAC6, these disruptions will be particularly intense, as the members of the group are highly dependent on economic activities that are projected to be among the most impacted by climate change. The impact on the productive structure will be both immediate and progressive. More frequent severe weather events will cause large one-off economic losses, including severe damage or destruction of the capital stock. The progressive impact of climate change—rising temperatures, changes in precipitation

patterns, among others—could undercut the underlying fundamentals of potential economic growth and economic competitiveness. Against this backdrop, the productive capital stock may undergo rapid depreciation—irrespective of losses caused by severe weather events—without proactive public policies and private investment aimed at measures to create greater resilience in affected sectors and that promote economic diversification.

Agricultural production in CAC6 countries is already under significant climate-induced stress. Falling precipitation levels, coupled with greater volatility in the timing of the rainy season and the mid-summer drought, have led to a 5 percent decline in crop duration in Central America for maize between 1981-2010 and 2015-2019, with a concomitant negative impact on agricultural yields (Romanello et al. 2021). If left unchecked, rising temperatures are projected—based on the UN Intergovernmental Panel on Climate Change (IPCC)'s A2 scenario—to result in a dramatic decline in agricultural yields by 2050 for beans (19 percent), maize (4-21 percent), and rice (23 percent) (Castellanos et al. 2022). Countries along the Dry Corridor in Central America, including El Salvador, Guatemala and Honduras—are particularly vulnerable to these shocks to agriculture, with large—predominantly poor—rural populations and an elevated dependence on subsistence farming. Lower agricultural output will intensify food insecurity and create greater pressure for internal and international migration.

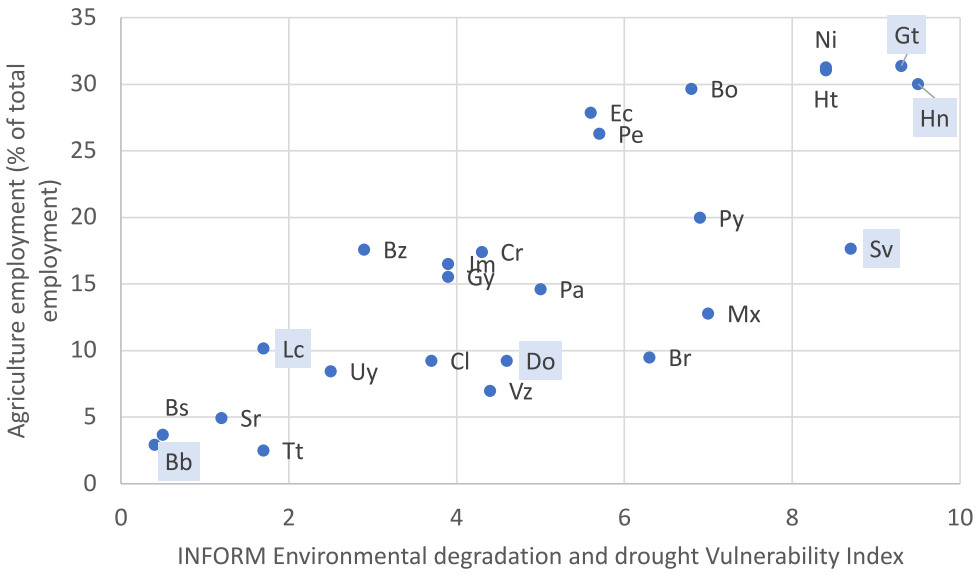
Agriculture constitutes one of the principal economic sectors in Central America. It is a major source of jobs, accounting for 30 percent of more of total employment in Guatemala and Honduras as well as greater than 15 percent in El Salvador—countries which are also among the most vulnerable to environmental degradation and drought in the region (Figure 2).[3] In the Dominican Republic and Saint Lucia, agriculture accounts for around 10 percent employment, and while these countries are potentially less impacted by drought, they are highly vulnerable to crop losses from severe storms. The sector is also a large contributor to overall economic output, exceeding 10 percent of GDP in Honduras. Agriculture is also an important generator of foreign currency, with foods and beverages exports equivalent to more than 25 percent of total exports in Honduras and exceeding 35 percent in Guatemala.

Rising severe weather events are projected to disrupt tourism. Severe weather events have a direct impact on tourism, as shown by Granvorka and Strobl (2013), who analyzed the effect of hurricanes on tourist arrivals and found a statistically significant reduction of 2 percent in monthly tourist arrivals and up to 20 percent for the largest event between 2003 and 2008. Pathak et al. (2021) estimated that a 1m rise in sea level in combination with weak, moderate and strong storms could result in coastal flooding affecting 34 percent, 69 percent and 83 percent of the tourism infrastructure in the Bahamas. Cevik and Ghazanchyan (2020) found that there is a statistically and economically significant negative effect on international tourism revenues in the Caribbean. Using a sample of 15 Caribbean countries between 1995 and 2017, the authors found that a 10 percentage-point rise in vulnerability to climate change corresponds to a 9 percentage-point drop in tourism earnings per visitor (or a 10 percentage-point decrease in tourism revenues as a percentage of GDP) on average.

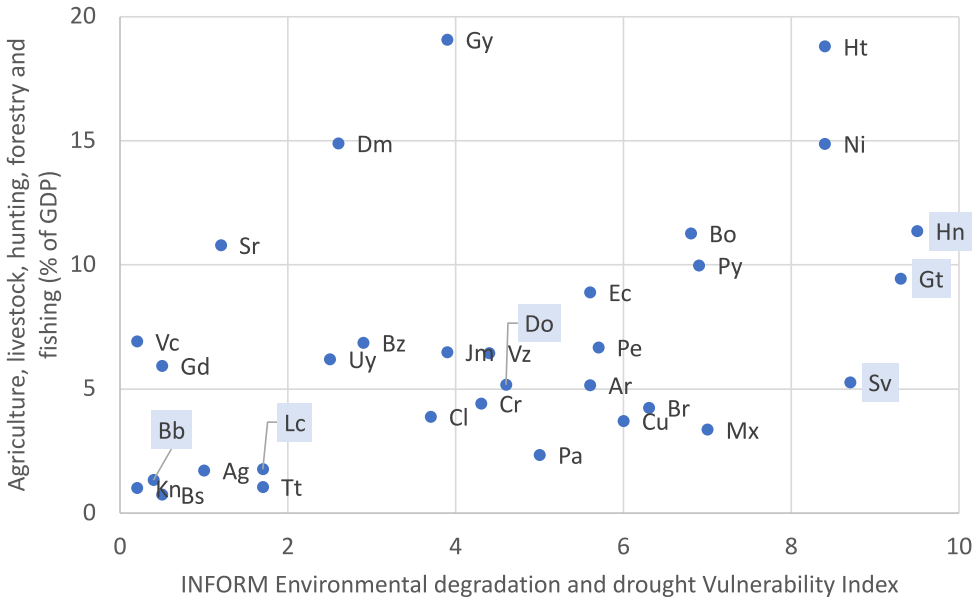
[3] Agricultural employment is highly gendered, with men making up more than 80 percent of the total in Barbados, Guatemala, Honduras, and Saint Lucia, and greater than 90 percent in the Dominican Republic and El Salvador.

FIGURE 2 Latin America and the Caribbean: Exposure of Agriculture-related Employment, Economic Activity and Exports to Environmental Degradation and Drought, 2015-2019 Average
(Percentages of total and index)

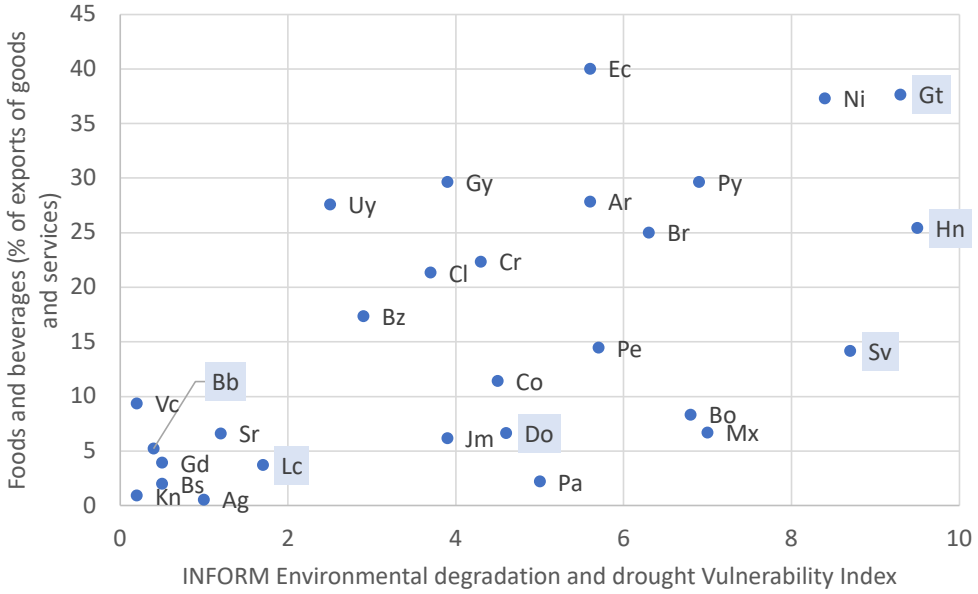
A. Employment



B. GDP



C. Exports

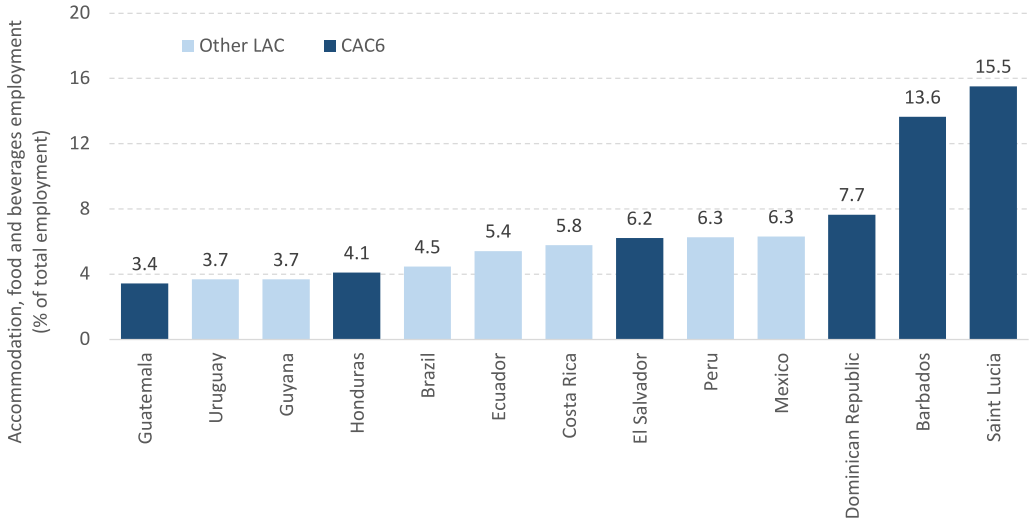


Source: Authors' elaboration, based on data from ILOstat, CEPALstat, UNCTADstat and INFORM.
Note: Antigua and Barbuda = Ag, Argentina = Ar, Bahamas = Bs, Barbados = Bb, Belize = Bz, Bolivia = Bo, Brazil = Br, Chile = Cl, Costa Rica = Cr, Cuba = Cr, Dominica = Dm, Ecuador = Ec, El Salvador = Sv, Grenada = Gd, Guatemala = Gt, Guyana = Gy, Haiti = Ht, Honduras = Hn, Jamaica = Jm, Mexico = Mx, Nicaragua = Ni, Panama = Pa, Paraguay = Py, Peru = Pe, Dominican Republic = Do, Saint Kitts and Nevis = Kn, Saint Vincent and the Grenadines = Vc, Saint Lucia = Lc, Suriname = Sr, Trinidad and Tobago = Tt, Uruguay = Uy, Venezuela = Vz

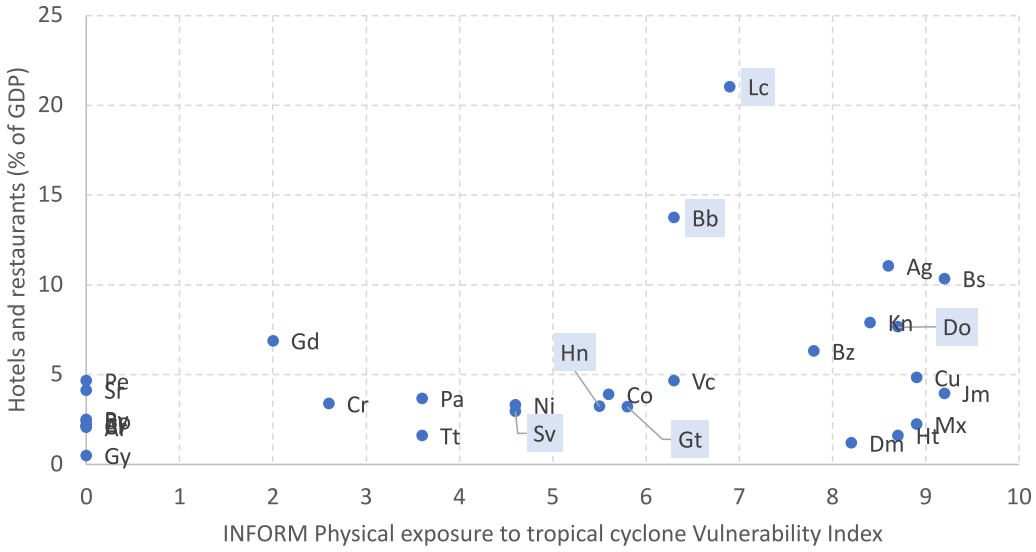
Tourism plays a central role in Caribbean countries, including those of the CAC6. Economic statistics do not adequately capture tourism as an industry, as it refers to a wide range of activities that are covered in other sectors. However, available data are indicative of the importance of tourism in CAC6 countries, particularly those in the Caribbean. Employment in accommodations and food services in Central American countries in the CAC6 group is largely in line with their regional peers (Figure 3). However, the share in total employment rises in Barbados (13.6 percent), the Dominican Republic (7.7 percent) and Saint Lucia (15.5 percent). In terms of economic output, hotels and restaurants account for more than 10 percent of GDP in Barbados and exceeds 20 percent in Saint Lucia—countries that are also at high risk for severe weather events. Perhaps the most striking contribution of the sector is the elevated share of travel services in overall exports of goods and services in some countries in the region. For example, the travel to total exports of goods and services ratio exceeds 80 percent in Saint Lucia and 50 percent in Barbados.

