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Abstract[1]

The government's response to the COVID-19 pandemic left Latin America and the Caribbean economies with increased levels of sovereign debt as a percentage of output, bringing up the question of debt sustainability in the region. The literature has identified two testable conditions on the fiscal reaction function for debt sustainability: i) a positive response of primary balances to debt (Bohn, 1995) and ii) the response of primary balances to debt should be higher than the growth adjusted interest rate (Ghosh et al., 2013). This paper revisits these conditions, both from the theoretical and empirical perspective. It introduces a new "implicit growth" measure which is the relevant one for the debt-to-GDP ratio dynamics. It also tests empirically both conditions for economies in the region. The results suggest that debt is likely sustainable in the region, although it cannot be assured at a 95 percent confidence level. A deep look at the causes of this results pointed towards fiscal fatigue, the fact that primary balances become less responsive to debt levels the higher the latter are. At post-pandemic debt levels sustainability is far from certain. The results here indicate decisive action is required to ensure debt will fall back to prudent levels.

JEL classifications: H62, H63, F34, E60
Keywords: Debt sustainability, Fiscal reaction function, Primary balance, Debt-to-GDP ratio

[1] We are grateful to Ugo Panizza, Andrew Powell, Theresa Ter-Minassian and Oscar Valencia for very useful comments and suggestions to early versions of this work. The opinions expressed here are only attributable to the authors and neither to the Inter-American Bank nor the World Bank. All errors are ours. Email: Juan Manuel Hernández: juanhe@iadb.org; María José González Jaramillo: mj.gonzalezjaramillo@gmail.com.

1. Introduction

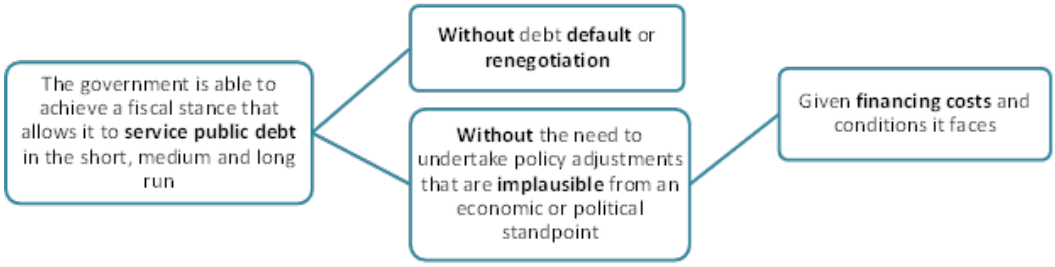
Debt sustainability is one of the fundamental pillars of public finances. Adequate and responsible management of the public debt is necessary for the efficient and smooth provision of public goods. The countercyclical management of fiscal policy requires that countries can finance themselves in moments of fiscal stress while generating confidence in their ability to repay in the future. In Latin America and the Caribbean (LAC), sovereign debt has been an essential buffer during economic crises, particularly during the COVID-19 pandemic. However, challenges remain to achieving countercyclicality, as fiscal efforts in good times have not always been enough to bring back debt to its pre-crisis levels. In the current context, the debt has displayed sinuous increases relative to the levels seen the last decade. That brings debt sustainability to the forefront of the region's policymakers' agenda.

Over the last decades, the discussion of public debt sustainability has increased substantially, involving academics, policymakers, and financial markets participants. Recently, there have been several attempts to define and explain the concept theoretically and develop methods to assess debt sustainability quantitatively, for example, D'Erasmo, Mendoza and Zhang (2016), Debrun et al. (2019), and Blanchard (2021). This paper defines debt sustainability and identifies it with a sequence of necessary conditions, beginning with universally accepted requirements and refining them due to the particularities of emerging economies, then it presents an empirical assessment of the region's public debts following the theoretical exposition based on the estimation of fiscal reaction functions, both linear and non-linear, to identify fiscal fatigue episodes and the implications for debt sustainability.

2. Public Debt Sustainability Theory

To establish this paper's scope, a public debt is said to be sustainable when the government's fiscal stance is *able* to service public debt in the short, medium and long run, taking into account its financing conditions and without implausible policy adjustments, default or renegotiation. This definition is akin to Neck and Sturm (2008), IMF (2003), D'Erasmo, Mendoza and Zhang (2016), and Debrun et al. (2019), and illustrated in Figure 1 below.

Figure 1. Debt Sustainability Definition



The fiscal stance is then the sequence of current and future primary balances, which is a stochastic process. This sequence reflects current and future fiscal policies and macroeconomic developments in the economy. The plausibility of fiscal policy is the likelihood that the prescribed path is attained, considering the macroeconomic framework as well as the political constraints of tax and expenditure policies.

Financing conditions are endogenous to debt sustainability. Markets charged interest rates increase as debt grows, as they perceive a higher likelihood of debt being unsustainable. Therefore, taking financing conditions as given means governments must be able to repay debts at the prevailing equilibrium interest rates generated by their actions as well as other shocks hitting the economy.

Debt sustainability is close to but not the same as the sovereign being solvent. The concept of solvency is equivalent to a positive net worth, meaning assets are enough to cover liabilities. Given that an asset value is intrinsically related to the cashflow it generates, having more assets than liabilities implies the cashflow assets generate for the entity is enough to pay all debts over time.

However, it is difficult to value a sovereign's non-financial assets, like highways, government buildings, people's human capital and natural biodiversity. In addition, these cannot be seized by creditors. Besides, governments have contingent and other non-financial liabilities, like public servant wages in the years to come, that are not accounted as government obligations even though they may imply a future negative cashflow. Therefore, the solvency concept for countries relates to the sovereign's ability to generate enough *free* cashflow to meet its financial obligations. That free cashflow is known as the primary balance, the government's net operating surplus or deficit. It excludes interest payments form the overall balance. The sovereign financial

obligations are generally equated to public debt, but recently the concept has widened to account for other financial liabilities, like underfunded pension systems or contingent liabilities.

In the literature on sovereign debt, a distinction is often drawn between solvency and liquidity. An entity is (il)liquid if, regardless of whether it satisfies the solvency condition, its liquid assets and available financing are (in)sufficient to meet a debt payment coming due. Through history, several solvent sovereigns have faced liquidity crises. These events tend to arise when a significant amount of debt comes due. A government may face shocks and external conditions that impair its ability to issue new debt to repay partially or totally the old one, while having the capacity to generate primary balances in the future to credibly meet its obligations in net present value. When borrowers refuse to roll-over debt, they force the economy into a debt crisis and default. Sovereign liquidity risk management is critical for the macroeconomic outlook, but its causes are beyond debt sustainability and more related to debt management.

However, solvency and liquidity cannot be totally separated, as financing conditions affect both. For example, a sovereign that is perceived as facing liquidity problems will likely need to pay higher interest rates. If those interest rates increase too much, then the sovereign may also become insolvent. So liquidity problems can provoke insolvency. At the same time, if a sovereign is perceived as being insolvent, access to markets may be curtailed, triggering a liquidity crisis, preempting any default due to a lack of solvency.

That current financing conditions depend on *perceived* future solvency and liquidity risks opens the door for self-fulfilling crises, as in Calvo (1988) and Cole and Kehoe (2000). When economic fundamentals are strong, even if interest rates rise the sovereign clearly remains solvent, precluding the risk of a debt crisis. At the other extreme, when fundamentals are weak, a debt crisis might be unavoidable. Self-fulfilling crises may occur when fundamentals are in an intermediate zone; if creditors worried about the future charge a higher interest rate today the debt becomes unsustainable, justifying then the creditors' high interest. But if creditors agreed to charge a low interest rate, debt remains sustainable, consistent with creditors' lower rate. In this intermediate zone, there are multiple equilibria (see Calvo, 1998; Cole and Kehoe, 2000; and Ayres et al., 2018 for analysis). The outcome is difficult to predict since it depends on whether creditors coordinate on the good (low interest rate and sustainable debt) or the bad (high interest rate and unsustainable debt) equilibrium. As long as the sovereign remains solvent under the good *equilibrium* prices, the sovereign's debt is considered sustainable but vulnerable to liquidity risk.

With concepts and definitions in place, the next subsection delves into the mechanics of debt accounting and debt sustainability, leading to the first testing procedure for debt sustainability.

2.1. First Necessary Condition: No Ponzi

To begin, the sovereign's debt-to-GDP ratio evolves period by period according to the following accounting relation:

$$d_t = \frac{(1+r_t)}{1+g_t} d_{t-1} - pb_t \tag{1}$$

where $pb_t \equiv \tau_t - exp_t$ is the primary balance to GDP ratio, d_t is the debt to GDP ratio at the end of period *t*, g_t is the GDP growth rate and r_t is the interest rate *paid* on government debt.

The intertemporal government budget constraint (IGBC) or no-Ponzi condition arises from replacing forward the debt dynamic equation (1) and imposing the transversality condition:[2]

$$d_{t-1} \leq \sum_{j=0}^{\infty} \left[\prod_{i=0}^{j} (1+g_{t+i})(1+r_{t+i})^{-1} \right] pb_{t+j} \tag{2}$$

This equates debt at the end of period $t-1$ to the net present value of *future* primary balances, ruling out schemes where debt grows exponentially and its never repaid. A Ponzi dynamic for debt is when the government finances existing debt by issuing new debt. This would cause debt to grow faster and faster to unrealistic levels in relation to country (or world) income. Such a scheme is bound to fail at some point.

Evaluating the no-Ponzi condition requires knowledge about future primary balances and interest rates *paths*. That implies in turn making assumptions about the institutions, government choices and market conditions prevailing each period.

One of many ways to model or interpret a sovereign's fiscal behavior is the fiscal reaction function (FRF). It describes how the primary balance reacts to the public debt from the previous period. In its simplest form, this relationship can be described by the following equation:

$$pb_t = \mu + \rho \cdot d_{t-1} + \varepsilon_t, \tag{3}$$

[2] The transversality condition states that the net present value of the residual debt is zero. When the sovereign has a terminal time T, it implies $d_T \leq 0$. For infinitely lived agents it becomes a limit:
$\lim_{T\to\infty} [\prod_{i=0}^{T}(1+g_{t+i})(1+r_{t+i})^{-1}] d_T \leq 0$.

where ρ determines the strength of the fiscal reaction (the higher was debt in the previous period then the higher the fiscal surplus in the current period) μ is an intercept, and ε_t is a stochastic fluctuation that may include other macroeconomic variables, trends, and random perturbations.

