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Assessing public debt sustainability for Costa Rica using the fiscal reaction function ☆

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ABSTRACT

This paper assesses Costa Rica's public debt sustainability empirically using three complementary approaches: the calculation of the debt-stabilizing primary fiscal balance obtained from the government's intertemporal budget constraint, the estimation of the parameters of a fiscal policy reaction function (FRF) following the methodology originally proposed by proposed by Bohn (2007); and the estimation of fan charts for the primary fiscal balance and public debt expressed as shares of GDP following the approach proposed by Celasun et al. (2006). With annual data from the period 1974–2018, we find that debt has been unsustainable for specific long- and short-term episodes. For the most recent observations, the conclusion is that debt trajectory is unsustainable. Given that a major fiscal reform was approved at the end of 2018, an uncertainty evaluation of its impact on the primary balance's adjustment path until 2023 and 2030 is included using the official estimated reform projections. The results indicate that the maximum level of the debt ratio will be 68% in 2026, after which this upward trend reverses.

1. Introduction

Among economic conditions, fiscal sustainability is key to macroeconomic stability. This is especially true for Costa Rica, a country with strong economic and social indicators compared to other Latin American countries but weak fiscal outcomes.

In fact, Costa Rica is among the region's countries that spends the most on social policies, and it has the least flexible[2] expenditure after Brazil. According to the OECD (2018), about half of this Central American government's public expenditures are dedicated to social spending, which focus on benefits in kind. Approximately 67%, whereas the OECD's average is 40%.

Health care is the largest in-kind program, accounting for 43% of total social spending, whereas education, mandated by the constitution, must account for at least 8% of GDP. This is higher than in any other OECD country.

The public spending structure has outpaced the government's income over the last two decades. Consequently, with the exception of 2006 and 2007, Costa Rica's government balance has been negative and, therefore, financed with internal and external public debt.

☆ The ideas expressed in this paper are those of the authors and do not necessarily represent the views of the Central Bank of Costa Rica.

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[2] According to the Expenditure Flexibility Index (OECD, 2020, p. 38). The index measures the share of total spending on interest, wages and transfers (considered mandatory).

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Even though this negative fiscal balance is long-standing, it was strengthened when, in response to the financial crisis of 2008, an expansionary fiscal policy was adopted as a counter-cyclical measure.[3]

Specifically, in 2009, among other policies,[4] the incumbent government decided to raise public wages by implementing a fifty-percentile policy to increase the wages of central government professionals to equal comparable fifty-percentile salaries of workers in the non-financial autonomous public sector, who earned higher remunerations, and increase transfers to decentralized institutions.

Given their structural nature, both measures were impossible to revert, so they increased the rate of growth of public expenditure significantly without sufficient income to serve as a counterbalance. In 2007, before the crisis, total expenditures accounted for 14.7% of GDP, and by 2018 this had grown to 20% of GDP (the largest of the last three decades). The average total income for the period 2007–2018 was 14.3% of GDP. As a result, the headline deficit averaged 5% of GDP from 2009 to 2018, and the primary balance was -2.5% of GDP for the same period.

During this stage, the growth of debt and its interest rate service became almost inertial: in 2018, when the headline deficit was 5.8 % of GDP, the primary balance was -2.3% of GDP. In a decade, from 2008 until 2018, expenditures on interest service increased from 2.1% of GDP to 3.5%.

Compared with that of other Latin American countries, Costa Rica's fiscal position deteriorated sharply. Its government debt ratio, measured as a percentage of its GDP, grew at one of the fastest rates in the region. The central government's debt increased from 24% of GDP in 2008 to 49% of GDP in 2017, representing a change of 102%. During this period, Argentina, Brazil, Chile, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Uruguay averaged a change of 73%.

Even when analyzed under the empirical thresholds estimated in the literature, the debt level reached a critical value by the end of 2017. Fall et al. (2015) stated that, for emerging economies, debt levels over 50% of GDP have negative effects on growth.

The rapid deterioration of public finances during this period encouraged every administration to discuss the need for fiscal reform, but a fragmented Congress prevented consensus. Therefore, only minor fiscal changes were implemented during these years.

Given this context, questioning whether debt is sustainable is unavoidable. Due to the vulnerabilities of a high debt level and its management, a growing proportion of the government's debt denominated in foreign currency[5] and a high level of dollarization in the financial system[6] signal that Costa Rica's debt dynamics could be on an unsustainable path. In such a case, the country could be particularly exposed to sudden stops, capital flow reversals, and financial instability.

Costa Rica's high and rising fiscal deficit and mounting debt are its main economic weaknesses. Therefore, in the short term, tighter financial conditions that might reduce private investments and curb growth could be expected. In the long term, a reduced scope for counter-cyclical policies could harm the country's comparative advantage vis-a-vis other emerging markets in attracting and even keeping foreign direct investment (OECD, 2018).

In fact, as time passed, the lack of consensus concerning fiscal reform increased the vulnerability and uncertainty of the country's fiscal balance and drove up risk premia, which led to a downgrade from credit rating agencies in 2014, 2016, and 2017. Moody's and Standard and Poor's, for example, downgraded Costa Rica's long-term debt in foreign and local currency from BB in 2017 and from BB- in 2016, respectively, to B+ in January 2019.

The latter downgrade was announced after a structural public finance reform was passed by Congress and approved by the Constitutional Court in December 2018. The credit agencies explained that even though the Law No. 9635, Ley para el Fortalecimiento de las Finanzas Públicas, implemented changes on the income and expenditure side,[7] they came a bit too late, and they would be too slow to rebalance the country's public finances.

Given this context and the need to characterize Costa Rica's fiscal balance in the short and medium term from various angles, our research assesses its public debt sustainability empirically using three complementary approaches: the calculation of the debt-stabilizing primary fiscal balance obtained from the government's intertemporal budget constraint (a function of the debt stock, the real interest rate and the growth rate of real GDP), the estimation of the parameters of a fiscal policy reaction function (FRF) following the methodology originally proposed by proposed by Bohn (2007), and the estimation of fan charts for the primary fiscal balance and public debt expressed as shares of GDP following the approach proposed by Celasun et al. (2006).

Accordingly, Section 2 provides a more detailed description of the main fiscal indicators for recent years using a comparative view of the medium term (last two decades) and the long term (four decades ago). Afterwards, Section 3 briefly explains the relevant theory, and Section 4 reviews the empirical framework and describes the specific methodology and data employed in this research. Section 5 continues with a discussion of the results of the empirical assessment, and Section 6 focuses on the risk evaluation. Section 7 concludes with our final remarks.

[3] This policy was centered on permanent changes to current expenditures.

[4] For instance, the non-contributing retirement regime of Caja Costarricense del Seguro Social (Costa Rican social security) was increased to 15%, and 5% of GDP was spent on investments to stimulate the economy.

[5] In 2010, external debt, which is all in foreign currency, was 10% of GDP. For 2018, it represented 17.2%.

[6] Private wealth in foreign currency as a percentage of total private wealth has been more than a third for the last ten years, and total credit in foreign currency as a percentage of total credit has been around 50%.

[7] It modified the income tax, the general sales tax (Law No. 6826), included a fiscal rule for current expenditure, and considered wage caps for the public sector (Law No. 2166).

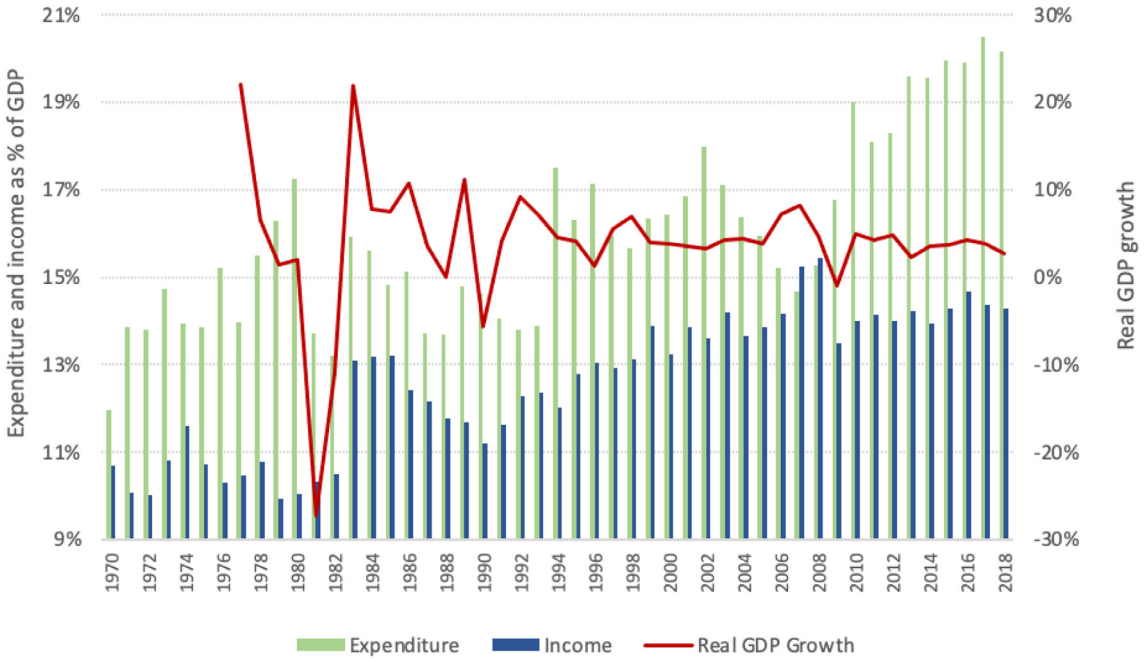


Fig. 1. Central government[1] expenditure and income as percentage of GDP and real GDP growth, 1970-2018. Source: Authors, with information from the Treasury (Ministerio de Hacienda).

[1]We only analyze the central government's variables as, in Costa Rica, since the crisis of the 1980s (which started in Mexico in 1981-1982) there has been no debt at the subnational level, and the non-financial public sector debt.

2. Costa Rica's public finances

At the end of 2018, Costa Rica's parliament approved a long-waited fiscal reform,[8] Ley de Fortalecimiento de las Finanzas Públicas. It took the country almost two decades to implement legal changes concerning income and expenditures that had been recognized as necessary since the early 2000s. However, the delay was not without cost. From 2008 to 2018, the fiscal deficit increased from -0.2% of GDP to 5.8%, the total debt increased from 23.8% of GDP to 53.6%, and interest payments grew by 14% year over year on average.

As this work is aimed at assessing Costa Rica's debt sustainability, it is necessary to have a better understanding of the country's fiscal behavior. This section provides a more detailed description of the fiscal variables included in the empirical model. It provides the reader with a better sense on how the country reached a critical point in 2018, as well as where its fiscal vulnerabilities come from and what risks to debt sustainability it might face in the near future.

Fig. 1 shows that, with the exception of 2006 and 2007, the government's fiscal balance has always been negative. In Costa Rica, public income is constituted mainly by taxes,[9] as they represent more than 95% of it, but it also includes non-tax entries, cash/current transfers, and capital income. Within expenditures, current expenditures[10] (salaries; public debt interest; and transfers to the public, private, and external sectors) represent more than 90% of the total, whereas the rest is spent on capital.

The history behind Fig. 1 begins in the late 1970s, when public finances were distressed by an oil shock that reduced revenues significantly due to higher import prices and decreased exports, as well as the acquisition of short-term loans in foreign currency to accumulate reserves that took place during those years.

The fiscal situation worsened when GDP began decreasing. At that time, the country had a fixed exchange rate that was over-valued, and it had a shortage of international reserves that led to a currency crisis. In 1981, this situation led to the suspension of the external debt service, and the fiscal deficit began to be financed with domestic debt.