FIGURE 3 Latin America and the Caribbean: Exposure of Tourism-related Employment, Economic Activity and Exports to Tropical Cyclones, 2015-2019 Average
(Percentages of total and index)

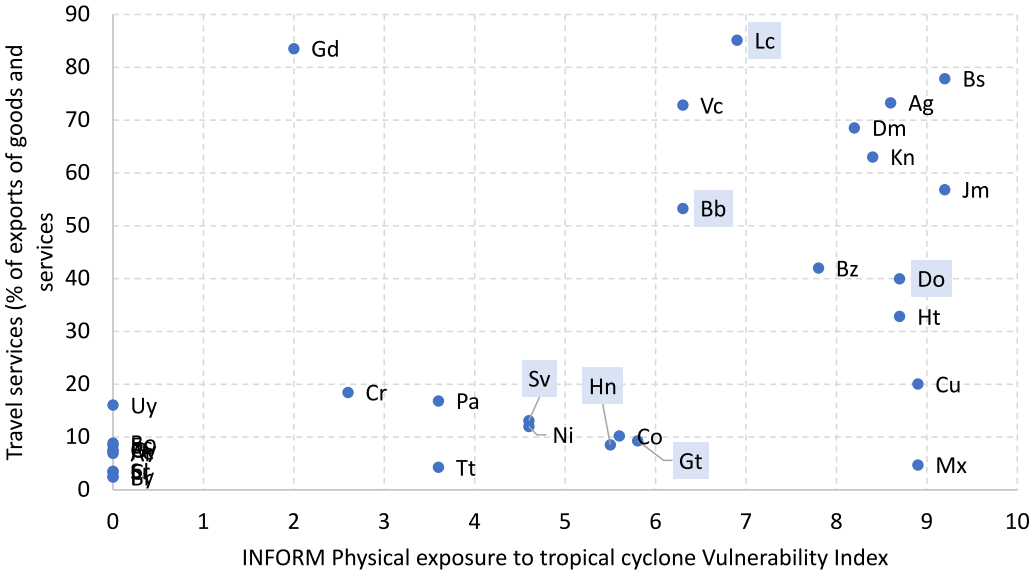
A. Employment



B. GDP



C. Exports



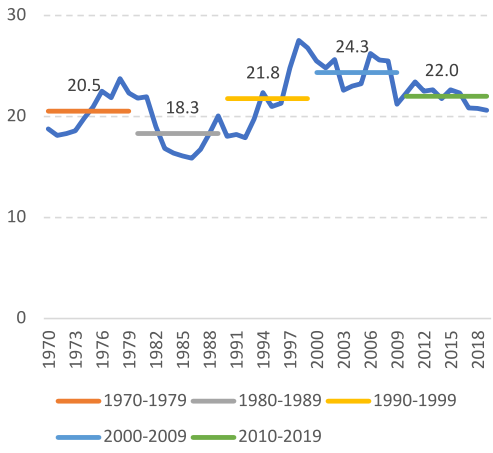
Source: Authors' elaboration, based on data from ILOstat, Central Statistical Office of Saint Lucia, CEPALstat, UNCTADstat, and INFORM.

Limited Levels of Investment

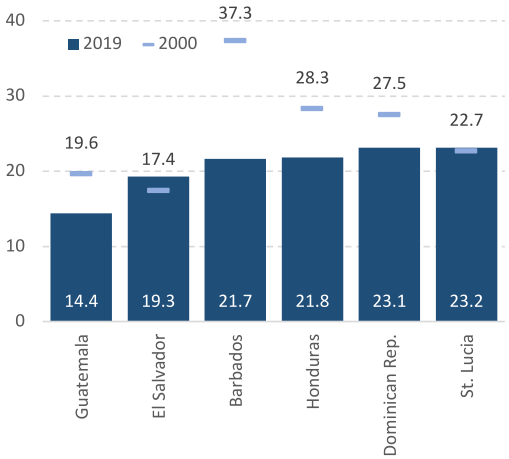
Investment fell in the period prior to the COVID-19 pandemic. Total gross fixed capital formation during the decade from 2010-2019 registered a significant reduction, falling to a period average of 22 percent of GDP, compared to 24.3 percent of GDP for the previous decade (Figure 4). However, the current level of investment is still higher than the levels seen between the 1970s and the 1990s. The contraction in total investment in 2010-2019 was

FIGURE 4 CAC6: Total Investment, 1970-2019 and Period Averages [a]
(Percentages of GDP)

A. Total investment, 1970-2019 [b]



B. Total investment, by country, 2000 and 2019



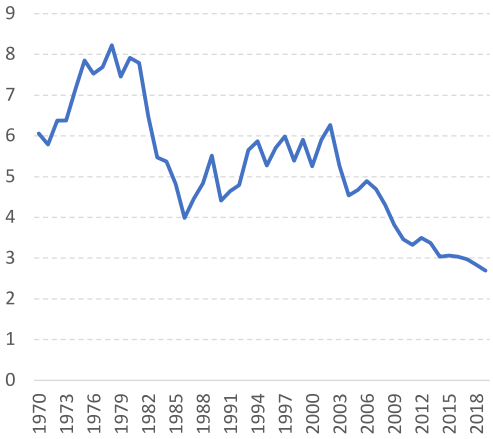
Source: Authors' elaboration, on the basis of IMF Investment and Capital Stock Dataset, 2021.
[a] Gross fixed capital formation. Ratios calculated on the basis of constant prices. [b] Simple averages.

not shared equally across CAC6 countries. Significant declines were registered in Barbados (-15.6 percentages points of GDP), Honduras (-6.5 percentage points of GDP), Guatemala (-5.2 percentage points of GDP), and the Dominican Republic (-4.4 percentage points of GDP). In contrast, investment levels rose moderately in El Salvador and Saint Lucia. The turn in total investment trends coincided with a cyclical slowdown in economic growth in the region and fiscal consolidation measures that limited public investment in some countries.

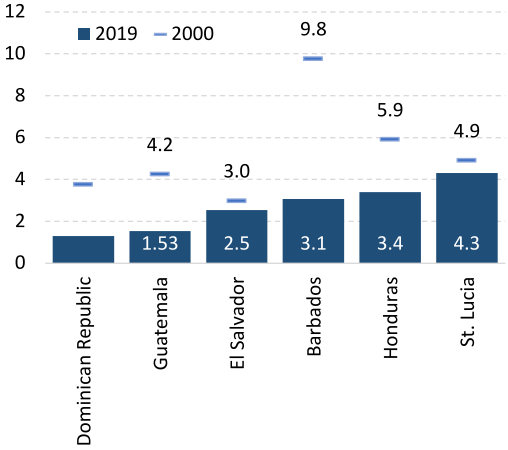
Falling public investment was the principal driver of the reduction in total investment. As Figure 5 shows, public investment fell precipitously on average in CAC6 countries beginning at the turn of the century. Public investment for the group averaged 2.7 percent of GDP in 2019, compared with 5.3 percent of GDP in 2000, a reduction equivalent to 2.6 percentage points of GDP. Unlike the tendencies observed for total investment, current public investment levels are substantially lower than during any other period since the 1970s. All

FIGURE 5 CAC6: Public and Public-Private Partnership (PPP) Investment, 1970-2019[a]
(Percentages of GDP)

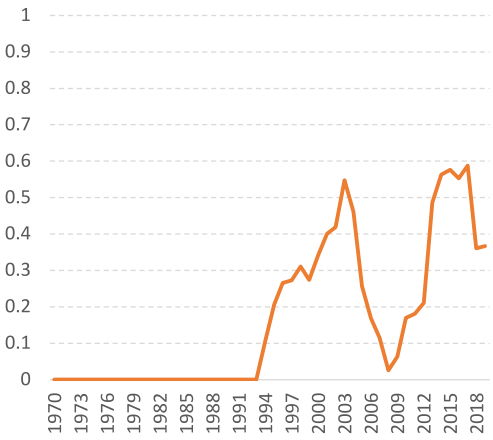
A. Public investment, 1970-2019 [b]



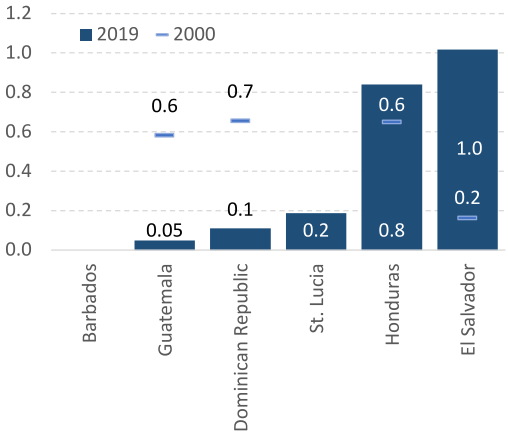
B. Public investment, by country, 2000 and 2019



C. Public-private partnership investment, 1970-2019 [b]



D. Public-private partnership investment, by country, 2000 and 2019



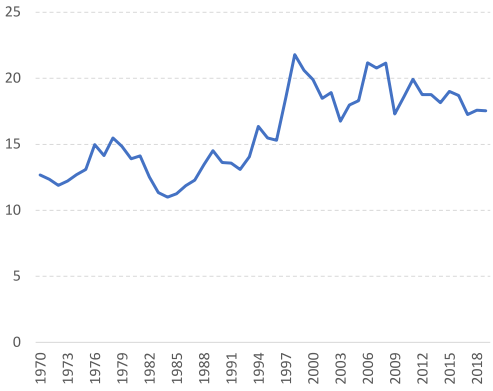
Source: Authors' elaboration, on the basis of IMF Investment and Capital Stock Dataset, 2021.
[a] Gross fixed capital formation. Ratios calculated on the basis of constant prices. [b] Simple averages.

CAC6 countries registered a decline in public investment in 2010-2019, with a reduction of more than 2 percentage points of GDP or greater in the Dominican Republic, Guatemala and Honduras, rising to a 6.7 percentage point of GDP reduction in Barbados. For the group, the fall in public investment between 1970 and 2019 was not offset by investment carried out through public-private partnership (PPP) modalities. However, in some cases PPPs have become increasingly relevant, such as in El Salvador and Honduras.

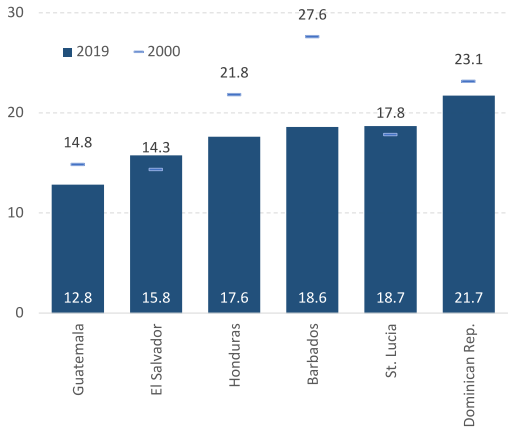
Private investment has not compensated for the decline in public investment in CAC6 countries. Private investment peaked at the end of the 1990s, before giving ground after a series of financial and economic crises swept the developing world (Figure 6). Since the early 2000s, private investment has exhibited a downward trend, although exhibiting pronounced volatility across time and countries. Between 2000 and 2019, private sector capital expenditure slipped significantly in Barbados and Honduras, with less pronounced declines in Guatemala and the Dominican Republic.

FIGURE 6 CAC6: Private Investment, 1970-2019[a]
(Percentages of GDP)

A. Private investment, 1970-2019 [b]



B. Private investment, by country, 2019



Source: Authors' elaboration, on the basis of IMF Investment and Capital Stock Dataset, 2021.
[a] Gross fixed capital formation. Ratios calculated on the basis of constant prices. [b] Simple averages.