The FRF gained importance after a series of papers by Bohn (1995, 1998, 2007, 2008) where he proposed a *sufficient* condition on the FRF that implies the no-Ponzi condition. Bohn showed that if there is a threshold $\underline{d}$ such that whenever debt is above it ($d_t > \underline{d}$) the primary balance's response to the public debt is positive ($\rho > 0$), then the no-Ponzi condition holds, that is the net present value of primary balances is greater than current debt.

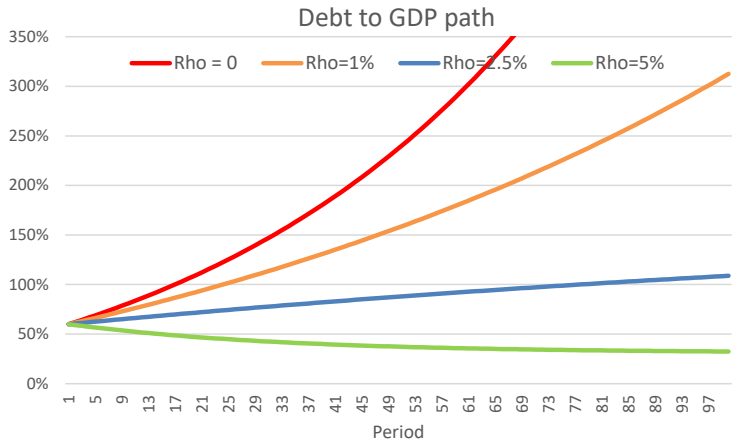
The result holds under many specifications of the FRF. Its robust the inclusion of control variables, as long as they are stationary after taking differences. It is also robust to (Co)-Integration of any finite order between the primary balance and debt.[3]

Two things are important to notice about Bohn's result. First, it considers how the primary balance reacts *when debt is high*. While is intuitive to think that a government profligacy when debt is low says little about debt sustainability, it becomes relevant when attempting to estimate the ρ coefficient. Second, there is no role for the interest rate or the economy growth rate.

To further understand this feature, Figure 2 shows simulations of the path of debt to GDP for several values of ρ. The starting point is a debt-to GDP ratio of 60 percent, and it assumes the primary balance follows a deterministic FRF ($\varepsilon_t = 0$) with intercept at -1 percent. For the debt dynamics it assumes a constant growth rate of 3 percent and a constant interest rate of 5 percent.

[3] The result hinges on the dominance of exponential growth over polynomial growth. Series with integration order *n*, denoted *I(n)*, become stationary after taking differences *n* times, which means the original series is a polynomial function of a stationary variable. In practice, most macroeconomic series become stationary after taking first differences.

Figure 2. Debt to GDP Paths: Simulations Depending on the Strength of the Fiscal Reaction



Source: IDB staff calculations.
Note: These simulations assume the primary balance follows a deterministic FRF with an intercept of -1 percent, a constant GDP growth rate of 3 percent and a constant interest rate of 5 percent.

The lowest trajectory (green) in Figure 2 corresponds to a high response FRF, $\rho = 5\%$. With such high response, the debt-to-GDP ratio converges to 31 percent, a path of a sustainable debt. On the other hand, the most explosive path in Figure 2 (red) corresponds to a coefficient $\rho = 0$, that is, a primary balance that does not react at all to debt. Debt to GDP grows exponentially and is never paid back, a clearly unsustainable path.

There are interesting cases when the parameter ρ takes intermediate values. When $\rho = 2.5\%$, the debt-to-GDP ratio converges to 174 percent and the primary balance converges to 3.4 percent of GDP. This is a high debt ratio, but the no-Ponzi condition is satisfied, and debt is not exploding. Several advanced economies maintain high debt ratios seemingly without risk of a crisis. But for an emerging economy, while solvent, the country might well be vulnerable to a liquidity crisis with a high ratio.

While both $\rho = 5\%\ and\ \rho = 2.5\%$ imply debt to GDP ratios that stabilize debt, the macroeconomic implications are different. With a faster reaction in the primary balance to the debt ratio, ($\rho = 5\%$), debt will fall more quickly, less interest will be paid, the final debt level will be lower and the required fiscal surplus to maintain that debt level will be less, but the adjustment may be harsher. A slower (albeit positive) reaction of the fiscal surplus to the debt level implies a more gradual adjustment, higher interest bills for longer and a higher debt level when debt

stabilizes, implying a higher primary surplus will then be needed to ensure sustainability which in turn implies more distortionary taxation.

The second highest path for the debt-to-GDP ratio in Figure 2 (orange), corresponds to an FRF with $\rho = 1\%$. Here debt is rising and continues to rise. In fact, debt to GDP would always be rising, and yet the no-Ponzi condition is also satisfied as the primary balance to GDP ratio also continues to rise. While debt growing to infinity is usually concerning, it is not necessarily bad if primary balances grow accordingly. For example, in nominal terms, sovereign debts are always increasing unboundedly on a balanced growth path.

Theoretically the country is solvent, the net present value of future primary balances covers the value of current debt, and yet it seems unrealistic to think that the primary balance to GDP ratio can rise without limit. It is reasonable to assume there is an upper bound on the primary balances *in proportion to GDP*. It is hard to achieve, not to mention sustain, primary balances larger than 100 percent of GDP. This is a very generous upper bound on the primary balance, as it fails to consider the inverted-U shape of the Laffer curve. At that level, distortionary taxation would severely reduce GDP and revenues would have to exceed production permanently. That implies the existence of maximum attainable primary balance to GDP ratio (pb^{max}), which fundamentally changes the debt sustainability analysis.

First, the fiscal reaction function cannot have a constant positive response of primary balance to all debt levels, because for exceptionally large debts the implied primary balance would surpass the maximum attainable. By definition, pb^{max} happens at a debt level d^f such that the marginal response of the primary balance to debt is zero. That implies Bohn's sufficient condition will not hold.

The inability of governments to keep growing the primary balance as debt grows is known in the literature as Fiscal Fatigue, see Ostry et al. (2010), Ghosh et al. (2013), Debrun et al. (2020), and Lozano-Espitia and Julio-Román (2020). The fiscal reaction function will be non-linear and generically decreasing in debt after d^f.

Hence a path in which the debt-to-GDP ratio grows unboundedly, like the orange one in Figure 2, is destined to fail Bohn's *sufficient* condition eventually. The next subsection shows that the limit on primary balances leads to a second necessary condition: Debt-to-GDP must be bounded.

2.2. Second Necessary Condition: Debt to GDP Ratios Must be Bounded Above

The existence of a maximum attainable primary balance together with a lower bound in the interest rate, say the risk-free interest rate $\bar{r}$, gives rise to an upper bound in the right-hand side of the no-Ponzi condition. Replacing $pb_{t+j} = pb^{max}$, $r_{t+i} = \bar{r}$ and $g_{t+i} = \bar{g}$ in equation (2) leads to:

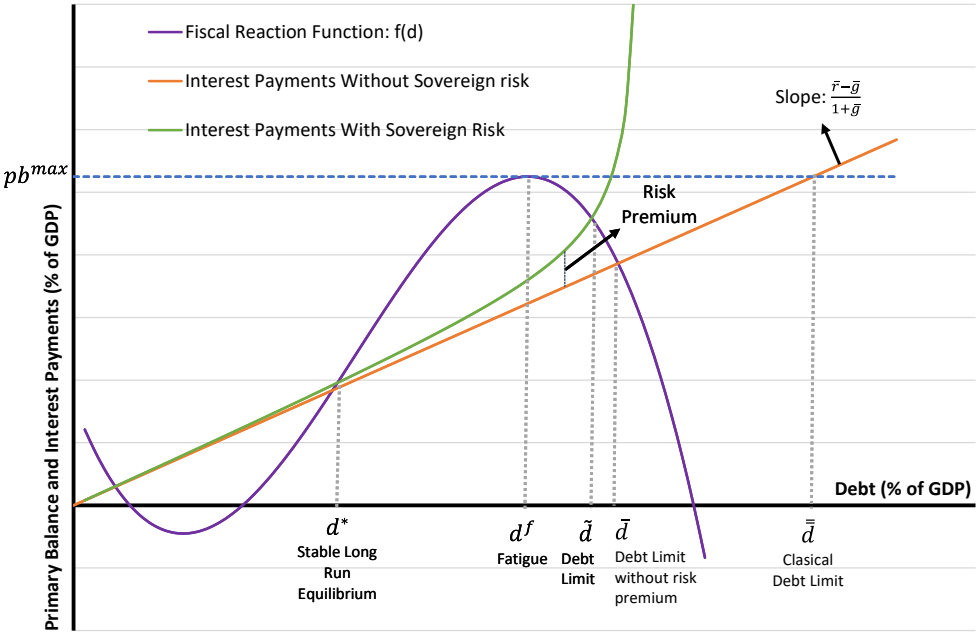
$$d_{t-1} \leq \frac{1+\bar{g}}{\bar{r}-\bar{g}} pb^{max} = \bar{\bar{d}}. \tag{4}$$

The bound $\bar{\bar{d}}$ on the Debt-to-GDP ratio appears in what is known as the classic approach to debt sustainability, discussed in IMF (2003), Buiter (1985), Blanchard (1990), Blanchard et al. (1991), Chalk and Hemming (2000), Neck and Sturm (2008), and Escolano (2010). It equates the debt interest payments at the maximum sustainable debt, adjusted by growth, with the maximum primary balance attainable in proportion to GDP. The net present value of primary balances is bounded above by $\bar{\bar{d}}$, any debt greater than that fails the no-Ponzi condition for sure. In that case, default or renegotiation is unavoidable, as the government cannot meet its obligations. Under the classic approach, any debt ratio below $\bar{\bar{d}}$ is sustainable, as the corresponding primary balance can be attained to keep debt-to-GDP constant.

The $\bar{\bar{d}}$ in equation (4) is not necessarily the maximum sustainable debt, as the FRF is generally decreasing in debt at high levels—Fiscal Fatigue. Hence a second upper bound $\bar{d}$ appears, the intersection of the FRF and the debt interest payments at the risk-free rate. Figure 3 depicts the FRF and the critical debt values.

In the deterministic case, without stochastic shocks to the primary balance ($\varepsilon_t = 0$), all debt levels up to $\bar{d}$ are sustainable and pay the risk-free rate in equilibrium. Stationary equilibria occur at all points where the FRF crosses the debt risk-free interest payments line (colored orange in Figure 3), $\bar{d}$ is the highest of them. Dynamically stable stationary equilibria are located where the FRF crosses the debt interest payments curve from below. These points are associated with stable long-run equilibria; whenever the starting debt level is not too far away in time debt will reach them. Crucially, $\bar{d}$ is not one of them. If debt is slightly above $\bar{d}$ it will inevitably grow to infinity. If it is below $\bar{d}$, debt will start contracting until it reaches a stable long-run equilibrium or until the sovereign repays all debt and accumulate net assets.