A year later, inflation reached 82% and the Central Bank of Costa Rica, BCCR, adopted a crawling peg exchange rate regime. By then, the external debt had been centralized in the BCCR to control its expansion and facilitate its re-negotiation.

[8] It is a comprehensive fiscal reform package with measures on the revenue (creating a VAT and two new income brackets in the personal income tax scheme and reducing earmarking) and spending sides (rationalizing some remuneration incentives), as well as a fiscal rule (gradually constraining the growth of current spending). For more detail, please refer to Appendix E.

[9] There are several different taxes, but in terms of their relative importance, the most representative are the general sales tax, customs tax, and income tax. These three represent almost 80% of total tax income.

[10] Between 70-75% of current expenditure comprises wages and current transfers.

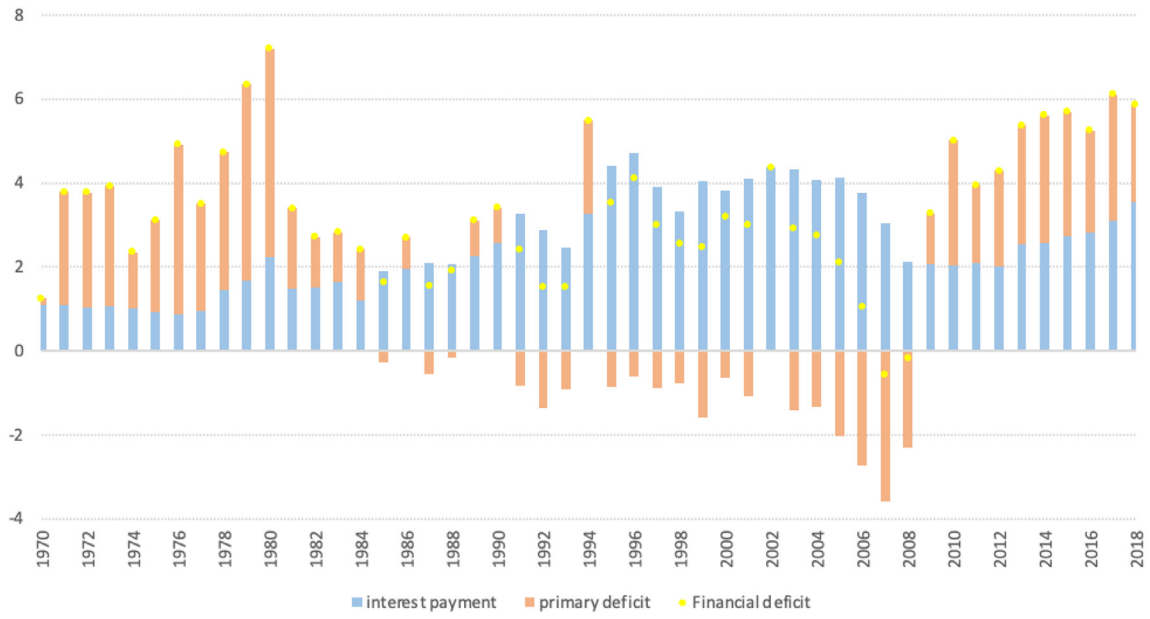


Fig. 2. Financial and primary deficit as percentage of GDP, 1970-2018
Source: Authors, with information from Ministerio de Hacienda.

From 1990 to 2005, the BCCR began canceling liabilities without generating inflation pressure due to a series of capitalizations from the Ministry of Finance. In 1992, the capital account was liberalized and in 1995, the BCCR's organic law was reformed, prohibiting this entity from financing the government in any manner.

Another fiscal shock came in 1994 with the bankruptcy of Banco Anglo, one of the state-owned banks. Its losses represented 1.8% of GDP to the central government. Afterwards, and until 2007, public finances showed significant improvements, as reflected in low fiscal deficits. This was attributable to a restrictive spending policy and higher tax revenues as result of economic growth during those years.

The situation changed in 2008, when the financial crisis reduced economic growth, and the government responded with an expansionary fiscal policy that changed the expenditure composition and growth structurally, as mentioned above, through permanent increases in wages and current transfers.

Because these changes in expenditure were not accompanied by changes in income, the fiscal balance has deteriorated significantly since that time. Naturally, the debt has increased accordingly.

The mismatch between income and expenditure and, hence, its financing, which is shown in Fig. 2, could also be described by dividing the sample into five periods: 1970–1982,1983–1993,1994–2006,2007–2008, and 2009–2018.

Broadly, the first period shows how the government increased its financing until it defaulted during the crisis in the 1980s. After that, there was a significant reduction in primary deficit because of the policies implemented in response to the crisis. This was followed by a decreasing trend in the financial deficit for a bit more than a decade, between 1994 and 2006. Afterward, there were two years of financial surplus, but due to the 2008 financial crisis and the adopted fiscal stimulus measures, it reverted quickly after 2008.

In Fig. 2, we also observe a primary surplus from 1991 until 2008, with the exception of 1994, due to the closure of the state-owned bank mentioned above. During this period, financial deficits resulted from interest payments on debt, but the level of debt decreased significantly, as shown in Fig. 3.

The structural change in the expenditure series with no income corresponds to the measures taken by the government in 2008, which provoked a noteworthy change in the debt behavior. Fig. 3 shows how, in 2008, the debt began increasing steadily but constantly. In ten years, the debt level as a percentage of GDP grew by 125%.

As Fig. 3 indicates, we hypothesize that Costa Rica's public debt is on an unsustainable path caused by an increasing mismatch between the growth rate of fiscal income and expenditure. This discrepancy escalated year by year due to a series of law projects for structural fiscal reforms that were not approved by Congress or the Constitutional Court. For instance, the law project Ley de Pacto Fiscal, proposed in 2004, was intended to change the sales tax to an aggregate value estimation and to adopt the global income tax, but it was never voted on in Congress. In addition, the law project Proyecto de Solidaridad Tributaria, endorsed during the Chinchilla-Miranda presidency (2010–2014), included a tax of 15% on passive rents and capital gains and would have transformed the general sales tax into an aggregate value tax. However, even though this project was approved in the legislature, it was rejected by the Constitutional Court, which ruled it invalid.

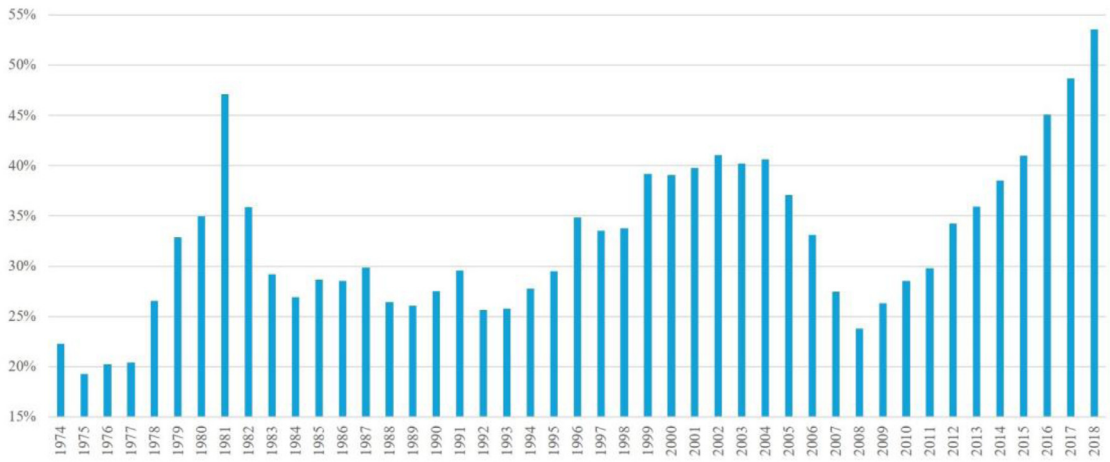


Fig. 3. Central government debt as percentage of GDP, 1970-2018
Source: Authors, with information from Ministerio de Hacienda.

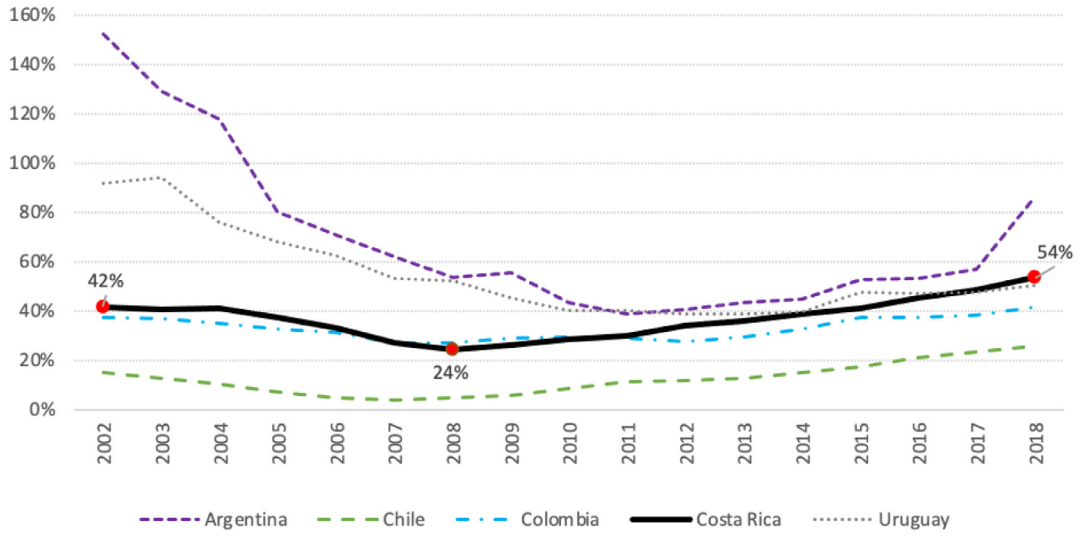


Fig. 4. Central government debt as a percentage of GDP for various Latin American countries, 2002-2018
Source: International Monetary Fund.

Relative to that of other Latin American countries, the observed rate of growth of Costa Rica's public debt since 2008 was among the highest. Fig. 4 shows a comparison among a subsample of countries.

To provide a better sense of the risks to debt sustainability, the Fig.s below show various characteristics of Costa Rica's public debt in more detail. Fig. 5, for example, shows how this debt grew after 2002 by separating internal and external debt.

In Costa Rica, Congress must approve the issuance of external debt. Therefore, the growth of this series from 2012 to 2015, as shown in Fig. 5, is attributable to Law No. 9070, which authorized the issuance of US$4 billion as external debt. Between 2016 and 2018, there were no other external debt issuances in the international financial market.

In addition, even when external debt is issued only in foreign currency, internal debt can be issued in local or foreign currency. Therefore, Fig. 6 reflects the distribution of the central government debt among currencies by displaying the share of the total debt in local currency. This result can be interpreted as a vulnerability indicator, as it reveals a degree of dependence between internal financial stability and foreign capital inflows.

Regarding how costly it has been for the country to increase its indebtedness during the last decade, Fig. 7 shows the weighted effective interest rate for the internal and external debt per year, since 2009. Based on the Fig. 7, in real terms, interest rates for internal and external debt have increased consistently; the government has cornered itself into relying on more expensive debt. Thus, the crowding out effect has affected credit demand and private investment.