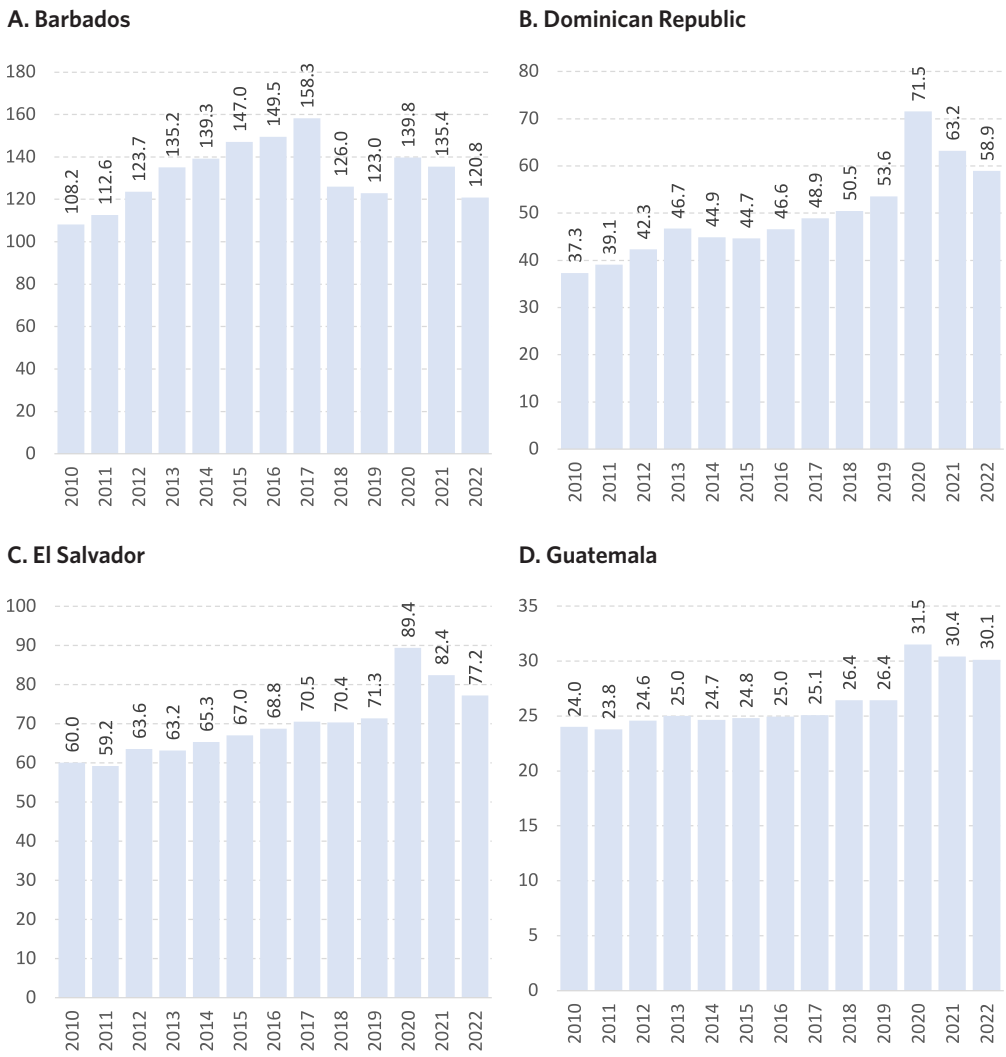
Reduced Fiscal Space for Active Investment Policies

Fiscal space to undertake climate change investment is limited. In the decade between 2010-2019, general government gross public debt rose sharply in most countries of the group: Barbados (14.8 percentage points of GDP), Dominican Republic (16.3 percentage points of GDP), El Salvador (11.3 percentage points of GDP), Honduras (21.2 percentage points of GDP), and Saint Lucia (9.9 percentage points of GDP) (Figure 7). In the case of Barbados, this variation hides significant volatility in the level of public debt, which rose to 158.3 percent of GDP in 2017, before a comprehensive restructuring in 2018-2019 resulted in a substantial reduction in the debt burden. Guatemala was the only country where debt levels remained relatively stable over the period, reflective of a tight fiscal stance. The COVID-19

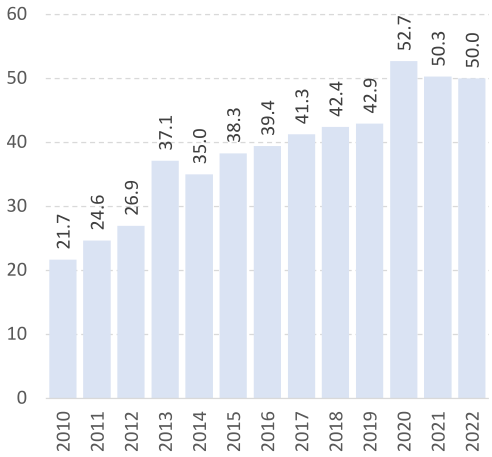
crisis, however, created a generalized and significant increase in public debt levels, which in many cases exceeded the growth observed during the decade prior. The most prominent increases between 2019 and 2020 were registered in Barbados (16.8 percentage points of GDP), Dominican Republic (17.9 percentage points of GDP), El Salvador (18.1 percentage points of GDP) and Saint Lucia (34.8 percentage points of GDP).

Debt levels began to descend in 2021, but further declines have been affected by new climate-related public spending pressures. Debt-to-GDP ratios fell in 2021, with further declines in 2022, principally due to the rebound in nominal GDP and the gradual withdrawal of COVID-19 support programs. However, efforts to reduce debt levels were at odds with new demands for public spending, which tended to remain above pre-pandemic levels. This reflected the continuing impact of the pandemic, new spending measures to offset the rapid rise in prices—especially for foods and fuels—and outlays to respond to severe weather events. In November 2021, Central America was impacted by two major hurricanes, Eta and

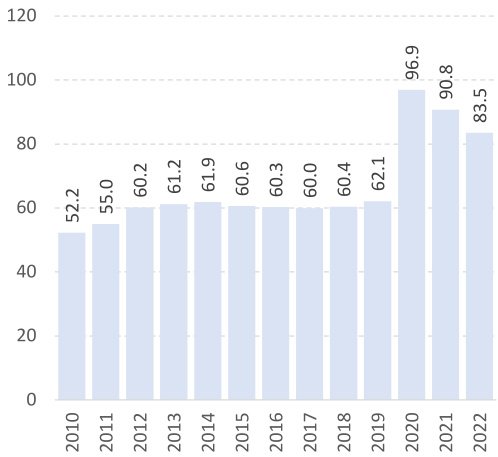
FIGURE 7 CAC6: General Government Gross Public Debt, 2010-2022
(Percentages of GDP)



E. Honduras



F. Saint Lucia



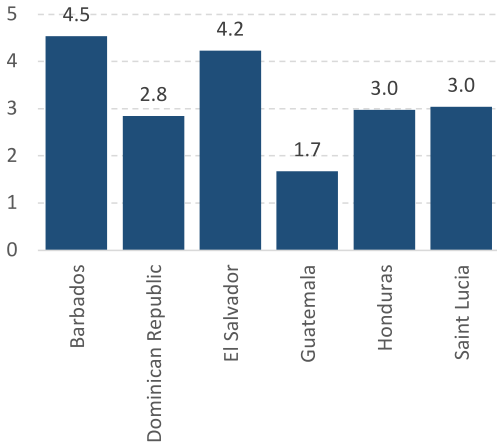
Source: Author's elaboration based on IMF (2023).

Iota, that caused widespread damage. Similarly, Barbados was hit by Hurricane Elsa in July 2021, which created estimated spending needs of 0.8 percent of GDP (Central Bank of Barbados 2021). Hurricane Eta was particularly destructive in Honduras, with disastrous flooding affecting roughly 45 percent of the population, creating additional spending pressures when the country was facing large COVID-19 pandemic demands. The Dominican Republic was directly hit by Hurricane Fiona in September 2022, requiring outlays equivalent to 0.3 percent of GDP for relief goods and services (Diario Libre 2022).

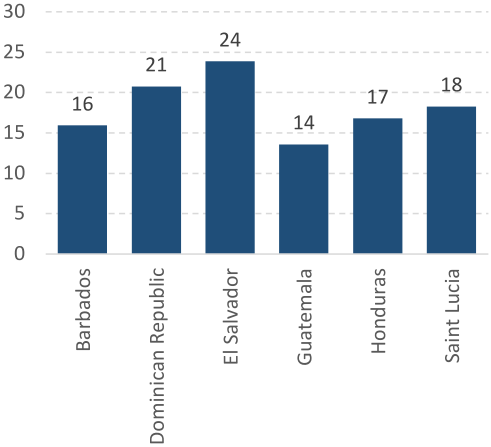
While the IMF considers current debt trends to be sustainable in most CAC6 countries, there is significant evidence of debt-related development distress. Recent debt sustainability analyses (DSAs) carried out by the IMF suggest that public debt levels are sustainable, although significant risks exist, in all CAC6 countries except El Salvador (Box 1). However, traditional measures of debt sustainability do not sufficiently capture the development implications of high levels of debt service (ECLAC 2023b). As Figure 8 shows, interest payments by members of the group are very significant. CAC6 countries dedicate between 14 percent and 24 percent of their tax revenues to cover interest payments, with the highest levels observed in the Dominican Republic and El Salvador. At the same time, interest payments are equivalent to nearly 100 percent or more of central government capital expenditures—which served as the principal instrument of fiscal adjustment during the last decade—in Barbados, Dominican Republic, El Salvador and Honduras. Interest payments represent roughly one-third of central government social spending in Dominican Republic, El Salvador and Honduras. As such, high public debt service imposes a significant barrier to pro-active climate investment.

FIGURE 8 CAC6: Central Government Interest Payments and Interest Payments as a Percentage of Tax Revenues, Capital Expenditure and Social Spending, 2022
(Percentages of GDP and percent)

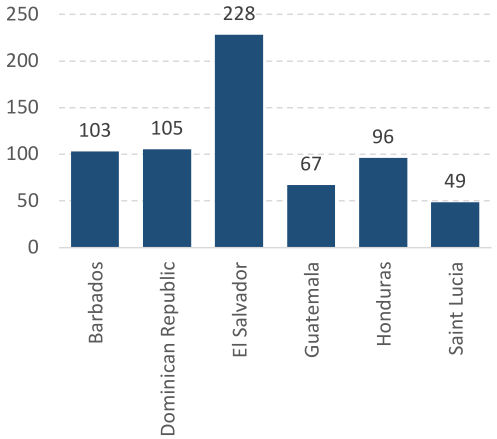
A. Interest payments (percentages of GDP)



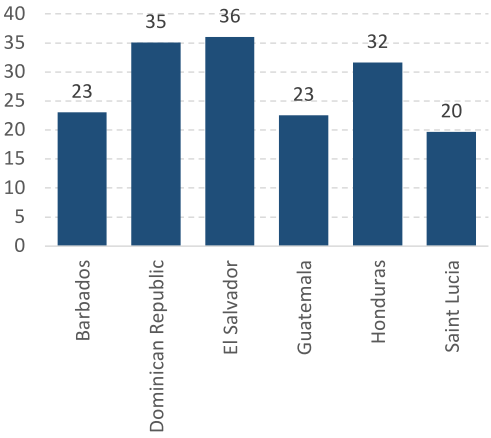
B. Interest payments as a percentage of tax revenues (percent)



C. Interest payments as a percentage of capital expenditure (percent)



D. Interest payments as a percentage of social spending (percent)



Source: Author's elaboration based on ECLAC (2023a) and IMF (2023).
Note: Ratios for interest payments and social spending correspond to figures from 2021.

BOX 1 Recent Debt Sustainability Assessments (DSA) by the IMF for CAC6 countries

The spectrum of debt sustainability of the CAC6 countries ranges from low risk of debt distress to unsustainable debt.

In the case of **Honduras**, the country has a low overall risk of debt distress and has a strong debt carrying capacity (IMF 2021b). Although Honduras' total public debt increased in 2018 from higher domestic borrowing, it is projected to decline. Additionally, Honduras' risk of external debt distress is low. These assessments assume that Honduras complies with the Fiscal Responsibility Law and has implemented structural reforms according to the IMF-supported program. They also assume that the share of external debt from multilateral and bilateral institutions remains constant over the medium term and that GDP growth estimates, made during the 2018 DSA, remain the same.

The public debt of the **Dominican Republic** is sustainable as of 2022, primarily because it has been proactively managing debt; it has a lower debt burden and gross financing needs compared to when the IMF conducted its previous DSA (IMF 2022d). Gross financing needs are not likely to become risky even under stress scenarios. Its downward debt path is vulnerable, however, to slower-than-expected growth or exchange rate shocks. A high share of its debt is long-term and held in foreign currency by official creditors.

Guatemala's central government debt is sustainable as of 2021 under current policies in the medium term (IMF 2022e). Additionally, its debt burden is resilient to short-term macroeconomic shocks and stress scenarios of a protracted pandemic. However, despite low indebtedness and prudent economic policies, having a narrow tax base limits productive spending and capacity to carry debt.

Barbados' debt is sustainable as of 2022, assuming gradual recovery of the tourism sector and the continuation of fiscal consolidation measures (IMF 2022b). Its public debt is on a downward trend after its fiscal responses to COVID-19 and after a sharp contraction in nominal GDP in FY2020/21. Nominal GDP has rebounded, and Barbados now has a favorable debt service schedule and improved market perceptions after a comprehensive debt restructuring in 2018-19. Risks remain; high volatility in its key macroeconomic indicators suggests that it must contain solvency risks with continuous fiscal consolidation. Barbados could face slower-than-expected growth in the tourism sector and might not sustain high primary surpluses or structural reforms over a long period or be unaffected by external factors. Barbados experienced a volcanic eruption in St. Vincent and the Grenadines in April 2021 and a Category 1 hurricane in July 2021.