Figure 3. Fiscal Reaction Function and Debt Interest Payments



Source: IDB staff calculations.
Note: Interests payments are net of average growth.

However, once random shocks to the primary balance are included ($\varepsilon_t \neq 0$), a risk premium emerges. As $\bar{d}$ is not a dynamically stable equilibrium, when debt is below but close to $\bar{d}$, a minor perturbance on the primary balance can take debt next period above $\bar{d}$ and put the economy on an explosive debt path, likely leading to default or renegotiation. But that implies the interest rate charged on that debt just below $\bar{d}$ cannot be the risk-free rate $\bar{r}$, it should include a risk premium that grows as debt approaches $\bar{d}$. Then the debt interest payment schedule must be convex in debt, like the green curve depicted in Figure 3.

Therefore, stationary equilibria are at the crossing points between the FRF and the risk-premium adjusted debt interest payments schedule. The highest of those crossing points, $\tilde{d}$ is the debt limit. Whenever debt is above $\tilde{d}$ it is on an unsustainable path, when it is below it will *likely* converge to a stable long-run equilibrium d^*

This exposition is akin to that in Ghosh et al. (2013) and, for simplicity, purposefully ignores *strategic* sovereign default—that is, the decision of a sovereign to not honor its debt commitments *when able to do so*, implying strategic default happens when debt is sustainable. Hence the government's ability to generate primary surpluses, captured by the FRF, is independent

of the default decision. However, the risk premium and thus the debt interest payment schedule is affected by the default decision.

In the sovereign debt literature (Arellano et al., 2008; Chatterjee and Eyigungor, 2012; and Mendoza and Yue, 2012) the benefits of sovereign default are proportional to the repudiated debt while the costs of default are proportional to GDP, which leads to a debt-to-GDP default threshold. Hence the qualitative analysis of the debt limits remains unchanged. The risk premium increases as the debt-to-GDP ratio approaches the strategic default threshold, which is no larger than the $\bar{d}$ level of *unavoidable default*. The interest payments curve's shape is still increasing and convex, just at a higher level. Quantitatively, the sustainable debt limit $\tilde{d}$ would be lower, but the analysis remains the same.

The literature findings are consistent with this framework of debt limits. Emerging economies have shown "Debt Intolerance," as described in Reinhart, Rogoff and Savastano (2003). They find the existence of country-specific debt levels above which the economy most likely enters a fiscal crisis, like the threshold $\tilde{d}$ described here. They also point that emerging and less developed economies seem to have lower thresholds than developed economies.

Going back to the four theoretical debt paths in Figure 2 the bottom three satisfied Bohn's condition. Still, the second highest is unsustainable as debt is not bounded. The next subsection focuses on what type of fiscal behavior prevents the sovereign from growing unbounded.

2.3. What FRF's Prevent Debt from Exploding?

Another consequence of the bounded debt-to-GDP ratio requirement is that Bohn's condition is not enough to decide if the sovereign is on a sustainable debt path. Assuming the debt thresholds are known, the goal is to determine if the economy's future primary balances path will keep debt within bounds or breach the $\tilde{d}$ threshold.

The challenge is compounded, as interest rates, growth and primary balances are all endogenous and react to debt levels. Keeping that in mind, the change in debt-to-GDP ratio follows from the debt dynamics equation (1):

$$d_t = \frac{(1+r_t)d_{t-1}}{1+g_t} - pb_t \Rightarrow \Delta d_t = \frac{(r_t - g_t)d_{t-1}}{1+g_t} - pb_t \qquad (5)$$

While remembering that FRF's are generically nonlinear, a first order *approximation* to the FRF around a particular debt level sheds light on the debt dynamics. Let the FRF's linear approximation have the form:

$$pb_t = \mu_t + \rho_t d_{t-1} + \varepsilon_t, \tag{6}$$

where the time subscript on the debt marginal effect ρ_t indicates that it is not constant. Replacing this linear form on the change in debt-to-GDP ratio equation, it follows:

$$\Delta d_t = \left[\frac{(r_t - g_t)}{1 + g_t} - \rho_t\right] d_{t-1} - \mu_t - \varepsilon_t. \tag{7}$$

In a stationary equilibrium, like d^* or $\tilde{d}$, debt stays constant in the absence of shocks, that is $\Delta d_t = -\varepsilon_t$. What makes a stationary equilibrium dynamically stable, like d^*, is the fact that when debt is slightly greater it tends to decrease, which implies:

$$\left[\frac{(r_t - g_t)}{1 + g_t} - \rho_t\right] < 0 \Rightarrow \rho_t > \frac{r_t - g_t}{1 + g_t} = \widehat{rg}_t. \tag{8}$$

Hence, to be in or near a stationary equilibrium d^*, the marginal response of the primary balance to debt (ρ_t) must be greater than $\frac{r_t - g_t}{1+g_t}$ which is known in the literature as the effective or growth adjusted interest rate, denoted $\widehat{rg}_t$. This is the same as the graphic condition found before, the FRF curve must cut the interest payment curve from below, which means the FRF's derivative at the crossing point, denoted ρ^*, must be greater than the interest payment curve derivative, which is the growth adjusted interest rate.

In the theoretical examples from Figure 2, both paths with bounded debts satisfy condition (8). However, in these cases all coefficients ($\bar{\rho}, \bar{r}, \bar{g}$) are constant. In reality, when debt increases the interest rate grows due to the default risk premium, growth falters due to the debt overhang, and ρ falls as fiscal fatigue kicks in. All together make condition (8) less likely to hold the higher the debt.

3. Empirical Assessment of Debt Sustainability in LAC

Assessing debt sustainability requires knowledge of the FRF to identify both the debt thresholds and the marginal response of the primary balance to debt. Exogenous shocks may drive debt close or past the level d^f where fiscal fatigue appears. At that level, negative shocks to the primary

balance are amplified in the next periods, as they imply lower primary balances, higher interest rates and thus higher debts. Hence, observing debt levels associated with fiscal fatigue serves as an early warning for debt crises.

Building up in the theory discussed above, the empirical assessment of debt sustainability in LAC begins with estimating the Fiscal Reaction Functions (FRFs) of the region's economies. The coefficient of debt: ρ, is critical for both the no-Ponzi condition and the debt boundedness condition.

Many analyses have been made estimating the FRF and calculating the ρ coefficient for emerging and developing economies. For example, D'Erasmo, Mendoza and Zhang (2016) calculate the FRF for the United States for the years of 1791 to 2014, and for advanced and emerging economies from 1951 until 2013. Ghosh et al. (2013) used the FRF approach to estimate the fiscal space, the difference between current debt ratios and the estimated debt limit.

Historical LAC data to estimate FRF's comes from standardized databases, like the World Economic Outlook Database, and national sources. It covers the 26 LAC countries, comprising an unbalanced panel of 731 country-year observations. Borrowing from the most common specifications referenced in the literature, the main variables included are the primary balance, gross debt, GDP, inflation, primary government expenditure, and exchange rate for countries in LAC. Time availability for some countries goes back to 1953, and data are capped in 2019 to avoid the COVID-19 debt surge.[4] Details about data availability for each country are in the Appendix.

3.1. Linear FRF Estimation

The rationale for a linear FRF estimation, after acknowledging FRF's are generically nonlinear, resides in the fact that economies tend to gravitate towards the stable long run equilibrium d^*. That means the estimation of a linear FRF should retrieve, in the ρ coefficient, the slope of the FRF in a vicinity of d^*. A negative ρ means on average the economy is a declining part of the FRF, which could point towards fiscal fatigue and an unsustainable debt path. When positive, it indicates that sovereign fiscal behavior quickly reacts to higher debts, avoiding fiscal fatigue. A positive coefficient can be compared with the average interest and growth rates to assess if the economy has been converging to a stable point.

[4] Public debt rose significantly during the pandemic in LAC economies. Given the shock's size and that is still early in the recovery, primary balances have not yet reacted to the high indebtedness, which could bias the FRF estimation.

A general version of a linear Fiscal Reaction Function (FRF) for country i has the following specification:

$$pb_{i,t} = \mu_i + \rho_i \cdot d_{i,t-1} + \Omega_i x_{i,t-1} + \varepsilon_{i,t}, \quad (9)$$

where $pb_{i,t}$ is the fiscal balance of country i in year t, and $d_{i,t-1}$ is the debt in the previous year. The coefficient ρ_i then determines the strength of the reaction of the fiscal balance to debt. To avoid endogeneity, debt appears as a lagged variable. The control matrix $x_{i,t}$ contains variates that affect the primary balance, in addition to debt, that are common in the literature. It includes the GDP cycle, government expenditure cycle, domestic inflation, exchange rate appreciation, and a linear trend. The error term follows an AR(1) process, $\varepsilon_{i,t} = \alpha\varepsilon_{i,t-1} + u_{i,t}$, to account for persistent omitted variables that could make up for serial autocorrelation in the errors. All together comprise the baseline model specified in equation (9).

The main challenge for the FRF estimation is the time series length. Few LAC economies have data available for long enough to make an independent estimation sensible. Panel A of Figure 4 shows the results for the coefficient of the lag debt (ρ_i) of the baseline model, for the 10 countries for which the estimation has more than 30 data points after excluding default periods and periods of inflation above 150 percent: Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Peru, Paraguay, and Uruguay. Including default episodes may bias the ρ coefficient *downwards*. This is because the act of repaying debt when high, by generating higher primary surpluses, is a critical part of the variation captured by the ρ coefficient. On the other hand, default episodes are characterized by higher debt levels that are reduced not by fiscal surpluses but by haircuts. That weakens the correlation between debt and primary balances. That is the reason we decided to exclude default episodes. Data for default episodes and their duration comes from Reinhart and Rogoff (2009) and from the database of defaults from the Bank of Canada and the Bank of England (Beers et al., 2021).

Only in three economies—Colombia, Mexico, and Peru—does the estimation point to a positive and significative (ρ_i) satisfying Bohn's condition. Given the short length of these series, it is not surprising that the results for the remaining countries are inconclusive.