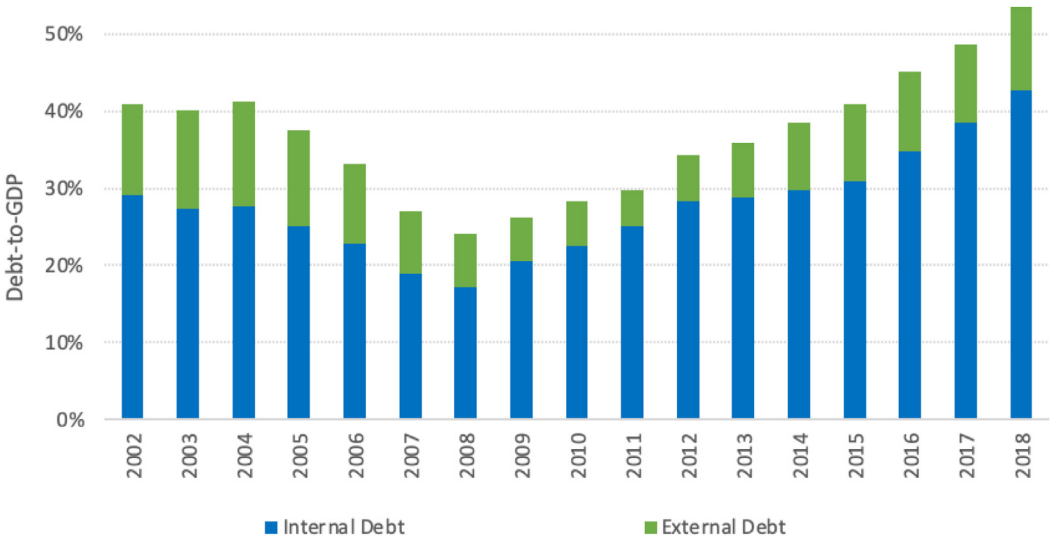


Fig. 5. Central government internal and external debt as a percentage of GDP, 2002-2018
Source: Authors, with information from Ministerio de Hacienda.

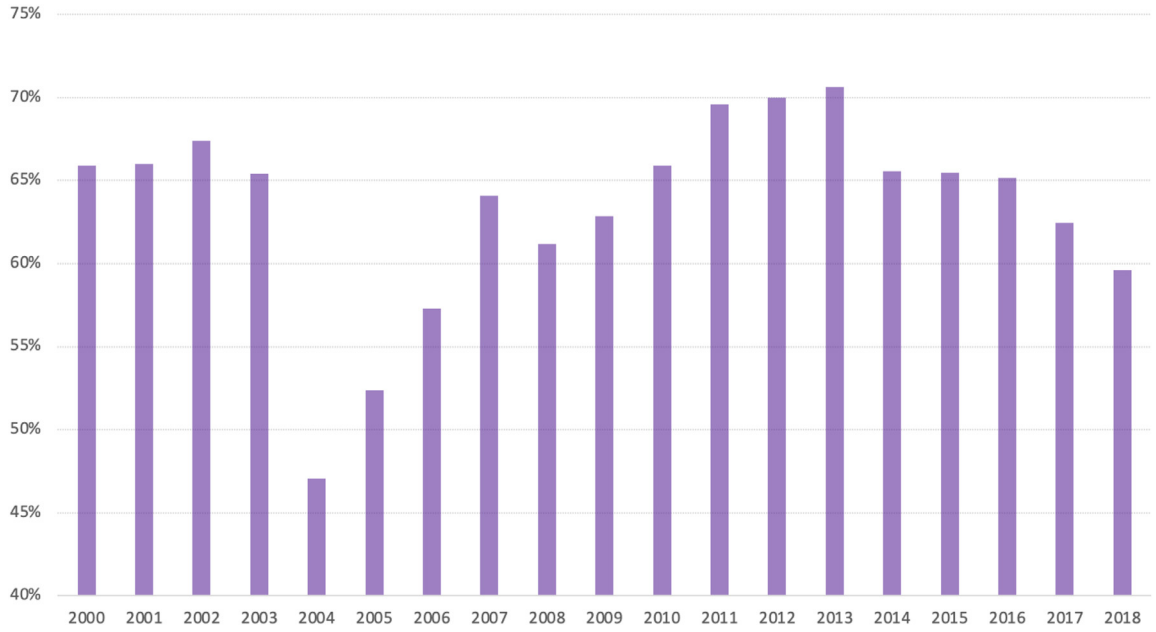


Fig. 6. Central government debt in domestic currency as a percentage of total debt, 2000-2018
Source: Authors, with information from Ministerio de Hacienda.

The last liability we depict for Costa Rica's debt sustainability assessment is the percentage of debt that will mature in the short run. Fig. 8 shows internal and external debt and demonstrates how more than half of the total debt is due before 2025. By maturity, 10.4% of the total debt is due in 2020, and 47.3% is due between 2020 and 2024.

The analyses above present a difficult position for the central government and indicate the relevance of an integral debt sustainability assessment. Indeed, even though changes have occurred due to fiscal reforms, the short-term vulnerabilities have not been mitigated.

3. Literature review

There is a vast body of literature on debt sustainability analysis, both in the formulation of standard concepts of government accounting and in the construction of empirical tests and indicators of fiscal solvency or debt sustainability. Exhaustive surveys can

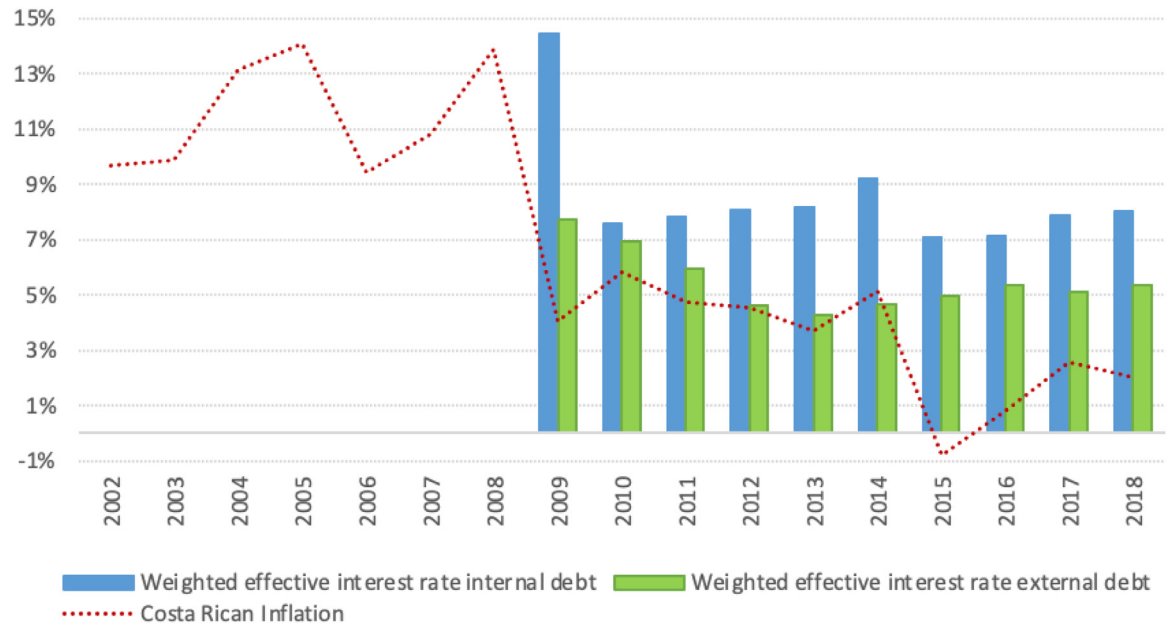


Fig. 7. Central government debt effective interest rates and inflation levels, 2002-2018
Note: Effective interest rate is the respective weighted average interest rate; however, it is available only from 2009 onward.
Source: Authors, with information from Ministerio de Hacienda.

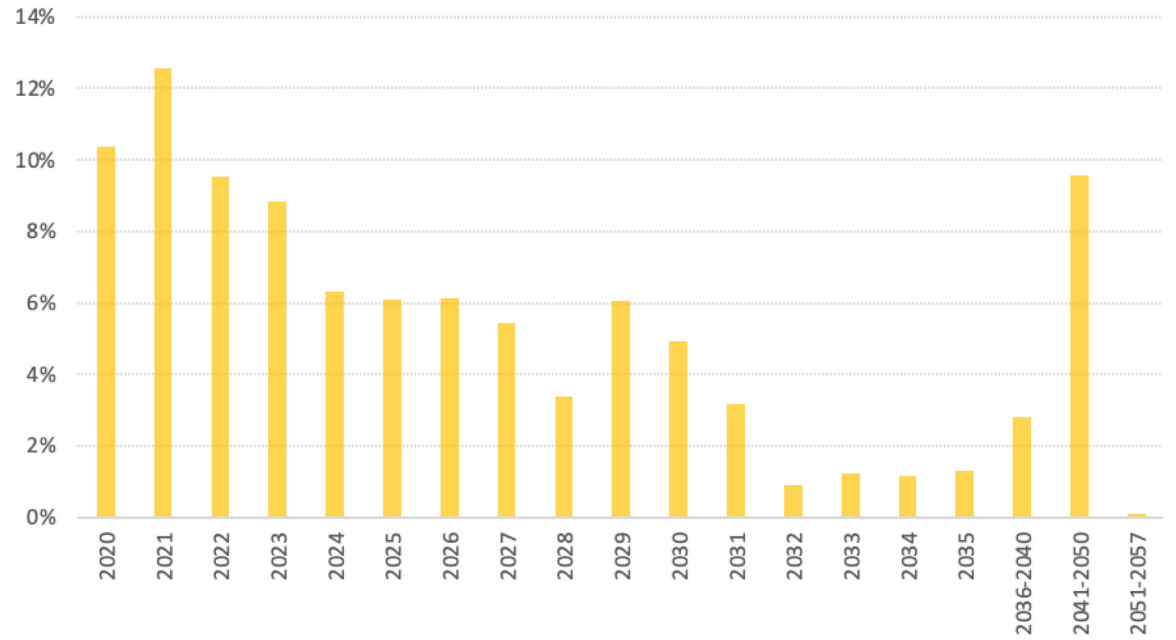


Fig. 8. Annual maturity structure as a percentage of total debt in 2019
Source: Authors, with information from Ministerio de Hacienda.

be found in Buiter et al. (1985), Blanchard (1990), Blanchard et al. (1991), Chalk and Hemming (2000), IMF (2003); Afonso (2005), Bohn (2008), Neck and Sturm (2008), Escolano (2010), and D'Erasmo et al. (2016).

According to D'Erasmo et al. (2016), classic public debt sustainability analysis studies extend the long-run implications from a deterministic intertemporal government budget constraint (IGBC).

The IGBC is evaluated in the steady state, so it relates the long-run primary balance as a share of GDP with the debt-to-GDP ratio and defines the latter as the sustainable debt level (Buiter et al., 1985; Blanchard, 1990; Blanchard et al., 1991). This approach is

known as the Blanchard ratio, and it resembles the government accounting approach in which deterministic limits for the debt and primary balance are defined, below which there is fiscal sustainability IMF (2013).

However, even though this approach provides insights about debt sustainability, Bohn (2007) showed that this traditional test has significant flaws, as the IGBC holds even under weak assumptions for the time series process of fiscal data, which means it is generally satisfied. Sustainability tests that rely on stationarity or cointegration conditions between the primary balance and debt-to-GDP ratio do not capture information about fiscal crises because the IGBC holds if either debt or revenue and spending (including debt servicing) are integrated or finite, but of an arbitrarily high order.

D'Erasmo et al. (2016) also noted that the IGBC methodology only defines the long-run debt for a given long-run primary balance if stationarity holds, thus missing the connection between the initial debt level and the steady state. In fact, multiple dynamic paths for the primary balance would satisfy the IGBC. In addition, this method does not account for uncertainty regarding the real economy or the domestic and foreign asset markets.

Given these weaknesses of the IGBC approach, the use FRFs has become more relevant when analyzing debt sustainability.

Bohn (1998, 2008) showed that in a linear FRF, a positive and statistically significant response of the primary balance to debt is sufficient to satisfy the IGBC. Therefore, the FRF analysis provides a broader scope for debt sustainability analysis and allows for linear and non-linear specifications (Mendoza and Ostry, 2008; Ostry et al., 2010; Ganiko et al., 2016).