Saint Lucia's public debt is sustainable as of 2020 but is subject to elevated risks (IMF 2022f). This assumes that the region's financial markets continue to significantly meet the government's financing needs and that the authorities implement ambitious medium-term consolidation measures to meet their 2030 debt target of 60 percent of GDP. Its gross financing needs were expected to spike and revert after paying off loans for a new airport with a dedicated airport redevelopment tax revenue. Key risks to its public debt include: 1) high near-term financing pressures in the context of weaker external market conditions and the pandemic; 2) weaker-than-projected growth and fiscal deficit paths and 3) high vulnerability to natural disasters.

El Salvador's debt is unsustainable under current policies as of 2022 (IMF 2022g). Without strong consolidation measures, public debt is projected to reach approximately 96 percent of GDP in 2026. Factors contributing to the unsustainable debt assessment include 1) relaxing fiscal policies despite better-than-expected economic recovery after unfavorable developments in 2020 and uncertainty of policy direction in 2021, 2) relying on short-term debt for financing and 3) elevated gross financing needs due to regular biannual repayments of Eurobonds starting January 2023.

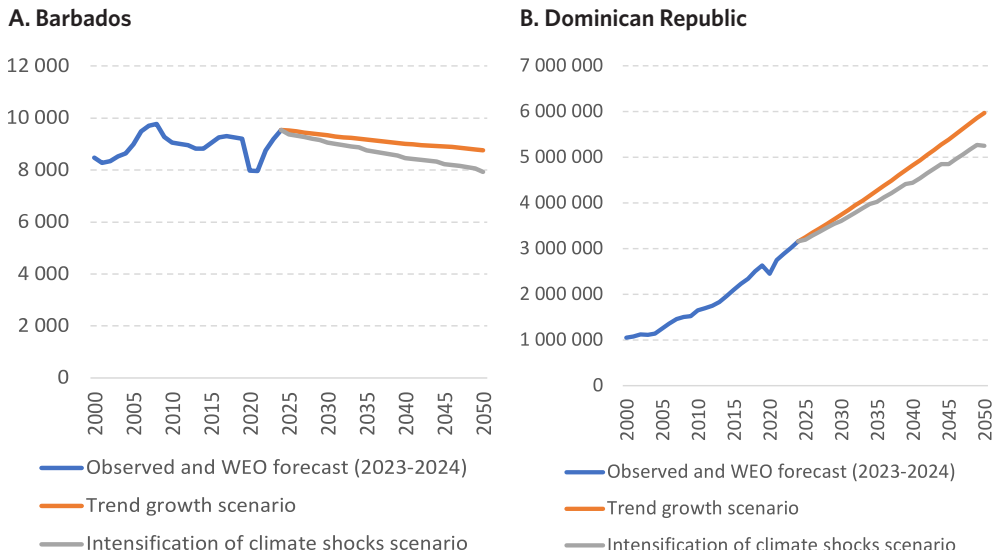
Source: Authors' elaboration, on the basis of IMF (2021b, 2022b, 2022c, 2022d, 2022e, 2022f).

CLIMATE CHANGE SHOCKS WILL NEGATIVELY IMPACT MEDIUM-TERM GROWTH

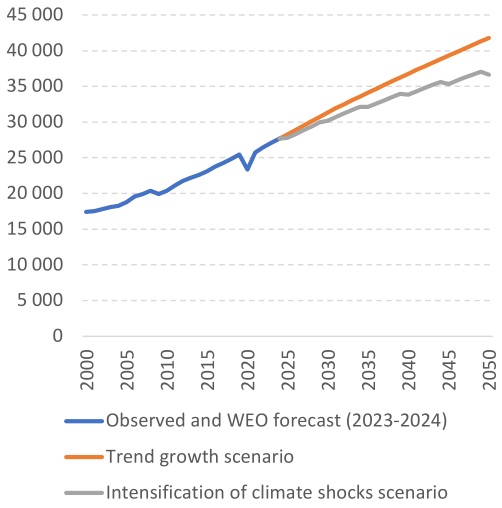
The economic impact of climate change in CAC6 countries are multi-fold and are not easily modeled. Following Central Bank of Chile (2017) and IMF (2022), a trend growth baseline scenario for 2025-2050 is estimated by employing a neoclassical Cobb-Douglas production function with constant returns to scale (Annex 1). A scenario that captures the intensification of climate change shocks is constructed by incorporating their effect through two principal channels. First, the model incorporates the forecasted economic losses due to the progressive reduction in labor productivity and agricultural production prepared by the Network for Greening the Financial System (NGFS) (NGFS 2021). Second, the model incorporates losses due to increasingly severe extreme weather events. This is simulated in the model with a series of progressively larger natural disasters occurring on five-year intervals across the forecast period. These events impact economic growth through their destructive impact on the capital stock.

The economic consequences of the intensification of climate shocks simulated for CAC6 countries are significant, with GDP in 2050 being between 9 percent and 12 percent below the trend growth counterfactual (Figure 9). The shortfall in growth reflects the progressive stepwise drag on labor and agricultural productivity caused by rising temperatures. These effects are especially acute in countries such as El Salvador, Guatemala and Honduras where the agricultural sector and related activities represent a significant share of economic activity. At the same time, all CAC6 countries will be exposed to an increase in severe weather events—droughts, floods, hurricanes, among others—that will have a destructive impact on the capital stock and, in turn, on economic growth. These effects would be tempered by the continued growth—although at a decelerating rate—of the labor force in countries such as the Dominican Republic, El Salvador, Guatemala and Honduras. In contrast, the level of GDP trends lower over the medium-term in Barbados as population levels decline.

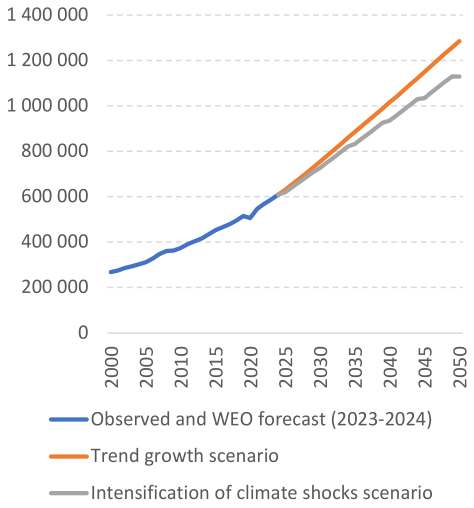
FIGURE 9 CAC6: Gross Domestic Product, by Scenario, 2000-2050
(Millions of national currency at constant prices)



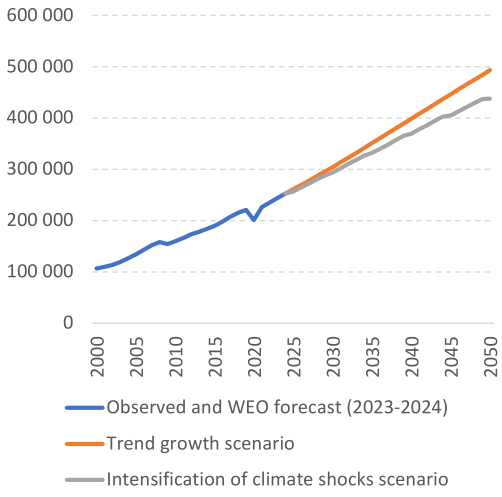
C. El Salvador



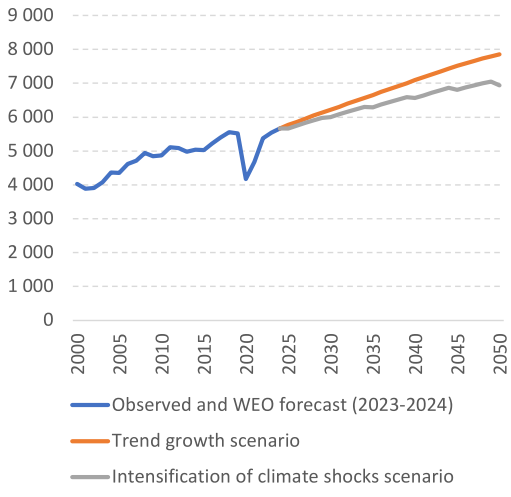
D. Guatemala



E. Honduras



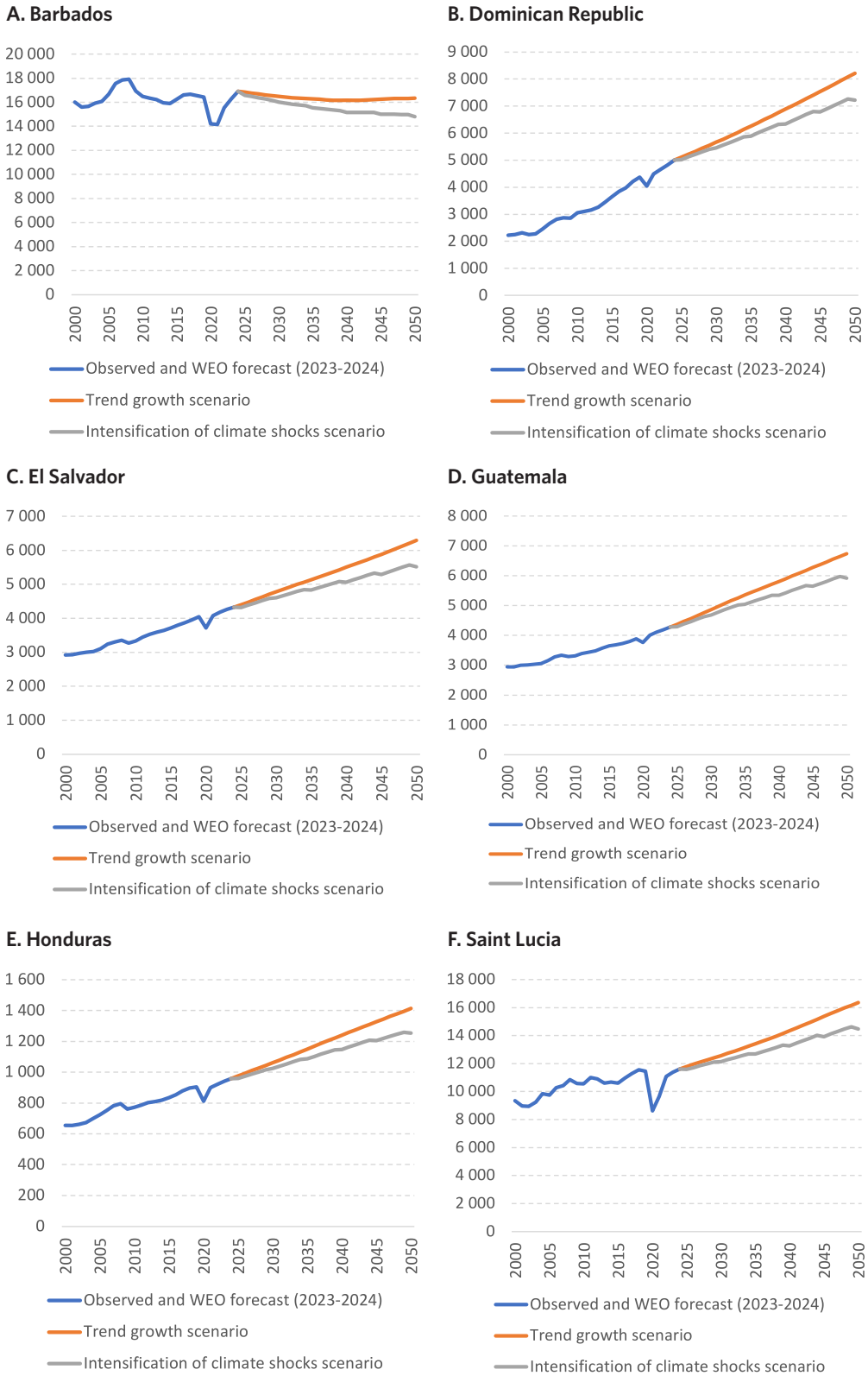
F. Saint Lucia



Source: Authors' elaboration.

The negative impact of climate shocks is also reflected in the trajectory of GDP per capita. Per capita GDP would continue to grow in most CAC6 countries, but at a lower rate than compared to the trend growth scenario counterfactual (Figure 10). This is particularly concerning for the countries of Central America and the Dominican Republic with relatively lower levels of per capita GDP, as their populations are projected to undergo a rapid demographic transition, suggesting that climate change will make attaining higher middle-income status before they grow older more difficult. These countries already face relatively higher levels of multidimensional poverty—income, education, health and basic infrastructure—which will be further aggravated by these trends. In the Caribbean, per capita GDP levels are significantly higher than in Central America and the Dominican Republic. Nevertheless, per capita GDP in Barbados is projected to decline over the period. In contrast, Saint Lucia may continue to register growth, approaching the level of Barbados, by 2050.