One way to address the lack of power of the individual countries FRF estimations is pooling together all countries in the region, as Ghosh et al. (2013) did for Europe. Estimating the fixed effect panel specification in equation (10) delivers a coefficient (ρ_{FE}) for the region. This

estimation takes advantage of the full sample of 26 countries with a total of 731 country-year observations. The resulting coefficient, shown in Panel A of Figure 4, is positive and significative at 95 percent, due to the small confidence interval attained with the pooled estimation.

$$pb_{i,t} = \mu_i + \rho_{FE} \cdot d_{i,t-1} + \Omega_{FE} x_{i,t} + \varepsilon_{i,t}. \quad (10)$$

The main caveat of the fixed effect estimator ρ_{FE} is that it could be masking heterogeneity not captured by the country individual intercept μ_i. When economies are similar both in both the shocks they face and in the fiscal institutions they have had in the sample, the ρ_{FE} coefficient reflects the marginal response of the primary balance to debt in *all* economies. Ghosh et al. (2013) argue this is a plausible assumption for the European Monetary Union economies, which are bound fiscally by the Maastricht Treaty, although some differences remain.

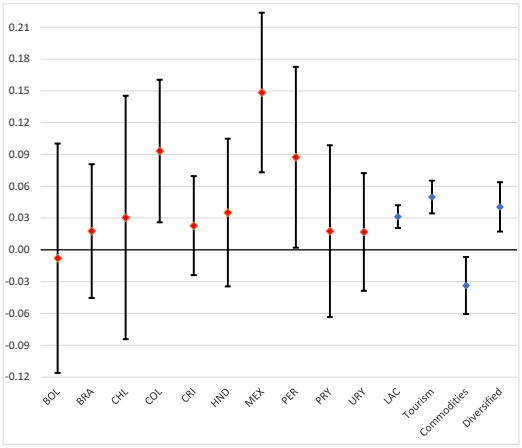
LAC economies differ in their fiscal institutions (FRF shape), as well as in the nature of the economic shocks they face (points of the FRF observed). That produced vastly different fiscal histories (debt paths) among countries in the region in recent decades. Hence, the region's ρ_{FE} coefficient reflects the cross-country *average* marginal response of the primary deficit to debt. Still, it is important to highlight that the positive ρ_{FE} reflects the strengthening of the region's fiscal institutions. While data for making a formal comparison are limited, Figure 5 shows the rolling coefficients, indicating ρ_{FE} was smaller during the 1980s debt crisis and subsequent lost decade and improved recently.

Dividing the sample of LAC countries according to their main exports (commodities, tourism or diversified) partially addresses the heterogeneity caveat, by grouping together economies exposed to similar external shocks, without losing too much power due to lack of observations.[5] Estimating equation (10) once per group produces three new ρ_{FE} coefficients, shown in Panel A of Figure 4. The marginal responses for tourism and diversified groups are positive and significative, while the one for commodities group is negative and significative.

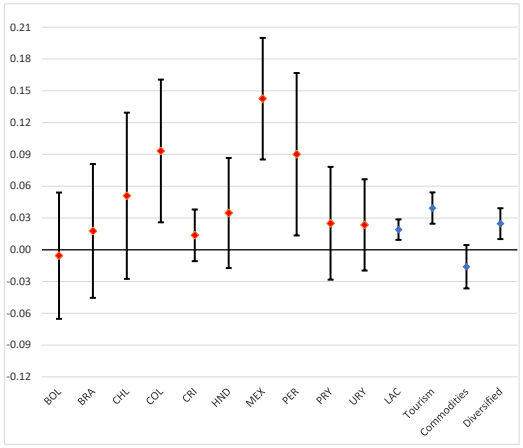
[5] This classification follows Cavallo et al., editors. (2022). Tourism countries had at least 15 percent of their total exports from tourism, commodities group includes countries whose exports of goods consist of at least 60 percent commodities. The rest of the countries are in the diversified group. For more details see the Data Appendix.

Figure 4. Debt Marginal Effect on Primary Balances

A. Baseline Model



B. Baseline Including Default Episodes



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: The point is the estimated coefficient of lag debt, while the error bars are the 90 percent confidence interval. See Section 3.1 for a definition of the Baseline model. Tourism group includes: The Bahamas, Belize, Barbados, Dominican Republic, Jamaica, Haiti, Panama, and Uruguay. Commodities group includes: Bolivia, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, and Venezuela. Diversified group includes: Argentina, Brazil, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Trinidad and Tobago.

The baseline estimation omits default episodes when estimating the ρ coefficient. Panel B of Figure 4 shows the same marginal effects of debt on the primary balance (ρ) when *including* the default episodes, thus averaging the response in default and non-default periods. Consistent with the intuition, the point estimates are no higher than their counterparts in Panel A.[6] However, estimating the ρ's using all the periods slightly tightens the confidence intervals.

To see the evolution of the fiscal reaction function through time, Figure 5 shows the rolling coefficients ρ_t for each group, obtained by capping the data sample at year t. As years are included, estimates become more precise. LAC's coefficient has mostly maintained a positive value since the middle of the 1990s. The same has happened to the tourism group and the diversified group.

[6] This is true for the group coefficients excluding "commodities" and most of the individual country coefficients. Paraguay and Uruguay show higher coefficients, both their new confidence intervals are contained in the old ones, which points towards a more precise estimate. Chile and Peru marginal responses become positive and significative once default periods are included. Chile is identified as in default between 1983 and 1990 and Peru between 1983 and 1997 by Reinhart and Rogoff (2009). However, both countries made considerable fiscal adjustments in these years, (Chile 1987-1990, Peru 1991-1997), generating sizeable primary balances and driving down debt which increases the estimated response of the primary balance to debt (Caputo and Saravia, 2021; and Martinelli and Vega, 2021).

That is consistent with the debt crisis of the 1980s in the region, and the time it took to build up good will in the markets.

Figure 5 . Marginal Response of Primary Balance to Debt over Time

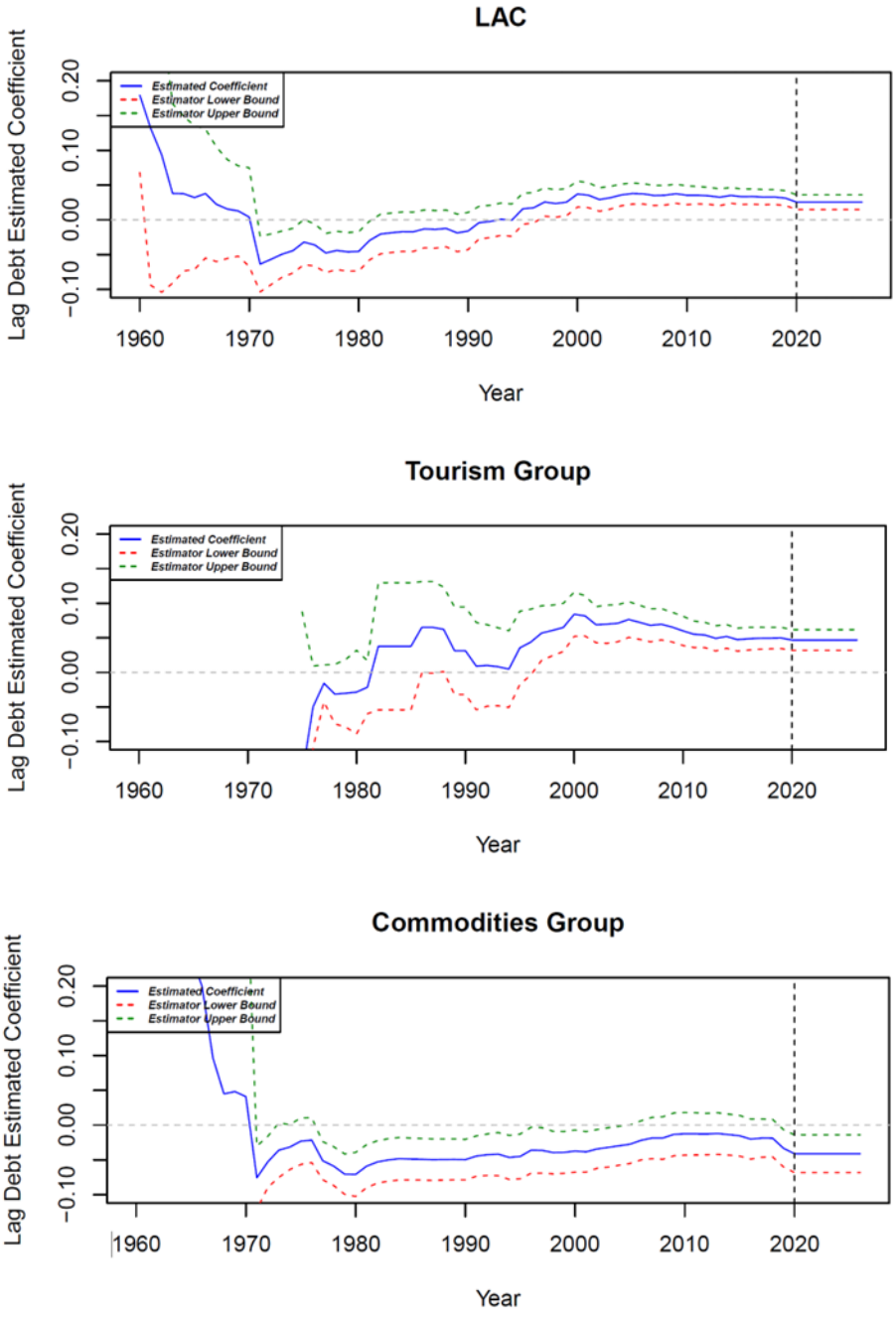
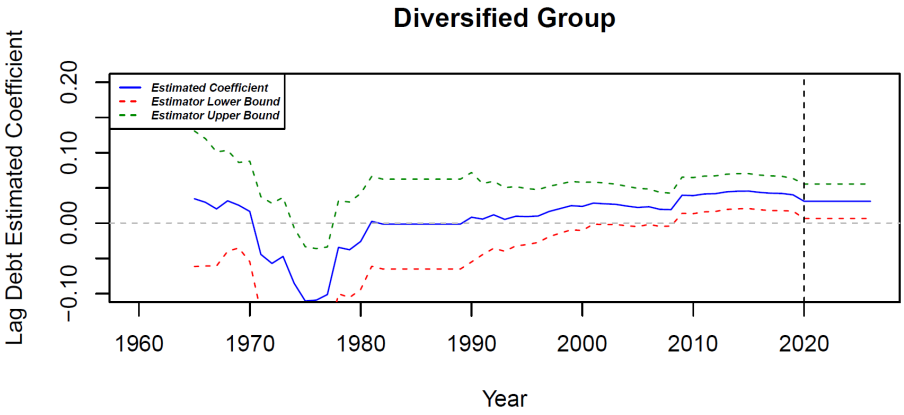