To study debt sustainability under uncertainty, a complementary branch of the literature uses time series tools to examine debt dynamics. The IMF (2003) estimates nonstructural vector autoregressive (VAR) models that include primary balance components jointly with key macroeconomic variables (output, growth, and inflation) and exogenous variables.

This line of research computes the probability density function for possible debt-to-GDP ratios based on forward simulations of the time series. Based on these results, fan charts are built which summarize the confidence intervals for future debt.

In general, the FRF approach is extended to include uncertainty. In applying this model to developing countries, Burger et al. (2012) measured how the South African government reacted to changes in its debt position. Using various methods for the FRF estimation, they forecasted the debt-to-GDP ratio by constructing fan charts.

Furthermore, Celasun et al. (2006) proposed a probabilistic approach using realistic shock configurations, namely pure economic disturbances to growth, interest rates, and exchange rates, the endogenous policy response through the FRF, and possible shocks arising from the fiscal policy itself, with simulations of the future path for fiscal variables. Based on the interactions between the economic shocks and the fiscal variables' paths, the authors built fan charts for the debt path for Argentina, Brazil, Mexico, South Africa, and Turkey.

In the case of Costa Rica, research on this topic is limited. Among the extant studies, Espinosa-Rodríguez and Valerio-Berrocal (2014) estimated the debt limit following Mendoza and Oviedo (2004) and used Monte Carlo simulations to compute the probability of surpassing this limit. They estimated that the limit would be surpassed after three years with a 76.0% probability.

In addition, Rojas and Sáenz (2003) studied the financial position of Costa Rica's public sector using the deterministic accounting approach. They performed debt a forecast assuming the primary balance did not change, the rate of growth of the international interest rate was small, and the economy's growth was 3.5% in the long-run and predicted that the debt-to-GDP ratio would be relatively stable for the period 2004-2010.

Finally, Hoffmaister et al. (2001) used a deterministic IGBC framework, which also builds upon the solvency concept, which holds that fiscal policy is sustainable if the debt level is equal to the present value of the future primary surpluses. The authors used a VAR model with the real interest rate, the growth rate, and the primary balance to measure the probability of fiscal policy sustainability. They argued that this probability could be upward biased, given that government expenditure is highly inflexible because compliance with specific spending allocations is defined by laws or the constitution. This suggests the primary balance would be lower than the historically observed balance.

We built upon this theoretical and empirical literature to design our study. We aim to characterize Costa Rica's fiscal balance in the short and medium term from various angles, so we begin by updating the estimations under the IGBC methodology. However, given its weaknesses, we complement this analysis with the calculation of the FRF and an assessment under uncertainty.

4. Empirical framework

As mentioned above, the IGBC methodology is our starting point, but we complement its results with the estimation of the FRF proposed by Bohn (2007) and a risk assessment. For the latter, we follow the fan chart approach proposed by Celasun et al. (2006). Therefore, in this section we briefly explain the methodological framework for each approach and provide the background for the interpretation of the results presented in Section 5.

4.1. Intertemporal budget constraint and solvency

The IGBC, in the deterministic case, defines fiscal policy as achieving sustainability if, during any given period, the debt level equals the present value of future primary surpluses.[11] Hence, it evaluates under the steady state and relates the long-run primary balance as a share of GDP with the debt-to-GDP ratio, defining the latter as the sustainable debt level (Buiter et al., 1985; Blanchard, 1990; Blanchard et al., 1991).

[11] In general, for Costa Rica, the primary balance has been a deficit.

In any given period, revenues and bond issuance must cover total government spending. To keep the notation as simple as possible, we assume that public debt takes the form of a one-period bond. Therefore, the entire stock of inherited debt must be repaid at the end of the period, along with any interest due. The period-t government budget constraint is given as follows:

$$G_t + (1 + i_t) D_{t-1} = T_t + D_t \tag{1}$$

where G_t is the non-interest expenditure (or primary expenditure) and T_t is the total tax revenue. At the end of period t, public debt, D_{t-1} is the stock of past obligations for which interest payments should be included.[12] Given that the primary balance is defined as primary expenditure minus total revenues, $PB_t = G_t - T_t$, we have

$$D_t = (1 + i_t) D_{t-1} + PB_t \tag{2}$$

It is common to scale the nominal amounts in the above equation as ratios of nominal GDP, Y_t, therefore from Eq. 2

$$\frac{D_t}{Y_t} = (1 + i_t)\left(\frac{D_{t-1}}{Y_{t-1}}\right)\left(\frac{Y_{t-1}}{Y_t}\right) + \frac{PB_t}{Y_t} \tag{3}$$

The rationale behind the Eq. 3 is that if the government's revenues can grow indefinitely, so can expenditure and debt. If GDP grows at an annual rate of θ_t, then

$$d_t = \left(\frac{1 + i_t}{1 + \theta_t}\right) d_{t-1} + pb_t \tag{4}$$

Where non-capital letters now represent the ratios. Hence, at any time, the public debt-to-GDP ratio results from the interest burden of past debt and the present primary deficit, which reflects fiscal policy decisions.

Finally, for the implementation of this methodological approach, it is necessary to assess the future trajectories of government expenditure, public revenues, economic growth and interest rates.

4.2. Fiscal reaction function

Building upon the intuition behind the IGBC, the standard FRF intends to measure the extent to which the government adjusts its primary balance in response to previous debt stock and current output gap.[13] Usually in the literature, the model is specified as follows:[14]

$$pb_t = \gamma_0 + \gamma_1 d_{t-1} + \gamma_2 Y_t + X_t \Gamma + \varepsilon_t \tag{5}$$

where pb is the ratio of primary balance to GDP, d is the ratio of public debt to GDP, Y is the output gap, and X is a vector of control variables.

Output gap is included in Eq. (5) because it controls for nonlinear responses as governments call for output stabilization, and because business cycles influence tax income (and hence, the reaction function itself). Therefore, the output gap works as an instrument to measure the impact of past debt on the primary balance.

For the Costa Rican model specification, we include three dummy variables. These account for the fiscal and economic crisis of the early eighties; the year 1994, as one of the state-owned banks was closed and represented an extraordinary expenditure for the government; and for the period after the 2008–09 financial crisis, given the structural change in government expenditure as part of the expansionary fiscal policy measures.

To understand how the FRF works, we start with the theoretical framework used by Burger et al. (2012), who build upon the solvency concept mentioned before, and obtained the following debt equation:[15]

$$\Delta d_t = \frac{r - g}{1 + g} d_{t-1} - pb_t \tag{6}$$

where r is the real interest rate, and g is the real GDP growth rate. Hence, the level of primary balance (deficit) that stabilizes the ratio of d is:

$$pb_t = \frac{r - g}{1 + g} d_{t-1} \tag{7}$$

[12] Technically, the budget constraint defined in equation 1 could be augmented by a term related to deficit monetization (i.e., part of the debt could be paid by the central bank). However, we abstract from this possibility, as, according to Law 7558, Art. 59, the Central Bank of Costa Rica has been forbidden to lend to the Treasury since 1995. Previously, starting in 1970 (accounting for all the time span used for the estimation), Law 1552, Art. 71 allowed the Central Bank to buy up to (near) 8% of budget in Treasury bonds, but not for debt payment. Therefore, for the empirical specification and estimation we control for the 1980s debt crisis, during which the Central Bank acquired debt from other public entities.

[13] Different from equation (4), the FRF uses the output gap instead of the nominal GDP growth to acknowledge that tax income and expenditure needs would differ based on the economic cycle. Controlling for the output gap would isolate the primary balance reaction to debt, as changes in the former would not be related to the economic cycle.

[14] Literature such as Burger et al. (2012), and Celasun et al. (2006).As we are measuring sustainability, from equation (4) we take $d_t = 0$ and solve for pb_t to define the primary balance which stabilizes the debt-to-GDP ratio. To clean the effect of past debt, we add relevant control variables.

[15] Equation (6) builds upon equation (4): First, as we want an intuitive result, we change the definition of primary balance from $PB_t = G_t - T_t$ to $PB_t = T_t - G_t$ to account for primary deficit. Equation (4) thus would become $d_t = (\frac{1+i_t}{1+\theta_t}) d_{t-1} - pb_t$, and after some algebra we obtain $\Delta d_t = (\frac{1+i_t}{1+\theta_t} - 1) d_{t-1} - pb_t = (\frac{(1+i_t)-(1+\theta_t)}{1+\theta_t}) d_{t-1} - pb_t$. By definition from nominal to real rates, we have $(\frac{(1+i_t)-(1+\theta_t)}{1+\theta_t}) = (\frac{(1+r_t)(1+\pi)-(1+g_t)(1+\pi)}{(1+g_t)(1+\pi)}) = (\frac{r_t - g_t}{1+g_t})$.

Therefore, for the regression analysis, our FRF basic specification is:

$$pb_t = \alpha_1 + \alpha_2 pb_{t-1} + \alpha_3 d_{t-1} + \alpha_4 Y_t + \in_t \tag{8}$$

Which is almost the same as Eq. (5) without the control variables for simplicity. Also, in this equation, the persistence of the primary balance is considered (recall Costa Rica's high degree of expenditure inflexibility) by including a lagged term. From it, we characterize the primary balance's reaction to debt changes in the short term with α_3, and in the long run with $\frac{\alpha_3}{1-\alpha_2}$.

To assess sustainability under this framework, the debt-to-GDP ratio should not follow an explosive path. Burger et al. (2012) argue that if $\frac{\alpha_3}{1-\alpha_2} = \alpha^* = \frac{r-g}{1+g}$, the debt-to-GDP ratio and the primary balance-to-GDP ratio would be first-difference stationary, meaning the necessary adjustments in the primary balance for debt stabilization are done in the next period.[16]

Unit root tests are informative in two ways. First, obtaining stationarity evidence could be a first guess on the final outcome, despite Bohn´s (2007) critique. Second, the estimation of Eq. (8) needs to measure the statistical properties of the series. If there are unit roots among the data, vector error correction models (VECMs) would be appropriate. Otherwise, vector autoregressive (VAR) or ordinary least squares (OLS) models could be used.[17] However, unit root evidence on the Costa Rican data series is not conclusive.[18] We extend the analysis by including estimations with VECM models, for which we use the following specification:

$$\begin{aligned} \Delta pb_t &= c_{11} + \alpha_{12}\left(pb_{t-1} - \beta_{12} d_{t-1} - \beta_{13}\right) + \Sigma_{11}\Delta pb_{t-1} + \Sigma_{12}\Delta d_{t-1} + \psi_{11} Y_t + \in_{11t} \\ \Delta d_t &= c_{21} + \alpha_{22}\left(pb_{t-1} - \beta_{12} d_{t-1} - \beta_{13}\right) + \Sigma_{21}\Delta pb_{t-1} + \Sigma_{22}\Delta d_{t-1} + \psi_{21} Y_t + \in_{21t} \end{aligned} \tag{9}$$

From this Eq. 9, the primary balance may be rewritten as a VAR in levels:

$$pb_t = c_{11} - \alpha_{12}\beta_{13} + \left(1 + \alpha_{12} + \Sigma_{11}\right) pb_{t-1} - \Sigma_{11} pb_{t-2} + \left(-\alpha_{12}\beta_{12} + \Sigma_{12}\right) d_{t-1} - \Sigma_{12} d_{t-2} + \psi_{11} Y_t + \in_{11t} \tag{10}$$

From the equations of the OLS/VAR and the VECM models, we can relate the FRF's coefficients between Eqs. (8) and (10) as:

$$\begin{aligned} \alpha_1 &= c_{11} - \alpha_{12}\beta_{13} \\ \alpha_2 &= 1 + \alpha_{12} + \Sigma_{11} \\ \alpha_3 &= -\alpha_{12}\beta_{12} + \Sigma_{12} \end{aligned} \tag{11}$$

Given the coefficient estimations, we compare these results with the previously defined α^* to assess fiscal sustainability.