FIGURE 10 CAC6: Per Capita Gross Domestic Product, by Scenario, 2000-2050
(US Dollars, 2022 constant prices)

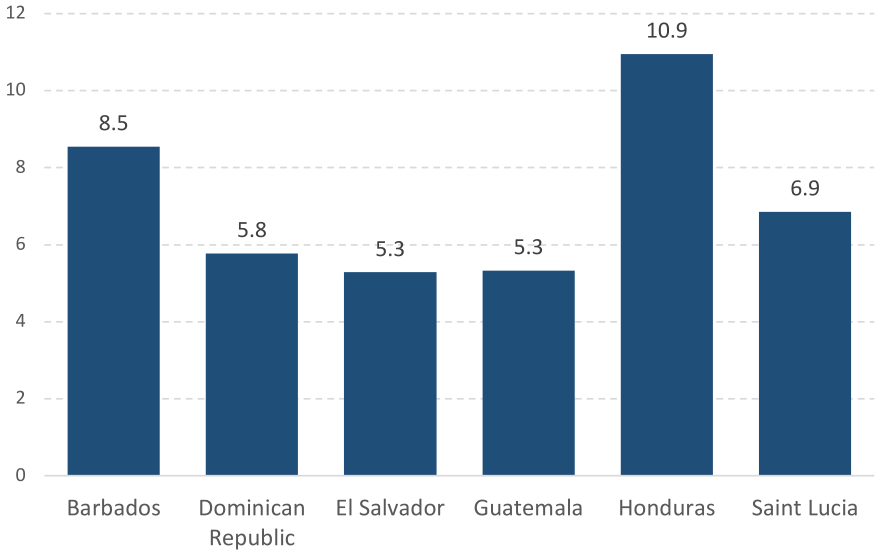


Source: Authors' elaboration.

INVESTMENT NEEDED TO FULLY COMPENSATE FOR CLIMATE SHOCKS ARE EXCEPTIONALLY LARGE

Compensating for the economic losses caused by climate change would require an unprecedented and sustained investment push. Returning to the level of GDP estimated under the trend growth scenario from the intensification of climate shocks scenario could be possible, but it would necessitate additional investment equivalent to between 5.3 percent of GDP and 10.9 percent of GDP per year on average (Figure 11). These investments would need to be economy-wide, driving a productive transformation that would generate sustained and sustainable economic growth. It is important to note that these estimated annual values do not consider potential inefficiencies in the implementation of investment projects or the existence of structural limits to additional investment. Therefore, policymakers seeking to compensate for the losses due to climate change should also consider other investments in areas such as research and development, education and training, and health, to bolster total factor productivity.

FIGURE 11 CAC6: Estimated Average Annual Investment Needs to Fully Compensate for the Economic Losses Under the Intensification of Climate Shocks Scenario Compared to the Trend Growth Scenario, 2025-2050
(Percentages of GDP)



Source: Authors' elaboration.

These results are broadly in line with estimates in the literature of the magnitude of investment necessary to achieve sustainable development objectives. Existing studies find that the magnitude of investment outlays could be very large (Table 1). Recent estimates for emerging markets and developing economies, including Latin America and the Caribbean, principally consist of costing exercises to close observed infrastructure gaps, with a particular emphasis on electricity and transportation. However, climate investments—targeting land use and agriculture, among others—are also included, either explicitly (land use or flood protection) or implicitly (infrastructure that would conceivably include climate adaptation

considerations). While these studies employ different methodologies, the projected annual investment needs largely converge, with estimated outlays being within the range of 3 percent to 8 percent of GDP per year. However, these estimates typically do not contemplate investments in education, healthcare and other elements of the social protection net, which will be crucial to ensure a successful and fair transition to a low-carbon economy.

TABLE 1 Selected Recent Studies of Comprehensive Climate and Development Investment Needs

Level	Source	Elements considered	Estimated annual investment needs
Emerging markets, excluding China	Bhattacharya et al. (2022)	Human capital; sustainable infrastructure; land use, agriculture, environment; adaptation and resilience	6.8 percent of GDP
Low- and middle-income countries	Rozenberg and Fay (2019)	Electricity, transport, water sanitation, flood protection, irrigation	7.2 percent of GDP: 4.5 percent of GDP (capital investment), 2.7 percent of GDP (maintenance)
Latin America and the Caribbean	Castellani et al., (2019)	Infrastructure and addressing extreme poverty	10.6 percent of GDP by 2030 16 percent of GDP by 2030 (including completion of secondary education)
Latin America and the Caribbean	Rozenberg and Fay (2019)	Electricity, transport, water sanitation, flood protection, irrigation	2.6 percent-8.8 percent of GDP, depending on scenario
Latin America and the Caribbean	Fay et al. (2017)	Infrastructure investment	3 percent-8 percent of GDP

Source: Authors' elaboration based on cited publications.

INVESTMENT IN LINE WITH NDCS WOULD LIMIT ECONOMIC LOSSES, BUT WOULD CAUSE DEBT DYNAMICS TO DETERIORATE

Accomplishing the climate change mitigation and adaptation objectives included in the NDCs would entail significant investments, but of a smaller magnitude than those to fully compensate for climate change-related economic losses. Figures included in some NDCs suggest that annual adaptation and mitigation investment outlays in the period leading to 2030 could span a wide range from roughly 1 percent of GDP to more than 20 percent of GDP in some countries (Table 2). Estimated annual investment needs for small island developing States (SIDS) in the Caribbean are especially large, reaching 21.8 percent of GDP per year in the case of Dominica. Nevertheless, the lack of exhaustiveness of investment requirements, both in magnitude and composition, is a major barrier to policy analysis and the formulation of climate financing mechanisms.

TABLE 2 Latin America and the Caribbean (Selected Countries): Estimated Annual Financing Needs for Adaptation and Mitigation as Published in NDCs Submissions *(Percentages of GDP)*

Country (year of NDC submission)	Climate objective		
	Mitigation	Adaptation	Total
Antigua and Barbuda (2021)	...	...	11.6
Bahamas (2022)	...	...	3.6
Belize (2021)	5.7	1.3	7.0
Cuba (2020)	6.1	...	6.1
Dominica (2022)	1.9	19.9	21.8
Dominican Republic (2020)	0.9	0.9	1.8
Grenada (2020)	9.4	...	9.4
Guyana (2016)	...	2.1	2.1
Haiti (2022)	1.9	6.2	8.1
Nicaragua (2020)	...	1.2	1.2
Saint Kitts and Nevis (2021)	6.7	1.4	8.1
Saint Lucia (2021)	2.2	...	2.2
Suriname (2019)	...	...	2.5
Trinidad and Tobago (2018)	0.8	...	0.8

Source: Authors' elaboration, on the basis of Climate Watch, [online] https://www.climatewatchdata.org/.

To examine the macroeconomic implications pursuing the actions outlined in the NDCs, the intensification of climate shocks scenario is modified to incorporate a climate change investment component. Given the paucity of information on investment needs for the countries of the CAC6 and to make the models tractable, investment needs for all countries are set to the values presented by the Dominican Republic in the country's first updated NDC submission.[4] Additional annual investment in the NDC investment model is set to 1.8 percent of GDP, with 0.9 percent of GDP for mitigation and 0.9 percent of GDP for adaptation.

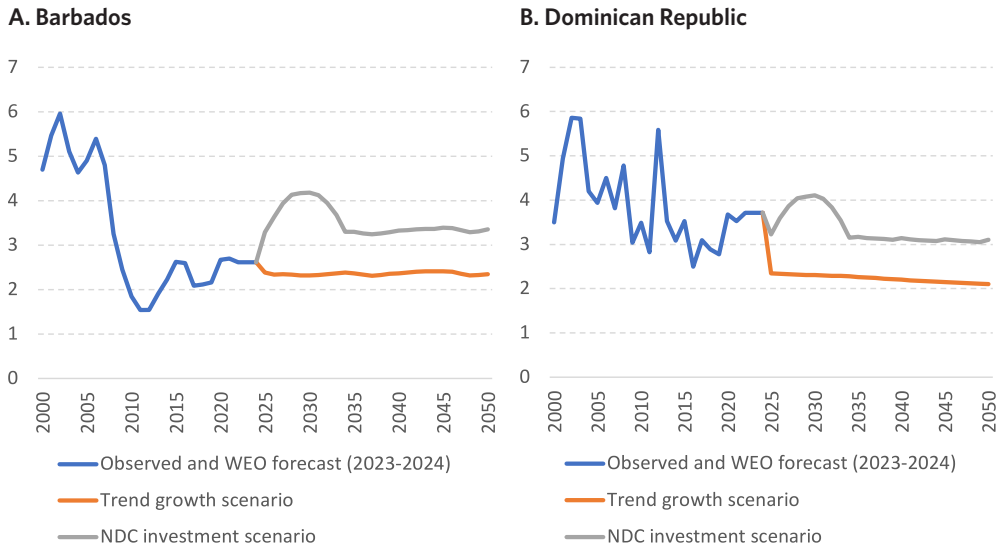
Investment requirements in the NDCs are not limited to public sector efforts, but also foresee the active participation of the private sector. In line with UN Conference on Trade and Development (UNCTAD) (2014), the model assumes that investment in adaptation is divided into 80 percent for the public sector and 20 percent for the private sector. In the case of mitigation investment, the public sector represents 40 percent of the total while the private sector accounts for the remaining 60 percent. The model therefore captures the impact of public and private NDC investment on GDP.

[4] Gobierno de la República Dominicana, Contribución Nacionalmente Determinada 2020 (NDC-RD 2020), [online] https://unfccc.int/sites/default/files/NDC/2022-06/Dominican percent20Republic percent20First percent20NDC percent20 percent28Updated percent20Submission percent29.pdf

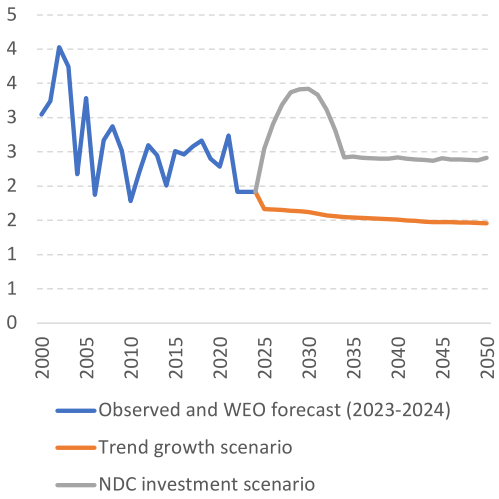
To analyze the impact of a front-loaded adaptation investment push, the model assumes that public adaptation outlays rise smoothly, doubling by the middle of the first decade of the projection period (2025-2034). Public adaptation investment subsequently declines, reaching a value that ensures that total public adaptation investment for the entire forecast period does not exceed the level that would have been observed if annual investment were held flat at the value, relative to GDP, obtained from the NDC of the Dominican Republic. In contrast, private sector adaptation investment is not front-loaded.

Under an NDC investment scenario, public investment would roughly double in most CAC6 countries during the first years of the front-loaded adaptation push but would remain at levels lower than those observed during the 2000s in most cases. Proactive front-loaded adaptation investment would result in a significant increase in public gross fixed capital formation (Figure 12). However, investment levels under an NDC investment scenario are not substantially higher than those seen in the early 2000s in Barbados, the Dominican Republic, El Salvador, Guatemala and Honduras. Public gross fixed capital formation after the initial front-loaded investment drive would remain above the levels that are projected to prevail over the projection period under the trend growth scenario. However, investment levels in the counterfactual case should be considered a lower bound, although they are in line with recent trends.

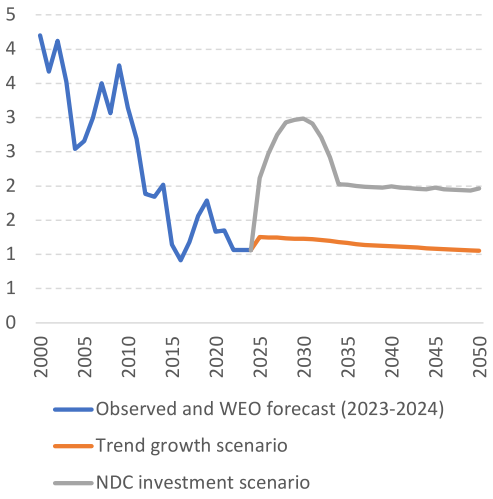
FIGURE 12 CAC6: General Government Public Investment (Gross Fixed Capital Formation), by Scenario, 2000-2050
(Percentages of GDP)