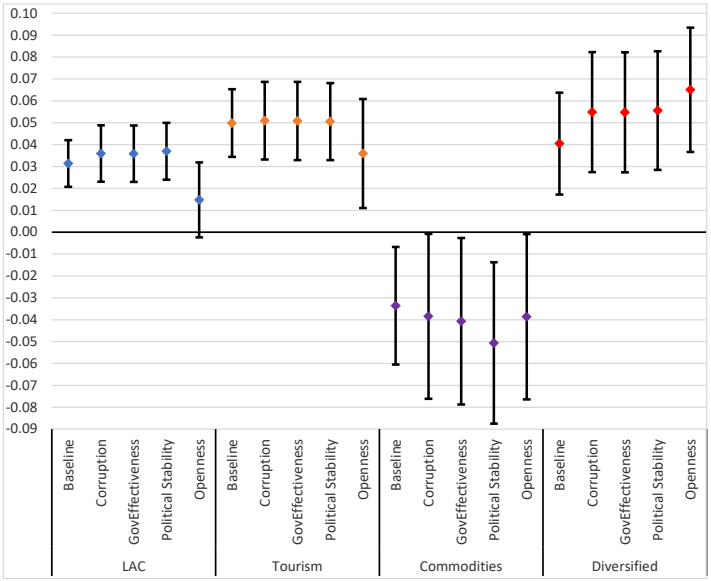
Figure 5., continued



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: Blue line displays the rolling coefficient of the baseline model. Dashed lines show the lower and upper bounds that are the 90 percent confidence interval. See Figure 4 for a description of the baseline model and the countries included in each group.

In the last few decades, the literature has brought to relevance institutional variables like corruption perception, trade openness, government effectiveness, political stability as key determinants of macroeconomic stability and thus debt sustainability (see Mauro and Zhou, 2020; Fournier and Bétin, 2018; and Grosu, Pintilescu, and Zugravu, 2021). The Fiscal Reaction Function (FRF) implicitly reflects the institutional environment underlying fiscal policy, hence including these variables in the estimation may increase its explanatory power. Unfortunately, the data availability for them is very limited, going no more than 30 years back for LAC economies (see Data Appendix). Hence their inclusion precludes the individual country estimations and severely restricts the sample.

Figure 6. Marginal Response of Primary Balance to Debt with Institutional Controls



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: The point is the estimated coefficient of lag debt, while the error bars are the 90 percent confidence interval. See Figure 4 for a description of the baseline model and the countries included in each group.

Figure 6 shows the marginal effect of debt on the primary balance for the baseline model and four additional estimations each one including one of the institutional variables mentioned before. To make it comparable, the sample used for the baseline model results in this case is the same as the one shared by the estimations with corruption, government effectiveness and political stability controls. The results of the estimation with these institutional controls are not significatively different from those of the baseline model for each of the groups and for the whole region. Given the observation loss that the inclusion of these variables implies, more than 40 percent of the original sample, the estimations in the rest of this paper will dispense with them. The omitted variable bias should be mitigated by the autoregressive structure of the error term and the trend control capturing the institutional strengthening seen by the region in the last few decades.

3.2. Interest and Growth Rates

After a first estimation of the marginal effect of debt on primary balances in the region, it is necessary to gather knowledge about interest and growth rates to assess the debt dynamics and determine their stability.

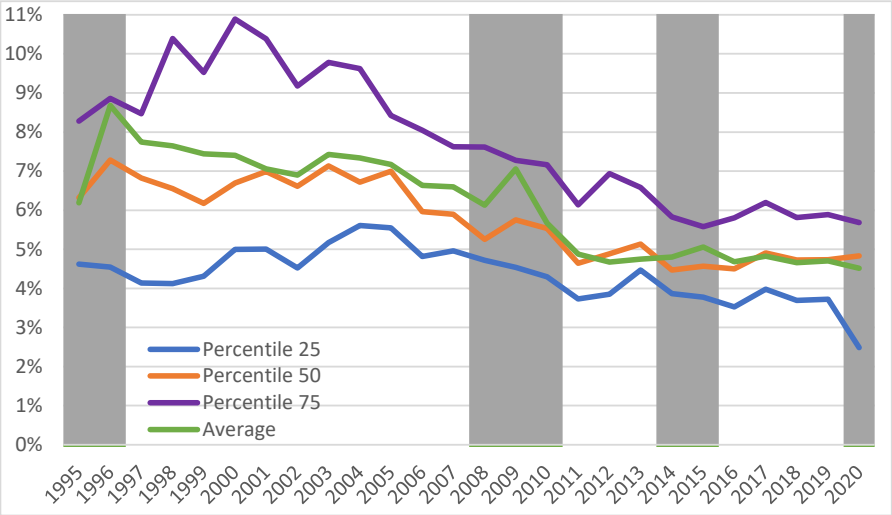
There is no such thing as the single interest rate on public debt. Sovereign debt comprises many lenders and instruments, each deal having its own terms and conditions, including denomination, maturity, and corresponding interest rate. Which of them is the one relevant for debt sustainability?

In nominal terms, the overall government balance OB_t is equal to the primary balance PB_t minus the interest payments INT_t. Given a debt stock at the end of the previous period D_{t-1}, the effective interest rate is implicitly defined from $INT_t = r_t D_{t-1}$, hence r_t is a principal weighted average of the interest rates on each bond or loan outstanding. Since it is the interest rate entering debt dynamics equation (1), it is the relevant one for debt sustainability.

However, the implicit interest rate is closely related to the market interest rates the sovereign faces. As sovereigns issue debt at multiple maturities, the implicit interest rate becomes a moving average of the rates prevailing at the time of issuance. Also, it blends the domestic and foreign currency interest rates according to its participation in outstanding debt, including changes in the interest rate paid on foreign currency debt due to exchange rate fluctuations. Thus, the implicit rate may lag developments in interest rates for currently issued debt, but in the long run it will always catch up.

The previous considerations imply that debt composition has an impact on the implicit interest rate. Debt management delves into the optimal debt mix, weighting not only debt sustainability goals but also liquidity and external shock vulnerability. This paper takes debt management as a given; see Powell and Valencia (2023) and references therein for a complete take on sovereign debt management.

Figure 7. Average and Median Public Debt Implicit Interest Rates for LAC



Source: IDB staff calculations based on data from Mauro et al. (2013), and IMF (2021).
Note: r refers to the implicit interest rate.

Figure 7 shows the evolution of the implicit interest rate on public debt for economies in the region. By the end of the 1990s and at the beginning of the current century, the median LAC economy was paying around 7 percent of its outstanding debt in interests each year. Ample international liquidity and growth in multilateral lending at low rates, brought the median implicit interest rate to levels between 4 percent and 6 percent during the last decade.

In the same fashion than with the interest rate, a question emerges about which growth rate is the appropriate one to use when talking about debt sustainability. Debt is usually presented as a debt-to-GDP ratio, because GDP reflects the total tax base the government can access to repay it. Real GDP growth accounts for the additional goods and services produced by the economy, which lessen the debt burden as tax receipts usually grow with GDP. If all debt were denominated in a basket of goods, like inflation-indexed bonds, the real growth rate would be the relevant one for debt sustainability.

However, in LAC economies a significant amount of public debt is denominated in domestic currency. Hence inflation reduces the debt burden in real terms, diluting the real value of debt and making a strong case for the use of nominal GDP growth rates. Nevertheless, debt not denominated in domestic currency, like foreign currency or indexed debt, will not be diluted by inflation. Quite the opposite occurs: during high inflation periods, exchange rate depreciation

substantially increases the debt burden in economies with a large amount of dollar-denominated debt. This points towards the growth rate of GDP in dollars.

In the same fashion as with the implicit interest rate, the growth rate g_t that appears in the debt dynamics equation (1) is a weighted average of the nominal, real and dollar GDP growth rates, where the weights are the fraction of debt denominated in each of these units. It can be recovered implicitly from the debt dynamics equation:

$$d_t = \frac{(1+r_t)}{1+g_t} d_{t-1} - pb_t = \frac{d_{t-1}}{1+g_t} + \frac{r_t D_{t-1}}{Y_t} - pb_t = \frac{d_{t-1}}{1+g_t} - \frac{OB_t}{Y_t}, \tag{11}$$

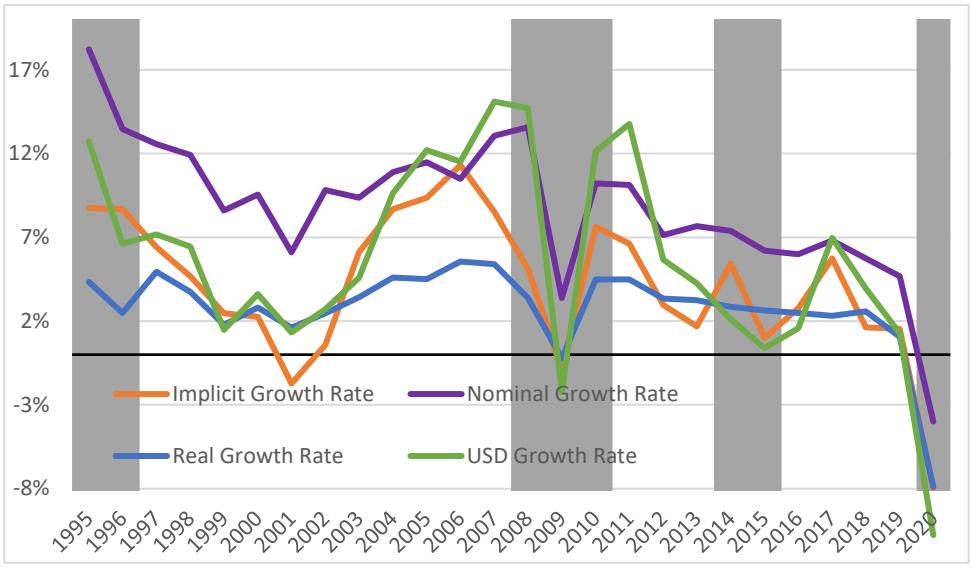
where $\frac{r_t D_{t-1}}{Y_t}$ is the interest paid on debt in period t as a fraction of GDP, and OB_t is the overall balance. From this relationship, it follows that the implicit growth rate is:

$$g_t = \frac{d_{t-1}}{d_t + ob_t} - 1, \tag{12}$$

where all lowercase variables represent shares of GDP.