Following the intuition explained before, for the periods when $\frac{\alpha_3}{1-\alpha_2} \geq \alpha^*$, the primary balance behaves in accordance to debt sustainability in the long run. In the short term, we compare the coefficient directly; when $\alpha_3 \geq \alpha^*$, the primary balance changes in accordance with debt sustainability considering the result of the next period.

Also, we consider the evidence of nonlinearities in fiscal reaction functions from the literature (Mendoza and Ostry, 2008; Ostry et al., 2010; Ganiko et al., 2016), thus, as a robustness check we include other control variables such as gaps for government expenditure, real exchange rate, and debt. The information provided by the estimated coefficients of these variables allows us to assess whether the fiscal reaction is stronger or weaker conditional to periods of high or low expenditure, debt, and real exchange rate.

Besides these variables, a linear trend is also included in some specifications to control for population growth (recall that debt and primary balance are used as GDP proportion). An interaction dummy variable between time and debt has been added as a control, given the structural break in the expenditure series after 2008.

Finally, we include a time-varying frame analysis to determine whether the sustainability analysis changed given different temporal information (short- and long-run debt sustainability behavior) and to check whether historical or political economic non-observable events biased the standard debt sustainability results. Therefore, from the original model specification, we estimate the α's of Eq. (11) by varying the sample period, in order to compare the results with the estimated α^*.

Specifically, we estimate α with data from a ten-year window from 1975 to 1985, then added a year (1986) to the sample and estimated once more. This process is done recursively until the whole data sample is included. The resultant α's are referred to as "expanding," given that the sample size increases by one year in each estimation.

In the same manner, we estimated another set of time-varying α's, but with the difference of beginning with the most recent data sample and adding year by year until 1975. This means we started with a sample from 2018 back to 2009 and added a year per estimation; the first year to be added was 2008, then 2007, and so on. The resulting estimated α series is called "contracting."

Based on this process, we obtain four series of time-varying α's (long- and short-run for expanding and contracting sets), which are compared to α^*. The short-run coefficients are analogous to the previously mentioned α_3, whereas the long-run coefficients relate to $\frac{\alpha_3}{1-\alpha_2}$.

4.3. Risk assessment

There are two important, interrelated caveats in standard debt sustainability analysis. First, uncertainty is not measured. Debt could follow several paths due to shocks in its determinants and still be sustainable (or not). Second, there is no way of breaking

[16] Even when $\frac{\alpha_3}{1-\alpha_2} > \alpha^* = \frac{r-g}{1+g}$, the d and pb ratios would be level-stationary, implying a stable relationship.

[17] OLS and VAR methods were applied. By construction, their results are the same, as they have the same specification.

[18] Test results are shown in Table 2. As the estimation approach is defined by these results, we performed an exhaustive list of specifications, for example augmented Dickey-Fuller, Phillips-Perron, and tests with structural breaks.

down the effect of the co-movements among debt dynamics' determinants. Multiple variables could have direct or indirect effects on debt dynamics and change, for example, a sustainable path to an unsustainable one, but there is no way to scrutinize so many unknown variables.

As an answer to these caveats, the debt's risk assessment attempts to measure expected and unexpected impacts on debt dynamics, with an exercise that resembles an out-of-sample forecast for debt with confidence intervals conditional on shocks over the debt's determinants.

For this research, we define fiscal[19] and non-fiscal[20] determinants in order to study the feedback from different economic outcomes on debt dynamics. For example, growth could determine future government income, while debt interest rate and exchange rate affect its cost, and foreign interest rate conditions may affect the interest level on new debt.

We follow Celasun et al. (2006), who based their debt feedback analysis on the FRF estimates along with economic relationships shaping the behavior of public debt ratio. Explicitly, the results are obtained through three steps: the FRF estimations; an unrestricted VAR with the debt's non-fiscal determinants; and a bootstrapping process, which simulates multiple shocks on the VAR's outcome. The latter displays the variables' behavior by means of fan charts.[21] Specifically, the debt path is calculated recursively with an FRF and the conventional stock-flow identity.[22]

For the uncertainty assessment, we start with the following specification:

$$\Psi_t = \gamma_0 + \sum_{k=1}^{p} \gamma_k \Psi_{t-k} + \xi_t \tag{12}$$

where $\Psi_t = (g_t, r_t^{US}, r_t, z_t)$. where $r^{US}$is the foreign interest rate, r is the effective interest rate on domestic central government debt, g is the real GDP growth rate, z is the nominal exchange rate vis-à-vis the US dollar, γ_k is a vector of coefficients, and ξ is a vector of error terms $\xi_t \sim N(0,\Omega)$.[23]

From the VAR model, Eq. 12, the variance-covariance matrix of residuals, Ω, is retrieved to characterize the joint contemporaneous co-movements between the non-fiscal shocks of debt dynamics. This model's forecasts of non-fiscal debt determinants allow us to obtain economic activity feedback for the uncertainty assessment.

As shocks occur each period, the VAR model generates joint dynamic responses of the non-fiscal debt determinants. There are not sensitive to the variables' ordering, as we are not looking for causal relationships, but for the overall year-to-year dynamics.

This specification is complemented by the analysis of shocks that are not contemporaneous. For example, we study how a shock on the economic activity on t may affect the budget at $t+1$. We consider expected and unexpected changes in the short run (1-2 years) for the non-fiscal and fiscal debt determinants and their interactions.

The estimated FRF is included as a reference for the interaction between primary balance, debt and output gap (which depends on the VAR's output growth path). Each of the forecasts of growth and interest rates with the VAR model, as well as the forecasts of the primary balance with the FRF, will yield corresponding paths for annual debt. These paths are computed recursively with the FRF and the conventional stock-flow identity:

$$d_t \equiv \frac{r-g}{1+g} d_{t-1} - pb_t + s_t \tag{13}$$

where s_t are the stock-flow adjustments for contingent liabilities or changes in debt valuation. We also include the data for total debt and its effective interest rate for Eq. 13.[24]

Finally, we allow for asymmetrical forecasted debt paths by employing bootstrapped errors in the fan charts' methodology. Because it is our aim to assess the results of these forecasts in light of the recently approved fiscal reform, we included the available data for the first semester of 2019. The risk assessment drawn in the fan charts[25] begins in 2020.

[19] The fiscal determinants considered are primary balance, expenditure, tax income, and interest payments, all for the central government and expressed as shares of GDP.

[20] The non-fiscal determinants are real GDP growth, debt effective interest rate, nominal exchange rate, and foreign real interest rate (one-year treasury rate for the United States).

[21] These are estimated using random vectors $\hat{\Lambda}_{t+1}, \ldots, \hat{\Lambda}_T$, such that $\widehat{\Lambda_t} = W v_t$ for each t, where $v_t \sim N(0,1)$ or v_t is bootstrapped, and W is the Choleski factorization of Ω; $\Omega = W'W$.

[22] The stock flow identity is $d_t \equiv \frac{r-g}{1+g} d_{t-1} - pb_t + s_t$, where s_t are stock adjustments.

[23] As we do not distinguish between foreign and domestic debt due to data availability, we chose to use the nominal exchange rate instead of the real effective exchange rate. On one hand, for the risk assessment we need forecasts for debt determinants and, as the real effective exchange rate is an unobservable variable, its forecast errors could compound other estimation errors. On the other hand, the forecasts published by the Banco Central de Costa Rica in its Macroeconomic Program 2019-2020 use the nominal exchange rate, and we would rather be aligned to this official source. Finally, we think nominal exchange rate use is appropriate as we are using aggregate debt, the central bank looks for low variance in nominal exchange rate movements, and there is a low and stable inflation level. For future research, the separation between foreign and domestic debt will open an important channel where the effective exchange rate would be of use.

[24] The effective interest rate is estimated by dividing interest rate payments by total debt. Future research may consider differentiating between local currency (colones) and foreign currency (US dollars) denominated debt as domestic debt can be issued in both, and external debt has only been issued in US dollars. This may influence the accuracy of the forecast for domestic and foreign debt, and the impact of the exchange rate.

[25] The results are depicted within a 90% confidence interval.

Table 1
Unit root test results.

Variable Augmented Dickey-Fuller	Unit root presence Specification*			
	1	2	3	4
Debt/GDP	Yes	Yes	Yes	No
Primary balance/GDP	No	Yes	No	No
GDP growth	No	No	No	No
Debt interest rate	Yes	Yes	Yes	No
Change in nominal exchange rate	Yes	Yes	No	No
One-year US treasury rate	Yes	Yes	Yes	No
CPI inflation	No	Yes	No	No
Structural break test	Specification*			
	1	2	3	4
Debt/GDP	NA	No, 2009	Yes, 2008	No, 1981
Primary balance/GDP	NA	Yes, 1980	No, 2008	No, 2009
GDP growth	NA	No, 2009	No, 2009	No, 2009
Debt interest rate	NA	Yes, 2007	Yes, 1989	No, 1995
Change in nominal exchange rate	NA	No, 2006	No, 2006	No, 1997
One-year US treasury rate	NA	Yes, 2000	No, 1977	No, 1977
CPI inflation	NA	No, 1982	No, 1982	No, 1990

Source: Authors, with Central Bank of Costa Rica, Costa Rican Treasury, and United States Treasury data.
Note: *1: Without intercept or trend; 2: With intercept, but without trend; 3: With intercept and trend; 4: First differences. NA means the specification does not apply to the particular test. For the structural break test, the year considered for the test is specified, and the result of yes or no corresponds to the presence of a unit root. All structural break tests were conducted with an innovational outlier.

5. Empirical assessment

Following the theoretical and empirical framework from the literature and adapting the debt sustainability assessment to the Costa Rican context, we use yearly data from 1974 until 2018.

The series were obtained from different sources: Variables such as central government debt, primary balance, expenditure, income and interest payments came from the Treasury's Ministerio de Hacienda, while the effective interest rate was calculated by dividing interest rate payments by total debt. Series data for GDP, inflation, and real exchange rate were gathered from the central bank, BCCR.[26]

The one-year US Treasury rates were retrieved from the Federal Reserve Bank of St. Louis, and the output, expenditure, and real exchange rate gaps were obtained with the Hodrick-Prescott filter.[27]

It was not possible to compile a data set with higher time frequency given its availability, and even with yearly data it was difficult to obtain a long annual data series for all variables. Some were available since 1950, but others only from 1970 or a later date.

Also, we only consider the debt of the central government, as in Costa Rica the trend of public debt is explained by its behavior. On average, its liabilities respond for more than three quarters of the total public debt. The remaining debt is owed by the BCCR and the non-financial public sector, it has maintained a constant behavior during the last two decades. This is because the BCCR constantly redeems its debt, and other non-financial public entities have acquired their debt to finance investment rather than for the current expenditure, as has been done by the central government. Therefore, it is the latter which explains the dynamics of total public debt.

The statistical properties of the series are key to define the correct specification of the baseline equation described by (8). Therefore, we begin our empirical review by testing for the presence of unit roots in the variables of the model.

Table 1 summarizes the results of two different unit root tests (augmented Dickey-Fuller and structural break test) using four different specifications (without intercept or trend; with intercept, but without trend; with intercept and trend; and first differences).

[26] BCCR and MH, by their acronyms in Spanish.

[27] We acknowledge the shortcomings of using the HP filter. Nevertheless, with annual data and the short sample size, it is difficult to use other approaches such as the Kalman filter. We use the HP filter with a lambda parameter value of 26. This estimation comes from Álvarez Corrales (2017), who based on Marcet and Ravn (2003) adjusted the parameter estimation to the Costa Rican business cycle, which has been described as less pronounced and of shorter length when compared to the US business cycle (standard, $\lambda = 100$). Still, when using both approximations of the output gap for FRF estimates, there were no major changes.