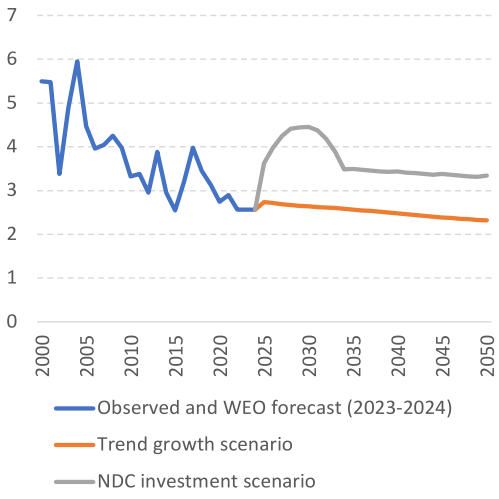
C. El Salvador



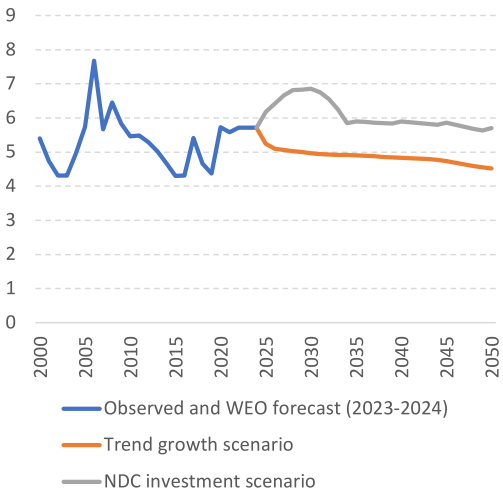
D. Guatemala



E. Honduras



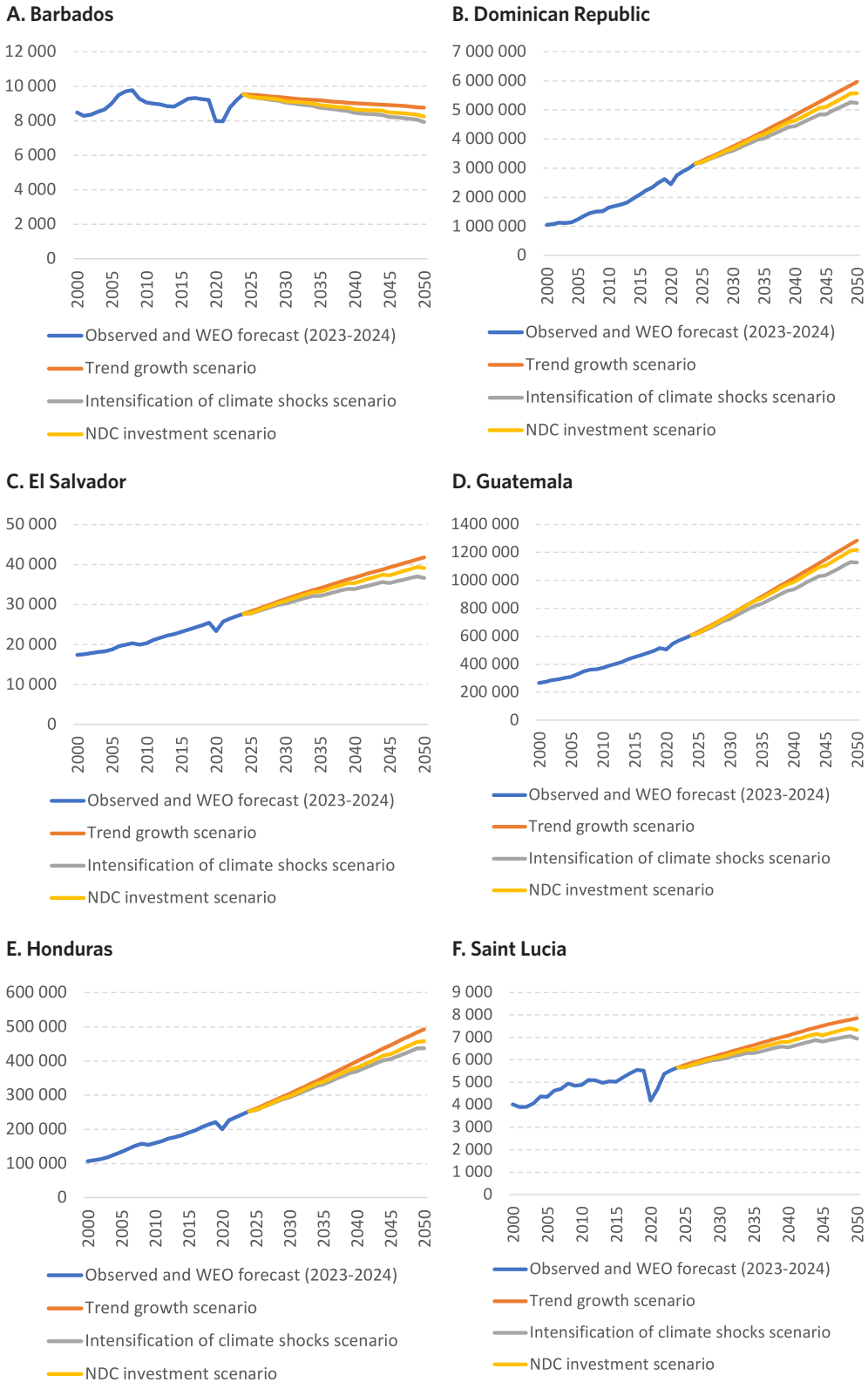
F. Saint Lucia



Source: Authors' elaboration.

An NDC investment push would attenuate the worst of the economic losses in the intensification of climate shocks scenario, but CAC6 economies would still be between 5 percent and 7 percent smaller in 2050 than under the trend growth counterfactual. A front-loaded adaptation investment push, and the accompanying increase in the capital stock, would accelerate economic growth in the short-term. Additionally, a growing climate adaptation capital stock would offset in part the impact of severe weather events on economic output (Annex 1). As a result, GDP in the NDC investment scenario would situate itself roughly halfway between that of the trend growth counterfactual and the intensification of climate shocks scenario (Figure 13).

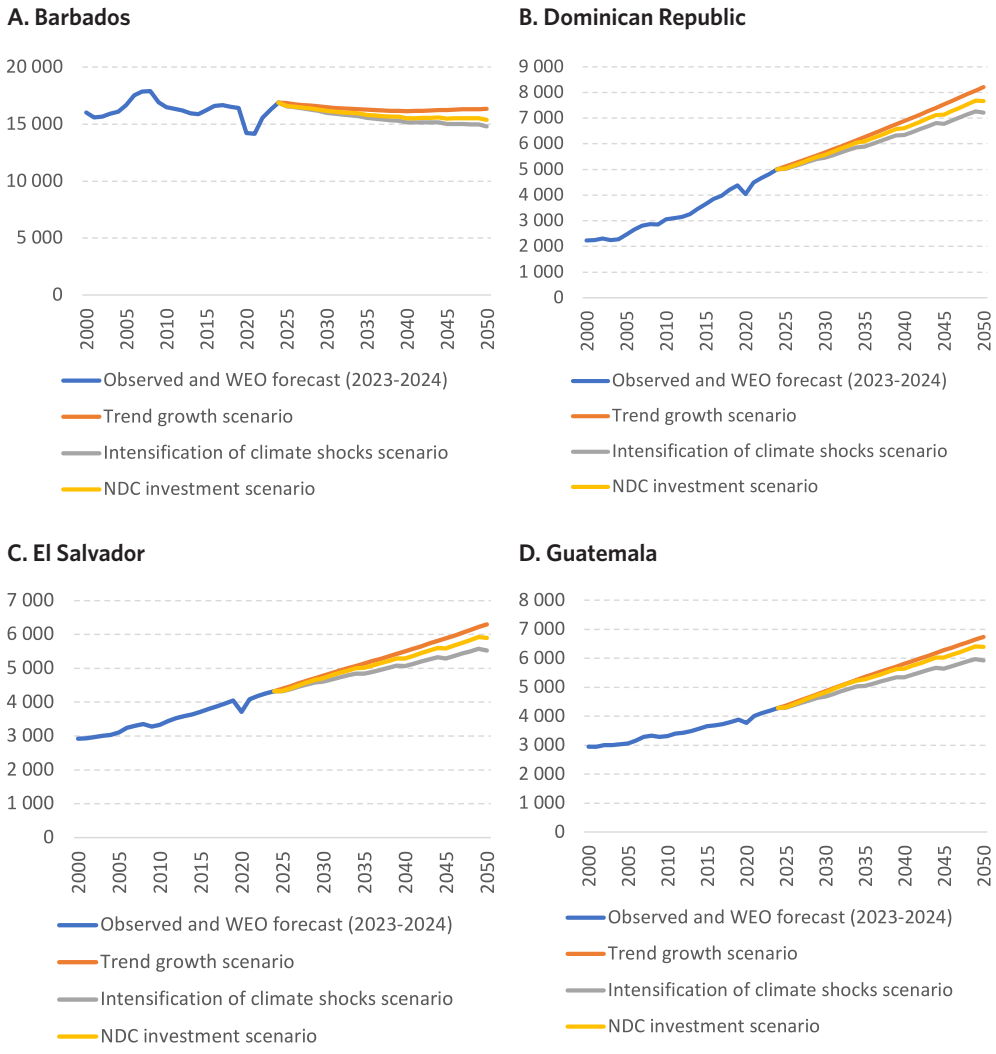
FIGURE 13 CAC6: Gross Domestic Product, by Scenario, 2000-2050
(Millions of national currency at constant prices)

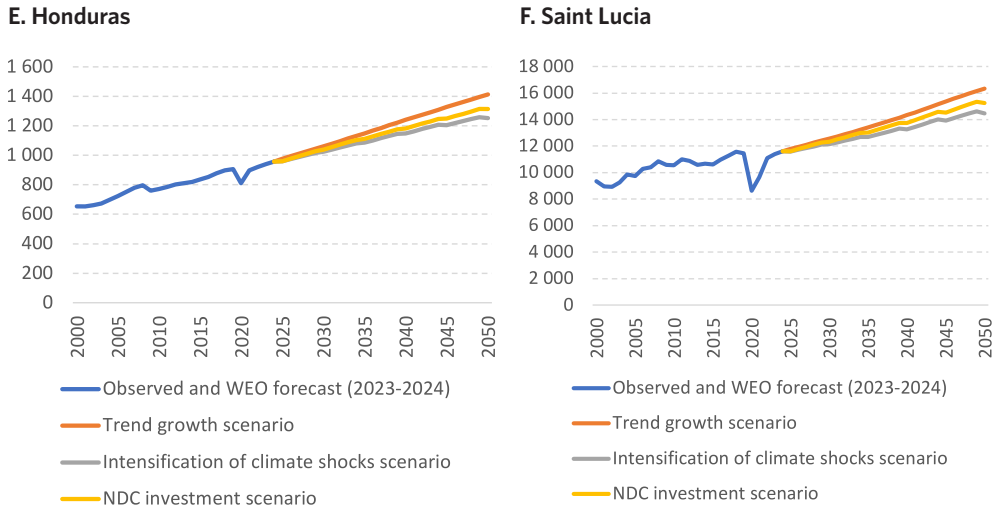


Source: Authors' elaboration.

Losses in per capita GDP would be offset in part by NDC investment, with a decline between 5 percent and 7 percent compared to the trend growth counterfactual. The front-loaded climate adaptation investment push and capital outlays for climate mitigation could support economic activity, resulting in higher levels of per capita GDP than under the intensification of climate shocks scenario (Figure 14). Although per capita GDP could trend lower compared to the trend growth scenario, climate investments could generate significant positive secondary effects, supporting employment creation and the formalization of economic activity.

FIGURE 14 CAC6: Per Capita Gross Domestic Product, by Scenario, 2000-2050
(US dollars, 2022 constant prices)





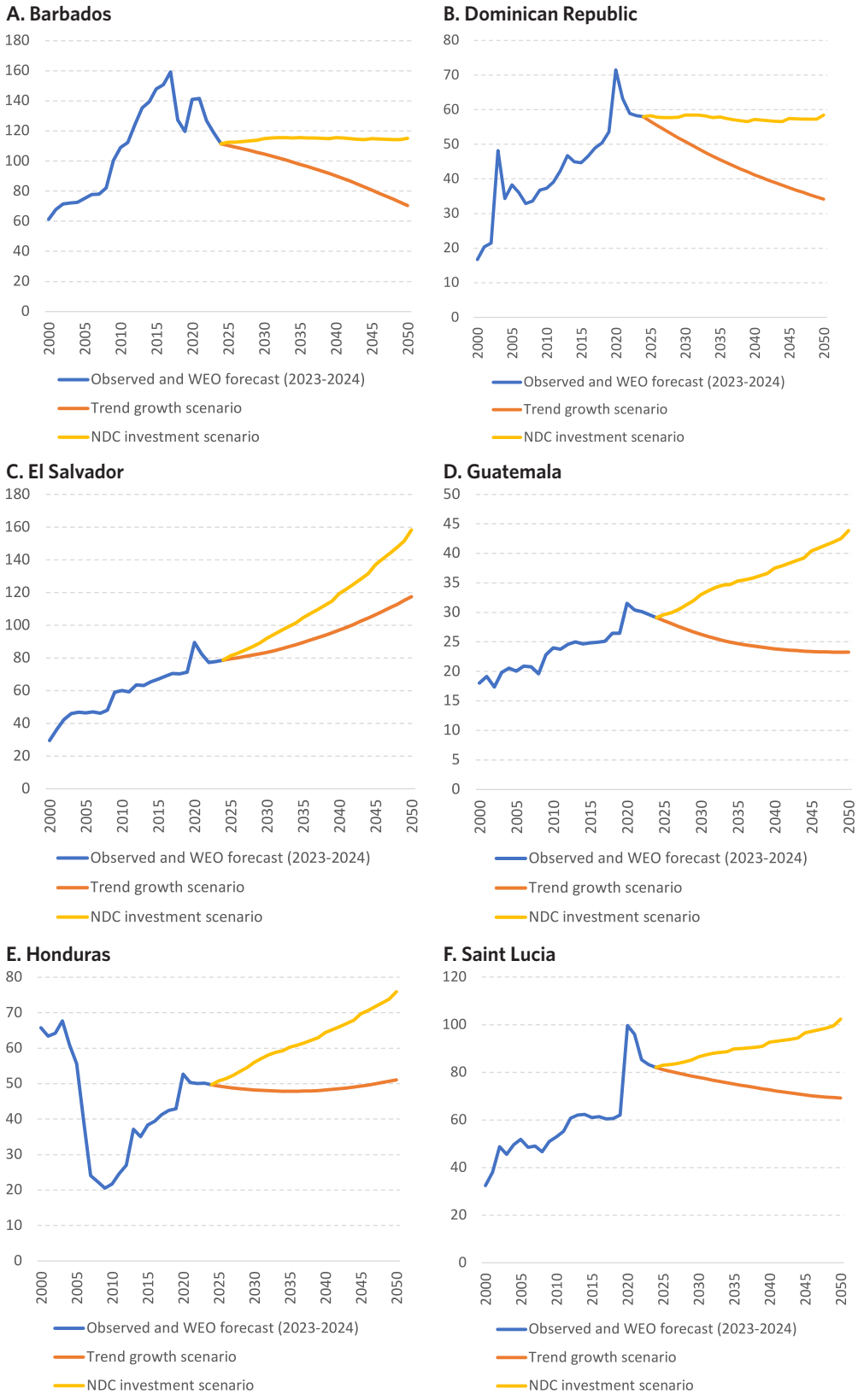
Source: Authors' elaboration.