Figure 8 shows the evolution of the median implicit growth rate for LAC and compares it with the median real and nominal, both domestic currency and dollar, growth rates. As discussed above, using the real growth rate tends to underestimate GDP growth against debt, while using the nominal growth significantly overestimates it.

Figure 8. Median GDP Growth Rates



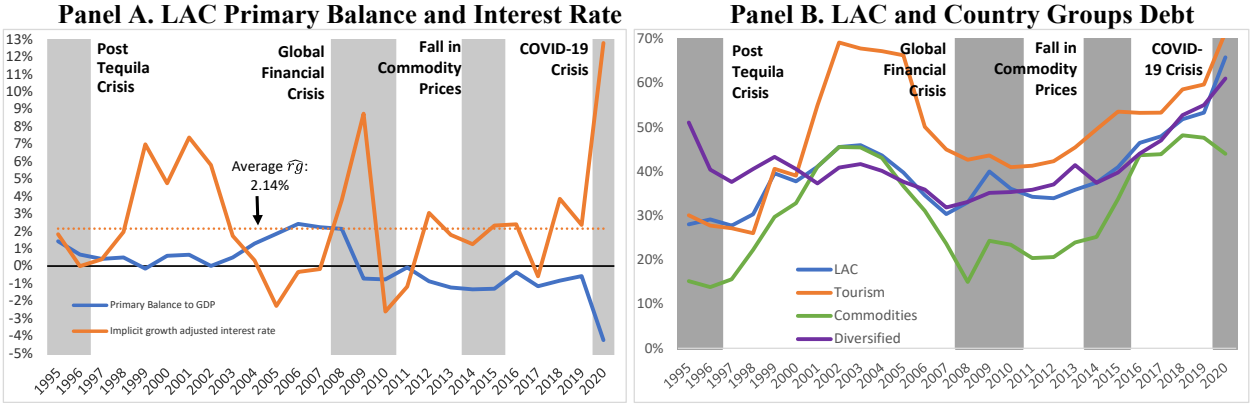
Source: IDB staff calculations based on data from Mauro et al. (2013), and IMF (2021).

An important caveat about implicit interest and growth rates is that they assume no default or renegotiation in the period. During default periods the sovereign does not pay its due interest and principal, but the debt is still accounted for in the debt statistics, which biases the implicit interest rate calculation. Also, debt renegotiation changes the outstanding amount of debt, and thus the debt-to-GDP ratio, without there being any payment or output growth. Therefore, all implicit interest and growth rates reported exclude default periods.

The derivation of the implicit growth rate also assumes away other causes of error in the debt dynamic equation, such as the stock-flow adjustment term or "below the line" budget items that provoke changes in debt. In the empirical estimations, periods with very high or low implicit growth rates are excluded. Nevertheless, the implicit growth rate captures most of the growth components of the debt-to-GDP ratio evolution and is an easy way to approximate the precise weighted average described before.

After discussing both implicit interest and growth rates, the next step is to tackle the growth adjusted interest rate, which is critical for the debt boundedness condition. One advantage of working with implicit rates is that they are perfectly consistent with the debt evolution. Panel A of Figure 9 shows the median growth adjusted interest rate (r-g) and the median primary balance as a percentage of GDP for LAC. The median growth adjusted interest rate for LAC economies is generally greater than zero, there are 419 positive and 308 negative observations in the sample. It also spikes during crises periods, which tend to coincide with deterioration in primary balances.

Figure 8. Median Primary Balance, Interest Rate and Debt (% of GDP)



Source: IDB staff calculations based on data from Mauro et al. (2013), and IMF (2021).
Note: The sample excludes default periods. r and g are the implicit interest rate, and the implicit growth rate, respectively. (r-g)/(1+g) average is the across-time average of the cross-sectional medians from 1995 until 2019.

The time average of the cross-section median growth-adjusted interest rate for the region is 2.1 percent. Within that regional average, the figures are 2.9 percent for the tourism group, 3.1 percent for the commodities group and 1.4 percent for the diversified group. In the region as a whole and in all groups except for commodities, the primary balance response to debt ρ_{FE} is greater than the interest rate with 95 percent confidence, according to the baseline model (see Figure 10). This indicates the average country in the region and these groups has been able to prevent debt from exploding, keeping it at sustainable levels.

The commodities group case is special, as its baseline estimated coefficient is negative and lower than the adjusted interest rate. This is because debt was very low in the early 1990s, and then showed the highest growth in the last 25 years among the groups, as shown in Panel B of Figure 9. In fact, is the behavior at low levels of debt, shown in Panel B of Figure 10 in the next subsection, what drives the coefficient.

3.3. Asymmetric Marginal Effects and Fiscal Fatigue

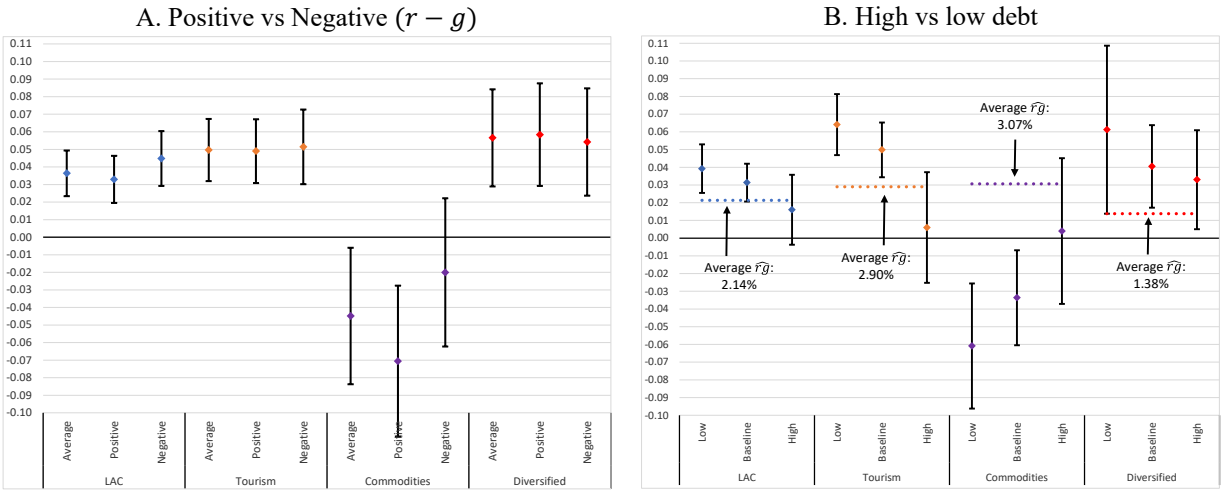
The results presented so far are about the average marginal response of the primary balance to debt. This subsection delves into the variation of such marginal response. First, the original Bohn's condition requires positive marginal responses above a certain level. This gives room for economies to be profligate when debt is low and is particularly relevant for developing economies, as they foresee high growth reducing their debt burden. Second, the region economies have faced several fiscal crises in the last 40 years, showing signs of fiscal fatigue. A full picture of the FRF is critical for understanding the region's vulnerabilities.

One particular concern from Panel A in Figure 9 is that, in the decade after the GFC, the region's median primary balances were negative, even as the effective interest rate stayed low but positive. This is consistent with the debt growing across the region. Negative growth adjusted interest rates may seem like an invitation to overborrowing, as governments have urgent needs, and a low or negative effective interest rate eases the debt burden. However, as a low $r_t - g_t$ is intrinsically correlated with high growth, governments should be deleveraging in good times.

The critical aspect for the overborrowing vs deleveraging discussion is the actual debt level. Highly indebted sovereigns are more likely to deleverage when $r_t - g_t$ is low than low debt governments, which are more likely to take on more debt. This points towards an asymmetric marginal effect of debt on the primary balance, depending on the sign of the growth-adjusted

interest rate. Including a dummy variable for negative $r_t - g_t$ periods to the baseline model and an interaction of this dummy with the lagged debt allows to quantify the asymmetric effect. Panel A of Figure 10 shows the estimation results for the extended model.

Figure 9. Asymmetric Debt Marginal Effects on Primary Balances in LAC



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: The point is the estimated coefficient of lag debt, while the error bars are the 90 percent confidence interval. r and g are the implicit interest rate, and the implicit growth rate, respectively Average $\widehat{rg}_t$ is the time average of the cross-sectional medians from 1995 until 2019 of the implicit growth adjusted interest rate. High levels of debt refer to periods where there is no default and the debt-to-GDP is above the 50th percentile of each country, while low levels of debt refer to periods where there is no default and debt is below that threshold. See Figure 4 for a description of the baseline model and the countries included in each group.

The results show that on aggregate the region's primary balances become slightly more responsive to debt when growth-adjusted interest rates are negative, suggesting an additional effort to deleverage. It is important to remember that the baseline specification controls for the real business cycle and inflation, hence the difference is indeed due to the debt level.

The converse is also telling. Economies in the region have been unable to increase their primary balances when facing high indebtedness and high interest rates, which is the time when adjustment is more critical. This is consistent with the episodes of fiscal crisis in the region since the 1980s and points towards fiscal fatigue.

Empirically identifying fiscal fatigue comes with its own challenges. The threshold d^f is not necessarily the same for all countries, and it may be not reached (barring default) due to governments implementing a fiscal adjustment or quickly falling into debt crises. The approach in this chapter seeks to find if the marginal response of the primary balance to debt diminishes when

debt is high, indicating fiscal fatigue is nearing. Fiscal fatigue is nearing when the marginal response of the primary balance to debt diminishes when debt is high.

Panel B of Figure 9 shows the results of measuring the marginal response of the primary balance to debt when it is high and compare it with that when debt is low. For each country, debt is considered high when it is above the median of the observed debt-to-GDP ratios in non-default periods. There is some evidence of fiscal fatigue for the region in the aggregate, and in the tourism and diversified groups.

The results, shown in Figure 10, indicate that for the average economy in the region and in each group the point estimate of the primary balance response when debt is high (above its country median), is smaller than the growth-adjusted interest rate, although statistically cannot ruled out to be greater with 95 percent confidence. As shown in Figure 9, public debt-to-GDP ratios in the region are well above their historical levels, making fiscal fatigue a reality across LAC and pointing towards vulnerabilities and risk of fiscal crises.