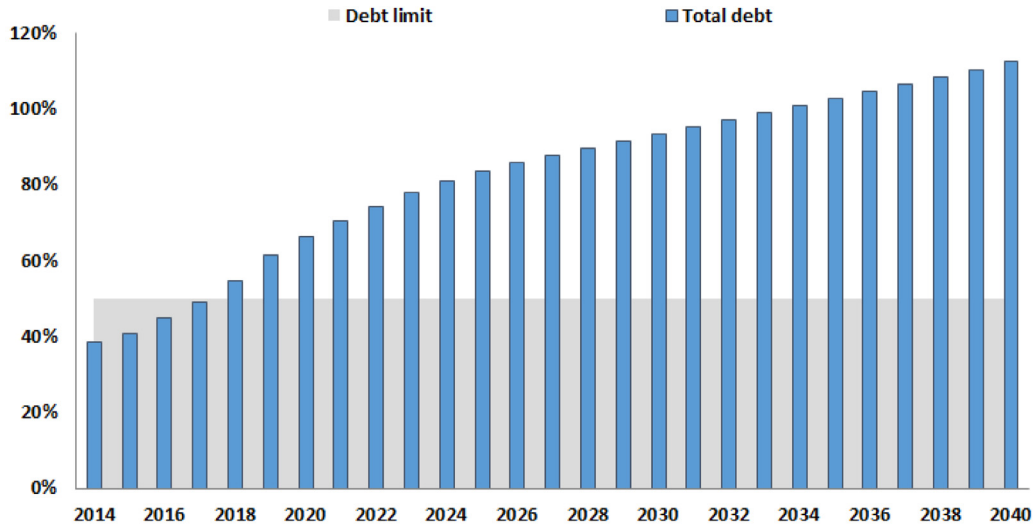


Fig. 9. Intertemporal budget constraint, total debt projection July 2018
Source: Authors.

Table 1 shows the tests are not strongly conclusive about the statistical nature of the variables. However, the ratio of debt to GDP behaves as a unit root process, even when structural breaks are considered.[28]

The year 2008 is recurrent in Costa Rica's analysis of macroeconomic data in general, and of the fiscal variables in particular, mainly because of the fiscal policy response to the financial crisis.

For the ratio of primary balance to GDP, there is no strong evidence for the unit root presence. As expected, the GDP growth and CPI inflation appeared to be stationary, whereas the debt's interest rate and the one-year United States treasury rates have strong evidence of non-stationarity, which is common for interest rate data. Finally, the change in the nominal exchange rate seems to have a unit root process, but when we use a structural break in 2006, this evidence was lost. The latter result is intuitive.

As for the time interval of this research, the exchange rate regime was fixed until the beginning of the eighties, when it changed to a crawling peg (quasi-fixed). Then, it changed to a band system by the end of 2006, where the central bank would only intervene if the exchange was negotiated outside the announced interval. Until then, the exchange rate had a visible upward trend with more volatility after 2006. By February 2015, the central bank adopted a managed floating regime, which allowed this entity to intervene in a discretionary manner to avoid excess volatility, and the exchange rate was defined by the market.

Besides the inconclusiveness of these tests, we prefer those from the structural break with intercept and trend (specification 3 in Table 1), as the structural break in 2008 is more representative of the most recent behavior of debt and primary balance (recall their movements from Figs. 2 and 3).

Whereas the unit root presence for debt-to-GDP ratio would be an indicative for non-sustainability, as stated by Bohn (2007) and described earlier, the time series properties of the data should not be taken as indicators of fiscal sustainability.

We start our empirical assessment by updating the estimations under the IGBC methodology, following the deterministic accounting approach Rojas and Sáenz (2003), and considering the economic context of 2018. The discussion of fiscal reform during this year was profound and generated social tensions that became visible with strikes at certain times. The largest movement came from the education and health sectors, whose strikes had a large social and economic impact: Students lost three months of classes, there were significant delays in scheduled surgeries, and main road blockages occurred, which affected exports by land.

By mid-2018, it was highly uncertain whether the fiscal reform would pass in the Parliament. There was also no clear idea on the cost of financing the deficit of the central government in case it was rejected.

Therefore, we estimated two scenarios under the IGBC approach. The first assumed no fiscal reform, and the results showed an exponential growth of the debt ratio (see Fig. 9), where the debt limit was already surpassed in 2018.

Also, the analysis showed that the required primary balance adjustment in the near future accounted for 7.1% of GDP in 2019 (see Fig. 10); given the context, this seemed unfeasible.

The second estimation assumed the approval of the fiscal reform. Hence, it considered the expected returns of the law on tax income and expenditure calculated by the Treasury. As a result, the path of the debt ratio reached a maximum in 2023 at a level of 65.9% (see Fig. 11). By that year, the required primary balance adjustment was 0.2% of the GDP (see Fig. 12).

[28] The years included for the structural break tests were chosen because they reflected atypical movements in the fiscal variables. For example, 1980 and 1982 represented the debt crisis, while 1995 signals the aftermath of the bankruptcy of the public bank, Banco Anglo. Also, 2008 and 2009 are intended to capture the fiscal decisions on wages and public employment in response to the financial crisis.

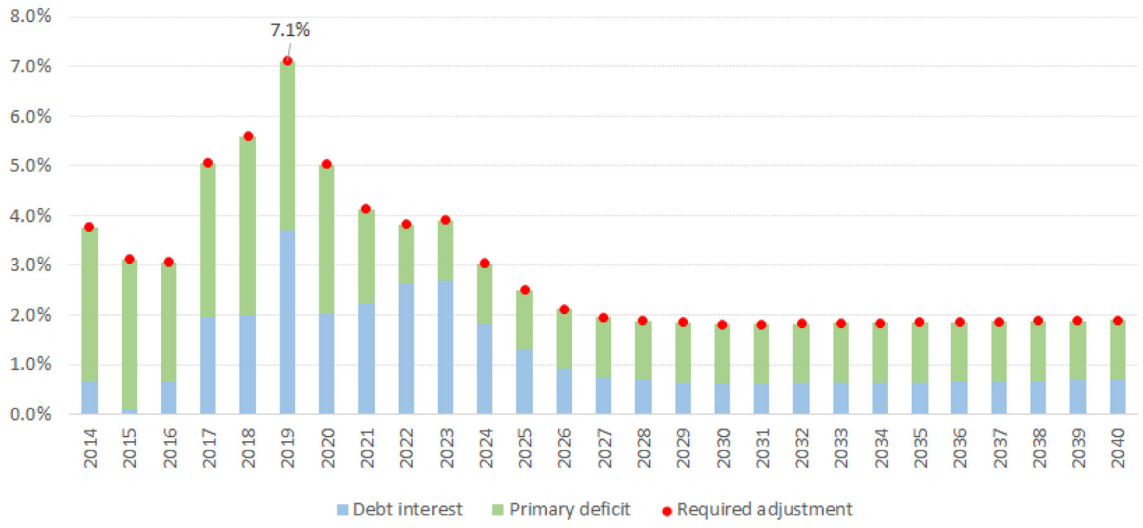


Fig. 10. Intertemporal budget constraint, required adjustment, July 2018
Source: Authors.

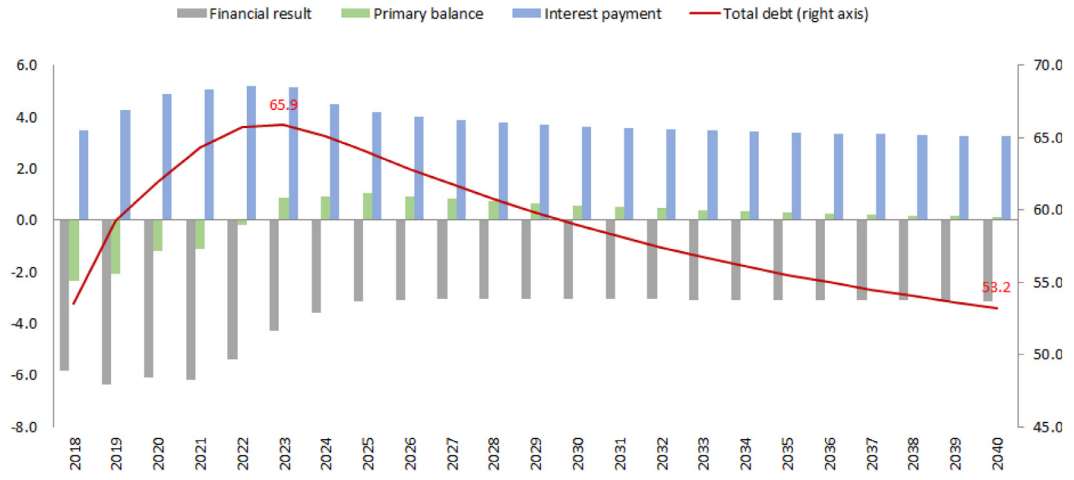


Fig. 11. Financial balance, primary balance, and total debt under fiscal reform
Source: Authors.

Table 2 shows the main assumptions and results for this model.[29] What we observed is that the primary balance adjusts to almost equilibrium up to 2022 (with a surplus in 2023), even when the debt ratio continues growing and goes from 53.6% up to 65.9%.

The underlying assumption is a portfolio rearrangement by the treasury, where short term debt is exchanged for longer maturities. Some external debt is also issued during 2020 and 2021, which translates into a reduction of the nominal interest rate. Given this trend and as time goes on, it is assumed that foreign investors will lower their risk premiums for Costa Rican debt, contributing to a decrease in the interest rate.

The estimates of the IGBC approach rely significantly on assumptions of future behavior. In this case, the treasury is assumed to pursue proficient portfolio management and a strict enforcement of the fiscal rule on expenditure.

Given the unit root tests results (Table 1) and the weaknesses of the IGBC approach mentioned in the literature, we complement the analysis of debt sustainability with the calculation of the FRF and an assessment under uncertainty.

[29] This table summarizes the results obtained from the IGBC model and the main assumptions employed in order to define the required primary balance adjustment as a function of the debt level, real interest rate, and real GDP growth. The data needed was obtained from the central bank or the treasury.

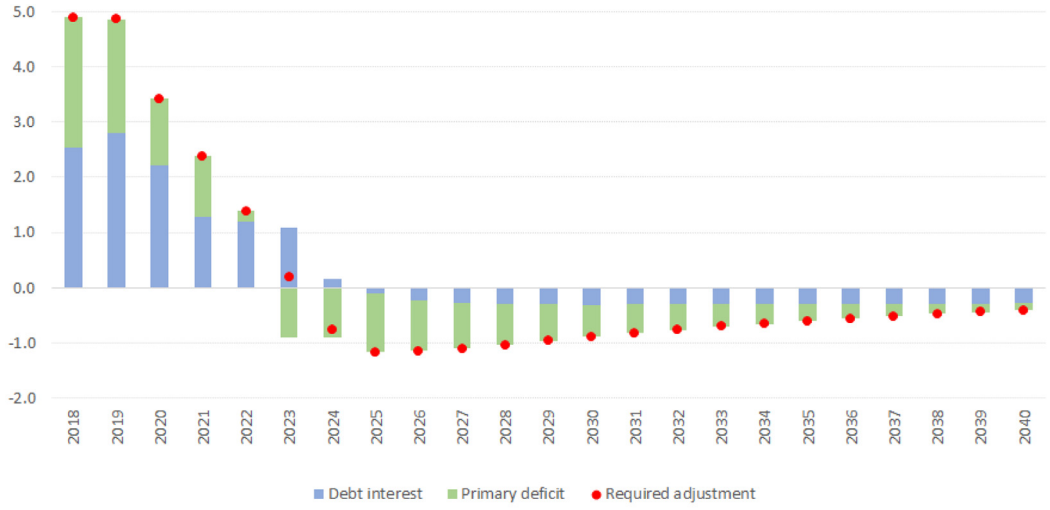


Fig. 12. Primary balance required adjustment, with fiscal reform
Source: Authors.