To assess the impact of an NDC investment push on public accounts, debt dynamics are modeled using the Debt Sustainability Analysis framework. Simplifying assumptions are employed to model debt dynamics for each scenario. Total revenues—excluding carbon tax receipts—and current primary expenditure are assumed to grow such that their share relative to GDP remains constant over the projection period. Carbon tax revenues are included in the models based on the work of Titelman et al. (2022), although they are inconsequential for the models' results. Capital expenditure consists of three components: an inertial component, that assumes that capital expenditure grows such that its ratio with respect to GDP remains constant; a front-loaded climate adaptation investment component; and a climate mitigation investment component. Movements in primary spending, and by extension the primary balance, are therefore predominately accounted for by changes in climate mitigation and adaptation investment. Debt dynamics are calculated using the modeled real GDP growth rate and primary balance, as well as the average effective interest rate on public debt (for the period 2018-2022) and inflation (GDP deflator from World Economic Outlook (WEO)), both of which are held constant over the forecast period.[5]

Public debt levels are projected to remain elevated or experience accelerating growth in most CAC6 countries in the NDC investment scenario. As shown in Figure 15, debt levels grow rapidly in El Salvador, Guatemala, Honduras and Saint Lucia. Debt dynamics over the projection period in these countries are heavily influenced by the creation of large primary deficits due to greater public investment outlays. Lower growth, relative to the baseline case, also leads to a greater contribution of the interest rate-growth differential to the increase in debt. In El Salvador, debt levels accelerate rapidly under any scenario. In contrast, in Barbados and the Dominican Republic, the NDC investment big push would result in public debt levels that remain roughly at the levels estimated in 2024 before the forecast period. However, this would imply that public debt in Barbados would exceed 100 percent of GDP.

[5] Effective interest rates are derived from dividing interest payments by the debt stock at the end of the previous year.

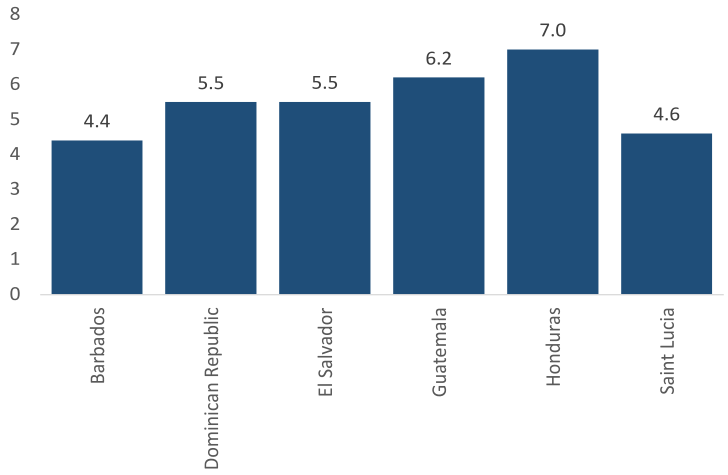
FIGURE 15 CAC6: Central Government Gross Public Debt, by Scenario, 2000-2050
(Percentages of GDP)



Source: Authors' elaboration.

High interest rates on public debt play a significant role in debt trajectories in the NDC investment scenario. The effective interest rate for public debt is elevated in most CAC6 countries (Figure 16). In Dominican Republic, El Salvador, Guatemala, Honduras and Saint Lucia, the prevailing rate approaching or exceeding 5 percent, reaching 6.2 percent in Guatemala and 7.0 percent in Honduras. The effective interest rate for public debt in Barbados is relatively lower, reflecting in large part the impact of the restructuring of public debt carried out in 2018 and 2019. However, effective interest rates may not adequately capture the market rates that countries would face if they were to finance NDC investment through debt offerings in international financial markets, which may be significantly higher. For example, Cevik and Tovar Jalles (2020) find that climate vulnerable countries, especially developing countries, face significantly higher borrowing costs, even when controlling for other factors that influence sovereign risk. Similarly, Beirne et al. (2020) argue that vulnerability to the direct effects of climate change is a significant driver of the cost of sovereign finance. At the same time, Cevik and Tovar Jalles (2020) suggest that countries with higher climate resilience—defined as a country's capacity to apply economic investments and convert them to adaptation actions—benefit from lower interest rates, highlighting the potential for negative feedback loops for countries who cannot finance front-loaded climate adaptation and mitigation investments.

FIGURE 16 CAC6: Effective Interest Rate on Central Government Gross Public Debt, 2018-2022 Average
(Percentages)



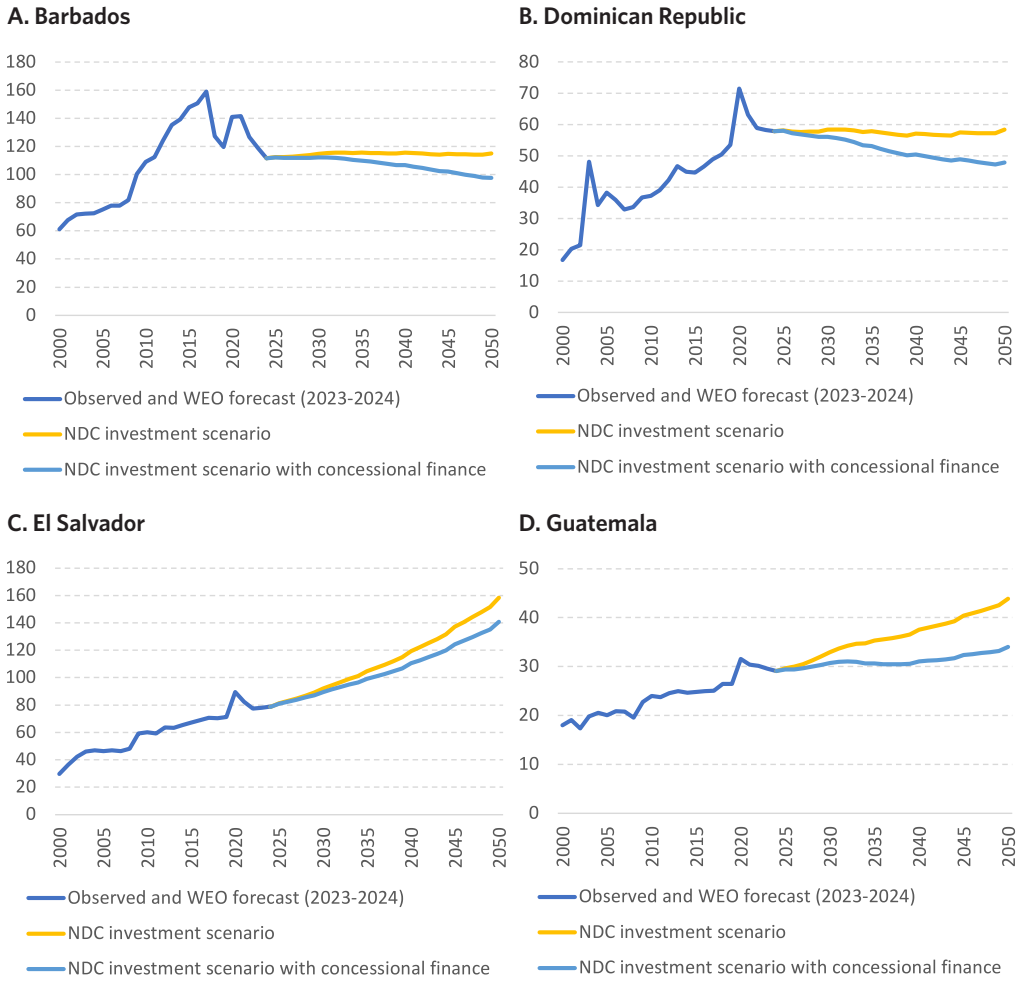
Source: Author's elaboration.

FINANCING COSTS OF CLIMATE INVESTMENT WILL HAVE A SIGNIFICANT IMPACT ON DEBT TRAJECTORIES

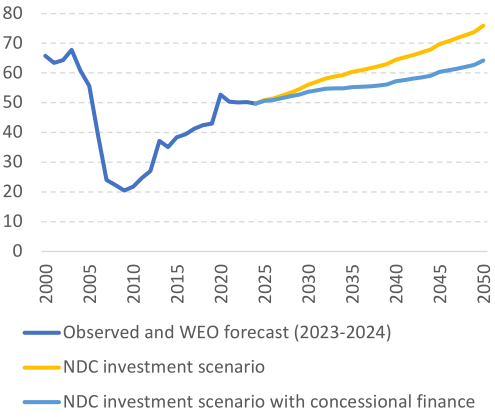
Reducing the cost of climate finance could bend debt trajectories and allow countries to implement NDC investment while they take measures to ramp up domestic resource mobilization. A major stumbling block to carrying out a front-loaded investment push is the

lack of sufficient public revenues or low-cost debt finance. The viability of proactive public climate investment efforts would be improved if countries could access sufficient concessional finance. To explore the extent to which concessional climate financing could impact debt dynamics, the NDC investment scenario is modified to use an interest rate that is one half of the prevailing effective interest rate for debt financed public climate investment. Under this scenario, public debt largely stabilizes in the medium-term in Saint Lucia (Figure 17). In Guatemala and Honduras, concessional financing softens the rise in public debt in the NDC investment scenario without concessional finance but does not fully stabilize the medium-term debt curve. In the Dominican Republic and Barbados, concessional climate finance would lead to lower debt levels, compared to the original NDC investment scenario, over the forecast period. In contrast, debt dynamics remain unfavorable in El Salvador, even with concessional financing.

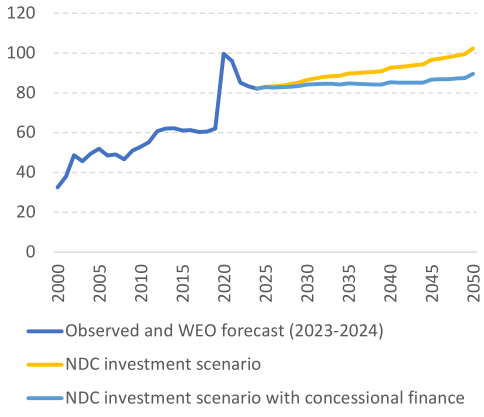
FIGURE 17 CAC6: Central Government Gross Public Debt, by Scenario, 1990-2050
(Percentages of GDP)



E. Honduras



F. Saint Lucia



Source: Authors' elaboration.

ENHANCING THE ROLE OF INTERNATIONAL FINANCIAL INSTITUTIONS TO SUPPORT CLIMATE INVESTMENT

Although current debt trajectories are considered sustainable, CAC6 countries face significant debt-related development distress limiting fiscal space for active policymaking. Interest payments on existing public debt are equivalent to around 100 percent of capital expenditures as well as more than 30 percent of social spending, in several members of the group. Upwards of 24 percent of tax revenues are dedicated to outlays for interest payments. High interest payments limit the fiscal space available to undertake proactive climate adaptation investments (ECLAC 2023b).

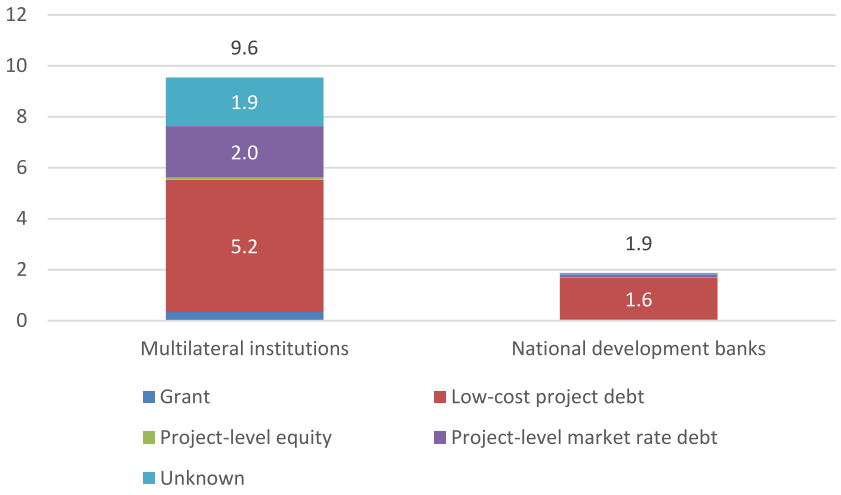
Lowering the cost of financing to undertake pro-active climate investments is crucial to promoting the creation of resilient economies. Borrowing costs, proxied by effective interest rates, are high in most CAC6 countries, particularly in Guatemala (6.2 percent) and Honduras (7.0 percent). These high interest rates make financing climate investments particularly difficult, as it leads to higher interest payments, which in turn reduce fiscal space. Reducing the cost of financing of climate investment is essential to promote climate investments and long-run economic development as well as address potential future macro-critical concerns.