Putting more structure into the Fiscal Reaction Function (FRF) can help alleviate the identification concerns, because at moderate debt levels, trends in the marginal effect of debt on primary balances may hint its behavior at higher levels that are not commonly observed. A polynomial FRF includes higher order terms of the lagged debt, in addition to the linear term and baseline controls. A cubic FRF is shown next:

$$pb_{i,t} = \mu_i + \rho_1 d_{i,t-1} + \rho_2 d_{i,t-1}^{+50} + \rho_3 \left(d_{i,t-1}^{+50}\right)^2 + \rho_4 \left(d_{i,t-1}^{+50}\right)^3 + \Omega x_{i,t-1} + \varepsilon_{i,t}. \quad (13)$$

where $d_{i,t}^{+50} = \max\{0, d_{i,t} - percentile_{50}^{i}\}$ measures how far above debt is from the country's 50-th percentile of debt levels (the median). With a linear FRF the marginal effect of debt is constant, with a higher order polynomial FRF the marginal effect is itself a polynomial of one degree less than the FRF. Table 1 shows the results from the estimation of the linear, quadratic, and cubic FRFs for LAC and each of the three country groups.

Table 1. Estimated Cubic Fiscal Reaction Functions

	Primary Balance															
VARIABLES	All LAC				Tourism Group					Commodities Group				Diversified Group		
Lag Debt	0.031***	0.039***	0.034***	0.031***	0.050***	0.064***	0.059***	0.055***	-0.034**	-0.061***	-0.050**	-0.044**	0.040***	0.061**	0.049**	0.044**
	(0.006)	(0.008)	(0.008)	(0.007)	(0.009)	(0.010)	(0.010)	(0.010)	(0.016)	(0.021)	(0.020)	(0.019)	(0.014)	(0.029)	(0.021)	(0.018)
Lag max{0,debt-percentile 50}		-0.023				-0.058**				0.065*				-0.028		
		(0.015)				(0.022)				(0.034)				(0.034)		
Lag max{0,debt-percentile 50}^2			-0.019				-0.077*				0.136				-0.025	
			(0.031)				(0.043)				(0.093)				(0.046)	
Lag max{0,debt-percentile 50}^3				-0.001				-0.076				0.263				-0.019
				(0.049)				(0.066)				(0.221)				(0.064)
Observations	731	731	731	731	195	195	195	195	262	262	262	262	274	274	274	274
R-squared	0.038	0.041	0.039	0.038	0.165	0.205	0.188	0.176	0.034	0.048	0.042	0.039	0.043	0.045	0.044	0.043
Baseline Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

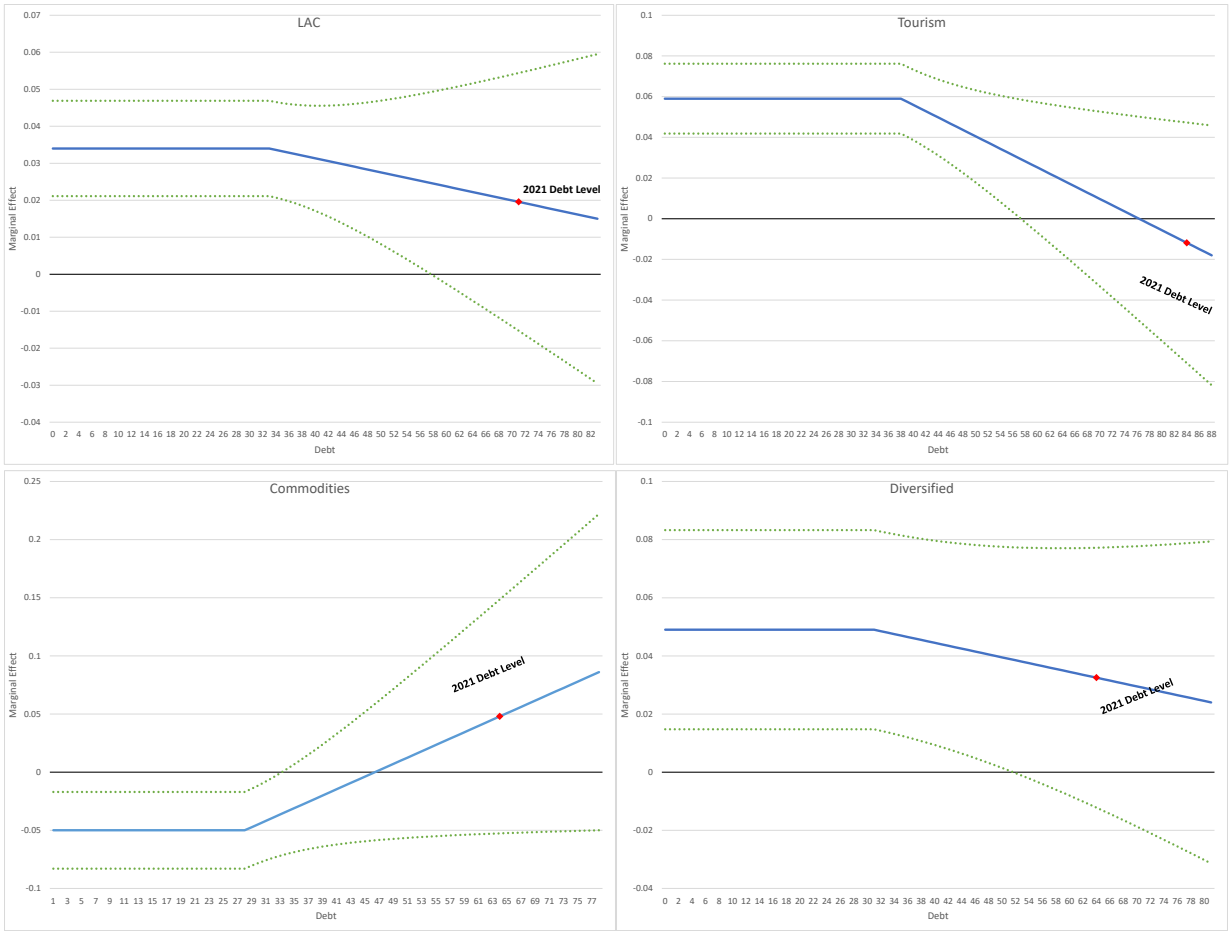
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: See Figure 4 for a description of the baseline model and the countries included in each group.

The results of the polynomial FRFs are not substantially different. The fact that higher order terms coefficients are not significative suggests that marginal responses of the primary balances to debt are not varying much with the *observed* non-default debt levels. This may be due to the economies staying far away from fiscal fatigue levels or by them quickly falling into default after reaching them. However what matters for sustainability is the marginal effect, shown in Figures 11 and 12.

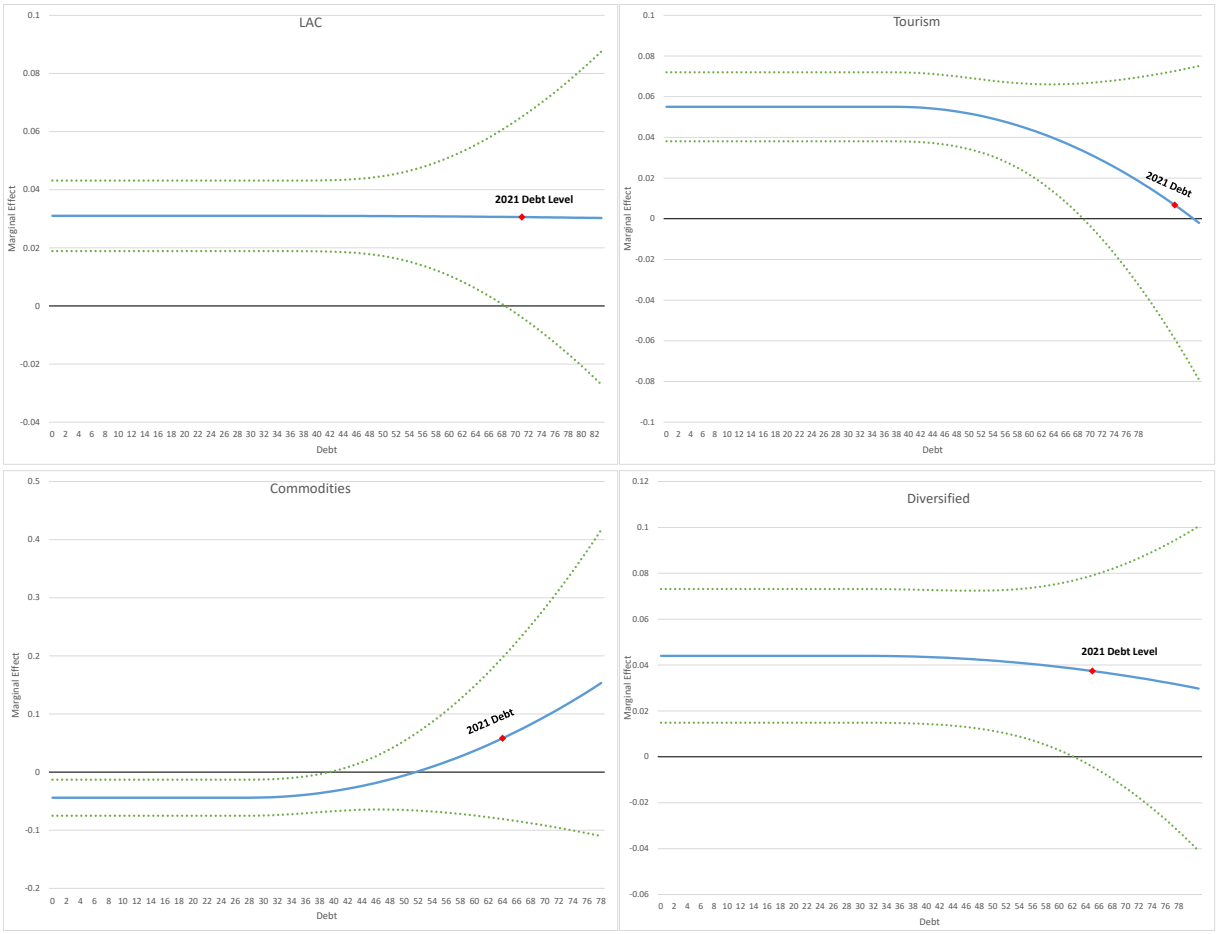
The results for the quadratic and cubic specifications are consistent with fiscal fatigue. For countries in the region, the response of primary balances to debt weakens as debt grows. Crucially, post-pandemic debt levels are such that neither the region's nor any of the groups' fiscal reaction function coefficients is positive and significative. This indicates a decisive action is needed to bring back debt to prudent levels. Automatic stabilizers and the post-pandemic recovery may not be enough to keep debt from exploding.