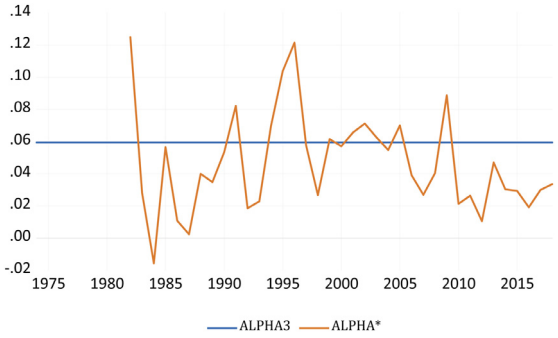


Fig. 13. Short-term debt sustainability analysis with time varying α, 1975-2018
Source: Authors.

The estimates under this approach considered different econometric models and specifications to account for comparability of results and robustness checks. Such a setup also ensures that the results are not driven by any one particular choice in the specification of the model or the variables included.

The OLS and VECM specifications of the FRF for the period 1974–2018 are shown in Tables 3 and 4 respectively. Their results may also be comparted to those using the threshold autoregression methodology shown in Appendix B1.

The results from the debt sustainability coefficient using the VECM estimation are almost the same as the OLS results. However, as will be explained later, the long-run analysis is divergent between the OLS/VAR and VECM estimates.

In most of the regression results obtained, the coefficient related to the initial debt ratio, α_3, is positive and statistically significant; its magnitude varies within a range between 0.05 and 0.08, similar to estimates for several countries from different studies summarized in Appendix D. These estimations show how the primary balance responds to the level of debt-to-GDP ratio.

The only exception is the base specification in Table 3, which has no control variables as the resulting debt-to-GDP coefficient is not statistically significant. This result acknowledges the importance of the inclusion for structural breaks and other periods where fiscal outcomes were affected for a particular reason—for example, the 80s debt crisis, the financial crisis, and the closure of Banco Anglo were all statistically significant and signaled a decline in the primary balance as share of the GDP.

This result seems intuitive, as the fiscal reaction's statistical significance is lost and the primary balance is more persistent, given that its lagged value has a higher estimate. The omission of the dummy variables would normalize a huge impact on primary balance and debt as something normal—not related to extreme situations, as was the case—which could lead to the false conclusion that there was no fiscal reaction at all in Costa Rica.

The estimates show a small, positive, and significant effect, which implies that debt is sustainable, as the positive coefficient is interpreted in the same direction of the primary balance when the debt level changes: If the latter increases, the reaction of the government will be to increase the primary balance in the following year; when the opposite occurs (i.e., initial debt decreases), the authority will ease the fiscal effort, decreasing the primary balance. For example, a 1% increase in the ratio of debt to GDP at $t-1$ is associated with a short-run increase between 0.05% and 0.08% in the ratio of primary balance to GDP.

Table 2
IGBC results considering the impact of the fiscal reform, 2019-2023.

	2018	2019	2020	2021	2022	2023
Debt ratio	53.60%	59.30%	62.00%	64.30%	65.70%	65.90%
Change in debt ratio	5.51%	5.56%	2.86%	2.36%	1.37%	0.16%
Primary balance	-2.35%	-2.06%	-1.20%	-1.10%	-0.18%	0.90%
Real interest rate (effective)	7.93%	7.44%	6.31%	4.92%	4.81%	4.71%
GDP growth	2.63%	2.19%	2.55%	2.85%	2.94%	3.07%
Deposits (national bank system)	-0.28%	0.76%	-0.51%	0.01%	0.01%	0.01%
Financial deficit	5.82%	6.34%	6.09%	6.16%	5.38%	4.27%
Interest expenditure (% of GDP)	3.47%	4.29%	4.88%	5.06%	5.20%	5.16%
Nominal interest rate	10.51%	10.39%	9.80%	8.17%	8.08%	7.85%
Inflation (GDP deflator)	2.39%	2.75%	3.28%	3.10%	3.11%	3.00%
External debt	10.22%	13.26%	14.38%	13.89%	13.38%	12.90%
Local debt	43.33%	45.85%	47.59%	50.45%	52.32%	52.97%
Total debt	53.55%	59.11%	61.97%	64.33%	65.70%	65.87%
Required primary balance	4.89%	4.86%	3.42%	2.38%	1.39%	0.18%

Source: Authors, with information from BCCR and Ministerio de Hacienda.

Table 3
Ordinary least squares estimation.

Dependent variable: Primary balance (Pb)				
Variable	OLS 1	OLS 2	OLS 3	OLS 4
Constant	-2.24**	-2.18**	-1.68	-1.55
	(0.88)	(1.03)	(1.55)	(1.73)
Pb $_{t-1}$	0.59***	0.53***	0.49***	0.83***
	(0.08)	(0.10)	(0.13)	(0.13)
Debt $_{t-1}$	0.08***	0.07**	0.07**	0.04
	(0.02)	(0.03)	(0.03)	(0.05)
Output gap	0.02	0.02	0.01	0.01
	(0.07)	(0.06)	(0.07)	(0.18)
Expenditure gap		-0.08***	-0.08***	
		(0.02)	(0.02)	
RER gap		0.02	0.02	
		(0.03)	(0.03)	
US Treasury			-0.06 (0.08)	
Dummy 80's	-1.59***	-1.93***	-1.59**	
	(0.58)	(0.54)	(0.62)	
Dummy 1994	-2.62***	-1.50***	-1.47***	
	(0.29)	(0.42)	(0.41)	
Dummy post-2008	-1.83***	-1.80***	-2.19***	
	(0.33)	(0.42)	(0.69)	
Observations	44	44	44	44
R^2	0.79	0.85	0.85	0.62

Source: Authors, with Central Bank of Costa Rica, Costa Rican Treasury, and United States Treasury data.
Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels.

Moreover, when looking at the long-run response estimated by the VECM model, the associated increase in primary balance would be close to 0.17%. Any short-run disequilibrium would be corrected by a change between 40% and 46% of the coefficient during the first year, meaning the overall adjustment of 0.17% would be achieved 2.5 years later.

Although the magnitude may seem small, this is consistent with Bohn's (2007) approach to debt sustainability: Even if the debt is on an explosive future path, its growth rate might not be fast enough, meaning the IGBC condition for sustainability holds.

Relative to other countries, Table D1 shows an international comparison for FRF estimates. Several studies document lagged debt coefficients between 0.02 and 0.12 for emerging and advanced economies.

The lagged primary deficit as a percentage of output—the coefficient that controls for inertia—is always positive and significant. For Costa Rica, this is expected due to the high inflexibility of expenditures and the difficulty to approve a comprehensive fiscal reform to tackle the outstanding historic public financial needs. The results show that every time the deficit increases by 1%, it will cause an increment between 0.31% and 0.59% in the following year's deficit.

Regarding the output gap, none of the estimations showed a significant coefficient. This might be because the business cycle has not been a determinant for the primary surplus; hence, there is weak evidence of fiscal policy not being used as a stabilization tool. At the same time, this unresponsiveness may be explained by the high degree of inflexibility in expenditures.

Table 4
Vector error correction model estimation.

Dependent variable: Primary balance (Pb)			
Variable	VECM 1	VECM 2	VECM 3
Debt $_{t-1}$	0.17***	0.17***	0.16***
	(0.06)	(0.05)	(0.05)
Output gap	-1.01	-0.02	-0.03
	(0.07)	(0.06)	(0.06)
Error correction	-0.40***	-0.44***	-0.46***
	(0.10)	(0.08)	(0.09)
ΔDebt$_{t-1}$	0.02	0.003	-0.005***
	(0.05)	(0.04)	(0.05)
Expenditure gap		-0.10***	-0.10***
		(0.03)	(0.03)
RER gap		0.01	0.01
		(0.02)	(0.02)
US Treasury			-0.04
			(0.07)
Dummy 80's	-1.58**	-1.75***	-1.47*
	(0.77)	(0.63)	(0.80)
Dummy 1994	-2.75***	-1.32	-1.28
	(1.06)	(0.94)	(0.95)
Dummy post-2008	-1.96***	-1.97***	-2.21***
	(0.47)	(0.38)	(0.55)
Alpha	**-0.05**	**-0.07**	**-0.08**

Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels. Alpha refers to α_3 from equation (11), the comparable coefficient with respect to the OLS and VAR estimations for the fiscal reaction function, particularly coefficient for $Debt_{t-1}$ in Table 3. Source: Authors, with Central Bank of Costa Rica, Costa Rican Treasury, and United States Treasury data.

Other variables included in the regressions are the expenditure gap, real exchange rate gap, and the foreign interest rate. The former is in all the cases highly significant, with a coefficient that fluctuates between −0.8 and −1.05. As long as the government expenditure is above its own trend as expected, it will determine a decrease in the primary balance. On the contrary, the real exchange rate gap is not statistically significant for all cases. The one-year US treasury rate was included as explanatory variable. However, it was not significant in any estimation, even though it had the expected negative sign.

In Appendix Table B3, we perform three additional estimations as a robustness check, as presented in Bohn (1998) and D'Erasmo et al. (2016), including other variables that can shed some light on the fiscal reaction dynamics. Namely, we measure the possible asymmetric response of primary balance conditional on a debt-to-GDP ratio above or below its mean when controlling for a time trend, and also with the squared deviation of the ratio relative to its mean. For instance, the asymmetric response estimation introduces a nonlinear spline coefficient when the debt is higher than its mean.

In the FRF that contains asymmetric response, the α_3 coefficient achieves a value of 0.14, while the spline parameter is -0.13 when debt is above its average. This means that for above-average debt ratios, the response of the primary balance is lower than for those below average, having a net effect of 0.01.

However, the spline coefficient is not statistically significant. This means there is no clear evidence for nonlinear effects on the FRF even when the primary balance's reaction or coefficient magnitude doubles with respect to the OLS estimates (0.07).

The second estimation adds the squared deviation of the debt ratio, which results in a coefficient of -0.01. This result is highly significant but close to zero, indicating that higher debt variability will generate a lower reaction of primary balance, but by a small magnitude.

The third equation includes a time trend, but its inclusion makes the lag of the primary balance non-significant. Additionally, the debt's coefficient changes its sign, implying there is no sustainability as Bohn (2007) defines it. The inclusion of the time trend could capture the positive effect of price level and population increases on both the debt and primary balance, but as they as shares of GDP, the overall effect is not straightforward.

Also, the trend inclusion takes away the autoregressive process for the primary balance. Therefore, as the primary balance decreases correspond to debt increases (especially for the last years of the sample), the debt coefficient becomes negative given the lack of feedback from the previous primary balance. Given its confounding nature in this case, we prefer to keep the results with time trend as an exogenous variable for robustness only.

We acknowledge the importance of finding evidence of nonlinear primary balance reaction, so we included the threshold autoregressive model (TAR), using debt gap as a transition variable. With it, we attempt to show the reaction function during different phases of the cycle related to the debt.

These estimations are presented in Appendix Table B4. The results turned robust and were similar to the OLS estimations. Thereby, for discussion, we focus only on a couple of new coefficients, $DebtGap_{t-1}{}^{+}$ and $DebtGap_{t-1}{}^{-}$, which are related to the positive and negative lagged debt gap observations, respectively.