Support for debt relief and restructuring efforts is necessary to support long-run fiscal sustainability. Creating sufficient concessional financing for climate investment should be a global policy objective, but it is insufficient to ensure that developing economies, including middle-income countries, can achieve sustainable and inclusive growth and maintain sustainable debt trajectories. Public debt levels are elevated in many countries in Latin America and the Caribbean, at levels not seen in two decades, despite experiencing a modest decline in relative terms in 2021 and 2022. High effective interest rates, coupled with weak long-run economic growth in the absence of a concerted investment push, will lead to unsustainable, even explosive, debt dynamics.

Low-cost climate financing by international financial institutions is essential to meet investment needs. These entities can provide crucial financing to reduce the cost of capital and

unlock investment. As seen in Figure 18, between 2019 and 2020, national development banks and multilateral institutions provided an average of $11.5 billion (0.2 percent of 2019 GDP) per year in climate finance in the region. An important amount was in the form of low-cost project debt or project-level market rate debt (Titelman et al. 2023). However, these amounts are currently insufficient to leverage the amount of private capital necessary to meet climate objectives. Multilateral institutions and national development banks should be further capitalized to increase their lending capacity.

FIGURE 18 Latin America and the Caribbean: Multilateral Institutions and National Development Banks Climate Finance, 2019-2020 Average
(Billions of dollars)



Source: Authors' elaboration based on CPI (2021).

Financing for climate-related macroeconomic policy imbalances is a welcome addition to the IMF´s lending toolkit but is currently insufficient. As highlighted in Titelman et al. (2022), the IMF is in a unique position to help countries smooth the path to net-zero emissions. The use of the Rapid Financing Instrument and the Rapid Credit Facility to aid immediately after natural disasters occur is indeed a helpful recourse to for post-event adaptation (IMF 2021). The implementation of the Resilience and Sustainability Facility (RSF) goes one step beyond by providing funds to reduce macroeconomic risks arising from longer-term climate challenges. The approval of an RSF arrangement for Barbados to shore up its balance of payments in the transition to a renewable based economy and the building of resilient infrastructure is of special significance to this study (IMF 2022b).

Building capacity to consider climate investment in policies is crucial. It is crucial to mainstream climate change policies in the macro-fiscal planning, budgeting, public investment management and public procurement and encourage cooperation between development partners—international financial institutions, bilateral donors—and between countries (The Coalition of Finance Ministers for Climate Action 2023). Technical assistance could play a catalytic role in helping governments adopt a strategic perspective that guides public policy towards prioritizing investments with high environmental, economic, and social returns. In

this regard, it is important to consider projects with significant positive externalities that are not financially viable on their own. Furthermore, it is essential to internalize the distributive effects of the policies to be implemented, as the impact of climate change and the policies to address it are not distributed equitably, ensuring that the vulnerabilities of low-income individuals and other populations are incorporated into the analysis.

Mainstreaming climate change issues in the work of international financial institutions is an important component of a pro-investment approach. The IMF is progressively including climate change considerations into its bilateral surveillance and analysis as part of its climate change strategy (IMF 2021). Recent Article IV staff reports have included climate change-related issues. However, recent work by the Task Force on Climate, Development and the IMF suggests climate change-related policy advice in Article IV staff reports is focused principally on carbon pricing, with less focus on improvements to macro-fiscal frameworks that would promote resource mobilization, investment, structural change and climate resilience (Task Force 2023).

More efforts are needed to include climate change considerations in Article IV reports. It is important to include both revenue and expenditure aspects of climate change and incorporate them into DSAs. DSAs should also fully incorporate the impact of carbon neutrality policies in fiscal revenues in hydrocarbon-producing/consuming countries (Titelman et al., 2023). Additional work is required to quantify the financing commitments for implementing the NDCs in the Latin America and Caribbean region (Task Force 2023).

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ANNEX 1

METHODOLOGY FOR THE ESTIMATION OF MEDIUM-TERM GDP GROWTH IN THE "TREND GROWTH" COUNTERFACTUAL SCENARIO

Following Central Bank of Chile (2017), medium-term GDP is forecasted using a Cobb-Douglas function that is frequently employed in neo-classical growth models. This function assumes that total value-added in the economy (output) can be expressed as a function of total factor productivity, the installed capital stock, and the labor force:

$$Y_{i,t} = A_i K_{i,t}^{\alpha} L_{i,t}^{\beta} \quad (1)$$

Where Y denotes GDP, K is the installed capital stock, L is the labor force and A corresponds to total factor productivity. The values of α and β correspond to the output elasticities of capital and labor, respectively.

The Cobb-Douglas production function assumes constant returns to scale, thus the sum of α and β is constrained to be unitary. As such, the output elasticity of capital (α) is traditionally set to be equivalent to $(1 - \beta)$.

The value of β in the model is set exogenously based on the labor share of GDP from national accounts, using data generated by the International Labor Organization (ILO) for SDG indicator 10.4.1.

Building on this production function, GDP trend growth is obtained by taking logs and differentiating the equation such that:

$$\hat{y} = \hat{a} + (1 - \beta)\hat{k} + \beta\hat{l} \quad (2)$$

Where the lowercase variables correspond to the growth rate of the variables in the previous equation.

Capital accumulation in the model follows a perpetual inventory equation that is typical in the literature:

$$K_{i,t} = (1 - \delta)K_{i,(t-1)} + I_{i,t} \quad (3)$$

Where $K_{i,t}$ corresponds to install capital stock, δ to the depreciation rate (set to 5 percent), and $I_{i,t}$ to the among of total public and private investment. Investment in the "trend growth" counterfactual scenario is assumed to remain constant relative to GDP—in line with recent trends in investment to GDP ratios—at a level to maintain the capital stock to GDP ratio steady over the forecast period.

The forecast period in this paper corresponds to 2025-2050. Observed data for GDP, GDP deflator, and general government fiscal accounts for 1990-2022 and estimated data for 2023-2024 are from the World Economic Outlook (IMF 2023), CEPALstat or national sources. The model was calibrated using estimated data for 2023-2024 from IMF (2023), due to significant continuing macroeconomic volatility caused by the COVID-19 pandemic.

Installed capital stock comes from the IMF's "Investment and Capital Stock Dataset, 1960-2019" database. Capital stock for the period 2020-2024 was estimated based on the growth of public and private investment from national accounts or for overall investment from IMF (2023).

Observed and forecast values for the potential labor force—defined as the population between the ages of 15 and 64 are from the World Population Prospects 2022 (UNSD 2022).

Growth of total factor productivity is taken as the median of the Solow residual for the period 1990-2022, or from estimates derived from Penn World Tables.

METHODOLOGY FOR THE ESTIMATION OF MEDIUM-TERM GDP GROWTH IN THE "INTENSIFICATION OF CLIMATE SHOCKS" SCENARIO

The impact of climate change on economic output is modelled through two principal channels: the progressive erosion of the underlying determinants of economic growth due to climate change through its negative impact on productivity and agricultural production; and the rising intensity of severe weather events.

To capture the progressive impact of climate change on economic output (GDP), the Cobb-Douglas production function (equation 1) is expanded to include country-specific expected macroeconomic losses, as published by the Banking Network Centrals and Supervisors to Green the Financial System (2021):

$$Y_{i,t} = (1 + \theta_{i,t})\widetilde{Y_{\iota,t}} \tag{4}$$

Where Y denotes GDP, $\theta_{i,t}$ is the cumulative macroeconomic loss caused by climate change in percentage, and $\tilde{Y}$ corresponds to the original Cobb-Douglas production function (equation 1).

In the "trend growth" counterfactual scenario, the value of $\theta_{i,t}$ is set to 0. In the "intensification of climate shocks" scenario, $\theta_{i,t}$ is equal to the cumulative country and year specific reduction in GDP (95th percentile) under the "current policies scenario" of the Networking for Greening the Financial System (2021).

The impact of the increasing intensity of severe weather events in the model is captured by subjecting the installed capital stock to a series of shocks that occur every five years.

The damage caused by these events—as a percentage decrease in the overall capital stock—increases linearly, from 1 percent in 2050 to a value equivalent to the maximum damage value (4.7 percent) for Central American countries in the EM-DAT database in 2050 (CRED, 2020). Caribbean countries were excluded from the calculation as estimated damage figures were extreme outliers and would introduce a significant bias.

METHODOLOGY FOR THE ESTIMATION OF MEDIUM-TERM GDP GROWTH IN THE "NDC INVESTMENT" SCENARIO

To estimate the impact on growth of an NDC investment push, the capital accumulation equation (equation 3) is modified to include public and private investment in climate change adaptation and mitigation:

$$K_{i,t} = (1 - \delta)K_{i,(t-1)} + I_{i,t} \tag{5}$$

With:

$$I_{i,t} = I_{inertial,i,t} + I_{public\ adaptation,i,t} + I_{public\ mitigation,i,t} + I_{private\ adaptation,i,t} + I_{private\ mitigation,i,t} \tag{6}$$

Where $I_{inertial,i,t}$ corresponds to the investment level established for the "trend growth" counterfactual scenario, $I_{public\ adaption,i,t}$ and $I_{private\ adaption,i,t}$ to public and private adaptation investment, and $I_{public\ mitigation,i,t}$ and $I_{private\ mitigation,i,t}$ to public and private mitigation investment.

Given the paucity of available estimates for climate adaptation and mitigation investment needs specifically for CAC6 countries, the annual investment needs from the NDC submission of the Dominican Republic—1.8 percent of GDP: 0.9 percent of GDP per year for adaptation and 0.9 percent of GDP per years for mitigation—are used as a proxy for all countries.

The distribution of climate adaptation and mitigation investment between the public and private sector is based on UNCTAD (2014), which estimates that 80 percent of adaptation investment and 40 percent of mitigation investment is carried out by the public sector.

Adaptation investment is assumed to mitigate in part the shocks to the overall capital stock due to severe weather events. In the "NDC investment" scenario the gross impact of the modeled severe weather events on the capital stock is reduced as a function of the share of adaptation capital stock in the total capital stock.

Public sector adaptation investment in the model is assumed to be front-loaded. In the first decade of the forecast period, adaptation investment rises smoothly to double by mid-decade, after which it declines smoothly before returning to a steady-state level. The steady-state level is constrained such that the sum of investment over the forecast period is equivalent to that which would have prevailed without a front-loaded investment push.

The "NDC investment" scenario assumes that global consensus is formed around the objective for achieving net-zero emissions by 2050. Therefore, the scenario sets the value of $\theta_{i,t}$

in equation 4 to the cumulative country and year specific reduction in GDP (95th percentile) under the "net-zero 2050 scenario" of the Network for Greening the Financial System (2021).

METHODOLOGY FOR THE ESTIMATION OF PUBLIC FISCAL ACCOUNTS IN THE "NDC INVESTMENT" SCENARIO

Very conservative assumptions are used to make the estimation of fiscal accounts more tractable:

Revenue:

- Total revenue, excluding carbon tax receipts, is assumed to remain constant as a percentage of GDP during the projection period.
- An estimate of carbon tax revenue is included based on the methodology used in Titelman et al. (2022). However, receipts from this tax are minimal and do not impact the results of the model.

Primary expenditure:

- Primary current expenditure remains constant as a percentage of GDP during the projection period. This is equivalent to a very stringent fiscal expenditure rule.
- Capital expenditure is modeled in two components:
    - An inertial component in which capital spending excluding climate investment is assumed to remain constant as a percentage of GDP during the projection period.
    - Another component that captures public investment in adaptation and mitigation.

Movements in primary expenditure and the primary balance are therefore entirely accounted for by changes in public investment in adaptation and mitigation.

Debt dynamics are modelled using the IMF's DSA framework. The components used in the debt dynamics equations include:

- Endogenously determined real GDP growth rate;
- Endogenously determined primary balance;
- Exogenous constant effective interest rate (observed average for 2018-2022); and
- Exogenous constant inflation (estimated change in GDP deflator in 2024) from IMF (2023).

METHODOLOGY FOR THE ESTIMATION OF PUBLIC FISCAL ACCOUNTS IN THE "NDC INVESTMENT WITH CONCESSIONAL FINANCE" SCENARIO

In the "NDC investment with concessional finance" scenario debt dynamics are calculated in two parts:

1. Public debt excluding climate investment is modelled using the assumptions employed in the "NDC investment" scenario.
2. Public climate investment debt is modeled as a separate balance sheet in which the debt dynamics employ a concessional effective rate that is assumed to be equivalent to 50 percent of the current effective rate used in the "NDC investment" scenario.

Total public debt is then presented as the sum of these two calculations.

TASK FORCE ON CLIMATE, DEVELOPMENT AND THE INTERNATIONAL MONETARY FUND