Figure 11. Quadratic Debt Marginal Effects on Primary Balances in LAC



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: Blue line displays the marginal effect of the quadratic debt on the primary balance. Dashed lines show the lower and upper bounds that are the 90 percent confidence interval. See Figure 4 for a description of the baseline model and the countries included in each group.

Figure 12. Cubic Debt Marginal Effects on Primary Balances in LAC



Source: IDB staff calculations based on data from standardized databases, and national sources.
Note: Blue line displays the marginal effect of the cubic debt on the primary balance. Dashed lines show the lower and upper bounds thar are the 90 percent confidence interval. See Figure 4 for a description of the baseline model and the countries included in each group.

4. Conclusions

This paper investigated the question of debt sustainability for Latin America and the Caribbean. A review of the accounting first principles and Bohn's (1995) result linking the fiscal reaction function and solvency led to the first theoretical condition for debt sustainability: a positive response of primary balances to debt. Further extending the analysis along the lines of Ghosh et. al. (2013) produced the second condition: the response of primary balances to debt should be higher than the growth-adjusted interest rate.

This paper explored the empirical counterparts of both conditions. The results suggest that debt is likely sustainable in the region, although it cannot be assured at a 95 percent confidence

level. A deep look at the causes of this results pointed towards fiscal fatigue, the fact that primary balances become less responsive to debt levels the higher the latter are.

In LAC, sovereign debt was a critical buffer during the COVID-19 pandemic. However, post-pandemic debt levels seem to have reached the point where debt sustainability is far from certain. The results here indicate only decisive action will bring debt back to prudent levels.

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Appendix

1. Construction of Groups

All 26 Latin American and Caribbean economies were classified into three groups according to their main export: tourism group, commodities group, and diversified group (see Table A.1).

Table A.1. Countries in Each Group

Classification by Export		
Tourism Group	Commodities Group	Diversified Group
The Bahamas	Suriname	Argentina
Barbados	Ecuador	Brazil
Jamaica	Paraguay	Costa Rica
Belize	Bolivia	El Salvador
Dominican Republic	Peru	Guatemala
Panama	Venezuela	Honduras
Uruguay	Guyana	Mexico
Haiti	Chile	Nicaragua
	Colombia	Trinidad and Tobago

Source: IDB Staff calculations based on *Caribbean Quarterly Bulletin* Volume 10 (Issue 1), IMF's Balance of Payments, and UNCTAD, 2021.
Note: We classified countries into three groups according to their main export: tourism group, commodities group, and diversified group: tourism group is the top third of the economies ranked according to the Tourism Dependence Index (from *Caribbean Quarterly Bulletin* Volume 10, Issue 1, 2021), commodities group contains the top nine ranked economies according to the ratio of commodities exports to total exports, and the diversified group includes the remaining nine economies.

The definition of the tourism group uses the updated version of the Tourism Dependence Index, developed by Mooney and Zegarra, 2020, which is found in *Caribbean Quarterly Bulletin* Volume 10 (Issue 1). This updated index is calculated using 5-year averages (2015-2019) for the total contribution of tourism to export receipts, to GDP, and to employment for each country. This group includes the top third of the economies ranked, including The Bahamas, Barbados, Belize, Dominican Republic, Jamaica, Haiti, Panama, and Uruguay (see Table A2).

Table A.2. Tourism Dependence Index for LAC

ISO3	country	Tourism Dependence Index
ARG	Argentina	7.6
BHS	The Bahamas	54.5
BLZ	Belize	37.9
BOL	Bolivia	7.2
BRA	Brazil	6.1
BRB	Barbados	41.4
CHL	Chile	8.9
COL	Colombia	7.4
CRI	Costa Rica	13.8
DOM	Dominican Republic	24.1
ECU	Ecuador	6.6
GTM	Guatemala	8.2
GUY	Guyana	5.1
HND	Honduras	10.7
HTI	Haiti	16.4
JAM	Jamaica	38.7
MEX	Mexico	11
NIC	Nicaragua	11
PAN	Panama	18.5
PER	Peru	8.8
PRY	Paraguay	3.8
SLV	El Salvador	13.3
SUR	Suriname	3.5
TTO	Trinidad and Tobago	7.7
URY	Uruguay	16.7
VEN	Venezuela	7.1

Source: *Caribbean Quarterly Bulletin* Volume 10 (Issue 1).
Notes: This index is calculated using 5-year averages (2015-2019) for the total contribution of tourism to export receipts, the total contribution of tourism to GDP, and the total contribution of tourism to employment for each country.

The second group is the commodities group. We constructed the ratio of commodities exports to total exports, and we took a series of steps to build this ratio. First, for each country, we obtained the average of the ratio of exports of goods to total exports from 2018-2019, using data from WEO October 2021. Then, we multiplied this ratio by the average ratio of commodities export value to merchandise export value from 2018-2019 (from UNCTAD, 2021). This gives us an approximate measure of the proportion of commodities exports to total exports. Finally, we selected the top nine ranked economies. This group includes Bolivia, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, and Venezuela (see Table A3). Lastly, we define the diversified group containing the remaining nine economies: Argentina, Brazil, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Trinidad and Tobago. Table A1 summarizes the countries in each group.

Table A.3. Commodities Exports Index for LAC

ISO3	country	Commodities Exports Index	Exports of Goods to Total Exports	Commodities Exports Index*ratio
ARG	Argentina	64.20%	80.82%	51.89%
BHS	The Bahamas	38.20%	13.26%	5.07%
BLZ	Belize	63.40%	40.35%	25.58%
BOL	Bolivia	94.00%	85.92%	80.77%
BRA	Brazil	66.60%	86.98%	57.93%
BRB	Barbados	39.50%	35.29%	13.94%
CHL	Chile	87.00%	88.20%	76.73%
COL	Colombia	79.80%	80.27%	64.06%
CRI	Costa Rica	44.60%	54.68%	24.39%
DOM	Dominican Republic	41.30%	53.81%	22.23%
ECU	Ecuador	93.90%	87.19%	81.88%
GTM	Guatemala	57.80%	72.58%	41.95%
GUY	Guyana	87.10%	88.60%	77.17%
HND	Honduras	51.00%	59.52%	30.36%
HTI	Haiti	12.30%	64.97%	7.99%
JAM	Jamaica	90.80%	30.65%	27.83%
MEX	Mexico	15.90%	93.69%	14.90%
NIC	Nicaragua	53.60%	75.72%	40.59%
PAN	Panama	41.10%	51.46%	21.15%
PER	Peru	90.50%	86.94%	78.68%
PRY	Paraguay	87.20%	93.23%	81.30%
SLV	El Salvador	23.00%	61.04%	14.04%
SUR	Suriname	98.10%	92.74%	90.98%
TTO	Trinidad and Tobago	57.20%	92.29%	52.79%
URY	Uruguay	79.50%	68.64%	54.57%
VEN	Venezuela	80.60%	96.76%	77.99%

Source: IDB Staff calculations based on Balance of Payments from IMF, and UNCTAD (2021).
Notes: Commodities Exports Index comes from UNCTAD (2021) report. Exports of Goods to Total Exports refers to the average of the ratio of the exports of goods to total exports from 2018 to 2019. The last column reports the multiplication of the index from UNCTAD and the average ratio of exports of goods to total exports.

2. Data Availability for Institutional Controls

Data Availability for Institutional Controls	
Tourism	
Bahamas	Yes
Barbados	No data for Openness
Belize	Yes
Dominican Republic	Yes
Haiti	Yes
Jamaica	No data for Openness
Panama	Yes
Uruguay	Yes
Commodities	
Bolivia	Yes
Chile	Yes
Colombia	Yes
Ecuador	Yes
Guyana	No data for Openness
Paraguay	Yes
Peru	Yes
Suriname	Yes
Venezuela	No data for Openness and other Institutional controls
Diversified	
Argentina	Yes
Brazil	Yes
Costa Rica	Yes
Guatemala	Yes
Honduras	Yes
Mexico	Yes
Nicaragua	Yes
El Salvador	Yes
Trinidad and Tobago	Yes

3. Number of Observations in the Models

	Number of observations						
Group/Country	Total Observations	Default Periods	Baseline	r-g<0	r-g>0	debt<per 50	debt>= per 50
LAC	**930**	**199**	**731**	**305**	**426**	**310**	**421**
Tourism	**241**	**46**	**195**	**72**	**123**	**83**	**112**
Bahamas	29	0	29	3	26	14	15
Barbados	25	2	23	0	23	11	12
Belize	18	5	13	5	8	6	7
Dominican Republic	39	14	25	11	14	12	13
Haiti	19	2	17	9	8	4	13
Jamaica	20	2	18	4	14	8	10
Panama	44	14	30	15	15	8	22
Uruguay	47	7	40	25	15	20	20
Commodities	**337**	**75**	**262**	**128**	**134**	**114**	**148**
Bolivia	44	13	31	20	11	16	15
Chile	39	8	31	7	24	16	15
Colombia	63	0	63	30	33	23	40
Ecuador	18	2	16	8	8	8	8
Guyana	22	18	4	3	1	2	2
Paraguay	49	9	40	16	24	20	20
Peru	43	12	31	15	16	15	16
Suriname	24	7	17	5	12	10	7
Venezuela	35	6	29	24	5	4	25
Diversified	**352**	**78**	**274**	**105**	**169**	**113**	**161**
Argentina	33	10	23	10	13	4	19
Brazil	40	0	40	5	35	18	22
Costa Rica	61	11	50	25	25	24	26
Guatemala	19	0	19	10	9	9	10
Honduras	61	25	36	18	18	16	20
Mexico	56	7	49	16	33	14	35
Nicaragua	23	23					
El Salvador	28	1	27	13	14	13	14
Trinidad and Tobago	31	1	30	8	22	15	15

Source: IDB staff calculations based on data from standardized databases, and national sources.
Notes: The information contemplates data until 2019 and omits periods of inflation above 150 percent. Total Observations refer to the number of data points where we have information in all the variables of interest. Default Periods are the years where there is default in the column Total Observations. Baseline refers to the observations used in the baseline model. The columns r-g<0, r-g>0, debt<per 50, and debt >= per 50, show the number of observations when there are no missing values either in any of the variables included in the corresponding model. The number of observations in columns of debt < per(50) and debt >= per(50) differ mainly due to missing information on primary balances.