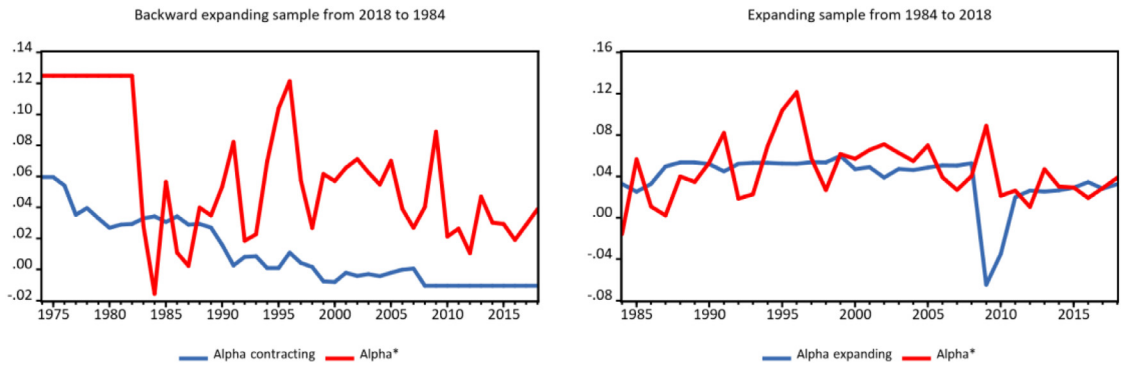


Fig. 14. Short-term debt sustainability analysis with time-varying α and varying sample, 1975-2018
Source: Authors.

When the debt level is above its long-run trend (positive gap), the coefficient is negative, meaning the government's fiscal reaction will be less responsive. The opposite occurs for the negative gap observations, and the reaction functions are more responsive. Overall, this accounts for evidence on nonlinearities given the statistical significance. Again, when the debt is high or is increasing above its long-run trend, the FRF losses strength and the primary balance is less responsive to past debt changes with an effect of 0.02,[30] almost a fourth of the OLS estimates. On the other side, there are almost no improvements in FRF when the debt is below its long-run path, a serious problem for Costa Rica's fiscal policy.

We also examined the TAR estimations using output gap as a transition variable.[31] We found no significant coefficient for this transition variable, which could again be interpreted as evidence that fiscal policy is unresponsive to the business cycle.

From all these econometric specifications, it seems that the results are robust and not driven by a particular choice of model or variables. But given the behavior of Costa Rica's public finances explained in Section 2, along with the time span considered in this research, we consider it is necessary to evaluate debt sustainability for a set of subsamples. Hence, the next step is to define periods during which fiscal policy has been sustainable according to the standard DSA framework as in Burger et al. (2012).

We begin with the short-run parameter by taking the OLS baseline specification with controls. The resulting estimate for $\alpha_3 = 0.07$ is compared with $\alpha^* = \frac{r-g}{1+g}$ presented in Eq. 7; if α^* is greater than α_3, it implies debt as share of GDP is not sustainable in the short term.

Fig. 13 shows the historical dates for short-term unsustainability are in the 1980s, corresponding to the debt crisis; 1994–95, the moment of Anglo Bank's closure; and 2009, with the international financial crisis causing the structural break in the debt path.

The long-run sustainability computed following Burger et al. (2012) is shown in Fig. A1 in the Appendix section for both the OLS and VECM models.

Our sustainability conclusions are completely different for both specifications. OLS indicates there has always been long-run sustainability, but the VECM says otherwise for all periods. The disparity of results brings doubts about the use of the standard DSA with the long-run coefficients.

Additionally, there could be an impact from specific historical periods with divergent macroeconomic and fiscal behavior, such as the '80s debt crisis, which can bias the coefficients.

To account for these caveats and in order to give more relevance to recent history, we computed short- and long-run DSAs while steadily enlarging the sample. We began estimating with a ten-year sample from 1975 to 1984. For a second estimation, we expanded the sample by a year and recovered the corresponding debt coefficient. This estimation was done recursively, and we report it as "$\alpha_{\text{expanding}}$" (right panel of Fig. 14).

We next performed the same exercise, but backward. Namely, the first estimation used a time sample from 2009 until 2018 and added a year at a time. Each respective coefficient is reported for the first year of the sample (e.g., 2009) as "$\alpha_{\text{contracting}}$" (left panel of Fig. 14).

Fig. 14 shows the results for the short run.[32] On the left, the backward-expanding window (alpha contracting estimate) visualizes the lack of sustainability of the 80s debt crisis well. Despite that, it seems as though the forward-expanding window (alpha expanding estimate) compiles recent fiscal events in a better manner. With it, is possible to see the 2018 uncertainty about fiscal sustainability when the fiscal reform was still in the bureaucratic process of approval, and it was difficult for the treasury to obtain funds through debt ($\alpha^* > \alpha_{expanding}$ at the end of the sample, i.e., 2018).

[30] To make this inference, we assume that both coefficients could be added, even though the related variables are not exactly the same. While one parameter is related to debt as ratio of GPD, the other is related to debt gap.

[31] See results in Table B1 in the Appendix.

[32] Fig. A2 shows the long-run counterparts. Both the expanding backward and forward samples still present the same issue of bias in favor of the sustainability conclusions, especially at the end of the sample near 2018.

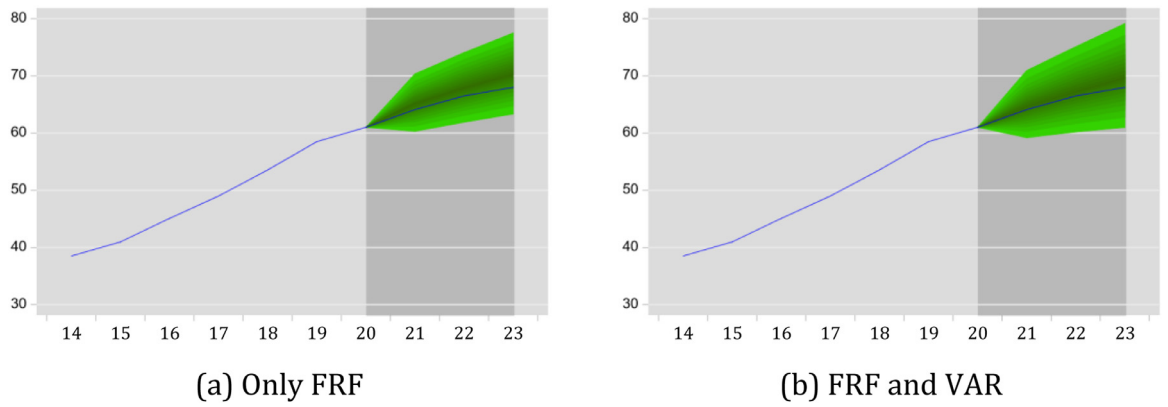


Fig. 15. Forecasted public debt path under uncertainty
Note: Treasury forecast in blue, this study's mean forecast in dark green.
Source: Authors, with information from the BCCR and Ministerio de Hacienda.

6. Risk assessment

The last part of our debt sustainability analysis is to build an assessment under uncertainty on our FRF results. Multiple sources exist that may affect the projected path of fiscal policy, such as domestic and foreign economic activity evolution and private agents' expectations.

Costa Rica has weak public finance results and a recently approved fiscal reform. These conditions have no clear net effect. On one hand, they reduce agents' disposable income because of taxes in a context of economic slowdown, with the ensuing negative impact on growth. On the other hand, the reform could foster agents' optimistic expectations about the public sector's finances and a decrease in domestic interest rates, which will provide a lower crowding-out effect for private investments.

It is difficult to determine which effect might dominate in the end. Moreover, given the normalization of international monetary policy, the increase in international interest rates, the negative effects of the implemented measures on international trade, and lower forecasts of international economic activity all add uncertainty to Costa Rica's fiscal policy outcomes. Therefore, a risk assessment is necessary. To do this, we follow the fan chart methodology proposed by Celasun et al. (2006).

This exercise will evaluate the estimated forecast made by the treasury, which considers the returns from the fiscal reform on the main fiscal variables. To do this, we need to include the projections of the non-fiscal debt determinants published by the central bank in its macroeconomic program.[33]

Given these projections, our aim is to obtain different debt paths with different probabilities by measuring the uncertainty of the debt forecast based on the feedback from economic activity. [34] This means we model the relationship between the main economic variables (real GDP growth, effective interest rate, foreign interest rate, and nominal exchange rate) and their impact on public debt.

Fig. 15 shows the debt's forecast under uncertainty. The blue line is our baseline for comparison; it represents the path forecasted by the treasury with the expected returns of the fiscal reform on income (tax raises) and expenditures (fiscal rule). The green spectrum represents the possible paths for debt that the model predicts. Each of them has an associated probability of occurrence.

For the estimations of the fan charts, we also ponder for comparison whether there is economic feedback activity or not. If there is, we use a VAR model to complement the FRF results (Fig. 15.b).

For both cases depicted in Fig. 15, the mean forecast (in dark green) is above the path projected by the Ministerio de Hacienda. Nevertheless, when we include the economic activity feedback in Fig. 15b, the fan chart's confidence interval widens.

The treasury's forecast is near the 45th percentile of the fan chart's average 70% debt ratio. Accordingly, the lower and upper bounds for the debt without feedback are 63% and 77% in 2023 respectively, whereas with economic feedback, these values widen to 61% and 79%, respectively.

To understand the underlying cause of these differences, it is important to analyze the debt determinants under uncertainty. Fig. 16 shows the primary balance forecast under uncertainty, with and without economic feedback.

The treasury's forecast of 0.1% for the ratio of primary balance to GDP in 2023 seems optimistic in comparison to the results of the model; it is above the 60th percentile of both fan charts.

It does not seem as though the primary balance is leading the differences between the debt paths observed in Fig. 15. When looking at other determinants such as the economy's growth rate and the change in the nominal exchange rate (Fig. 17), there are no important differences between the treasury's forecast and the fan chart estimates, except in the long run, as the potential GDP growth forecast is 3.2% instead of the 3.5% used by the treasury.

[33] Macroeconomic program of January 2019.
[34] For comparison, we do both estimations: with and without economic activity feedback.

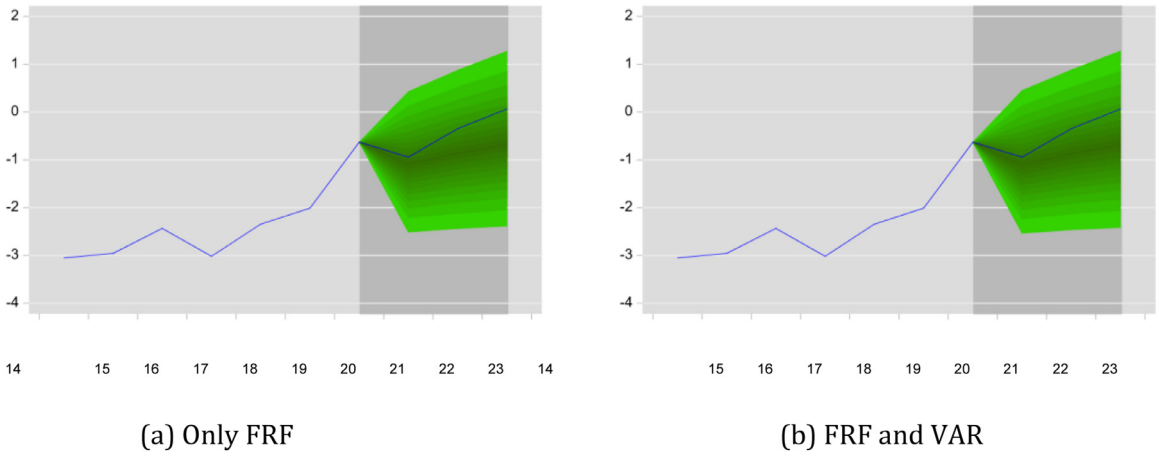


Fig. 16. Primary balance uncertainty forecast
Note: Treasury forecast in blue, this study's mean forecast in dark green.
Source: Authors, with BCCR and treasury data.

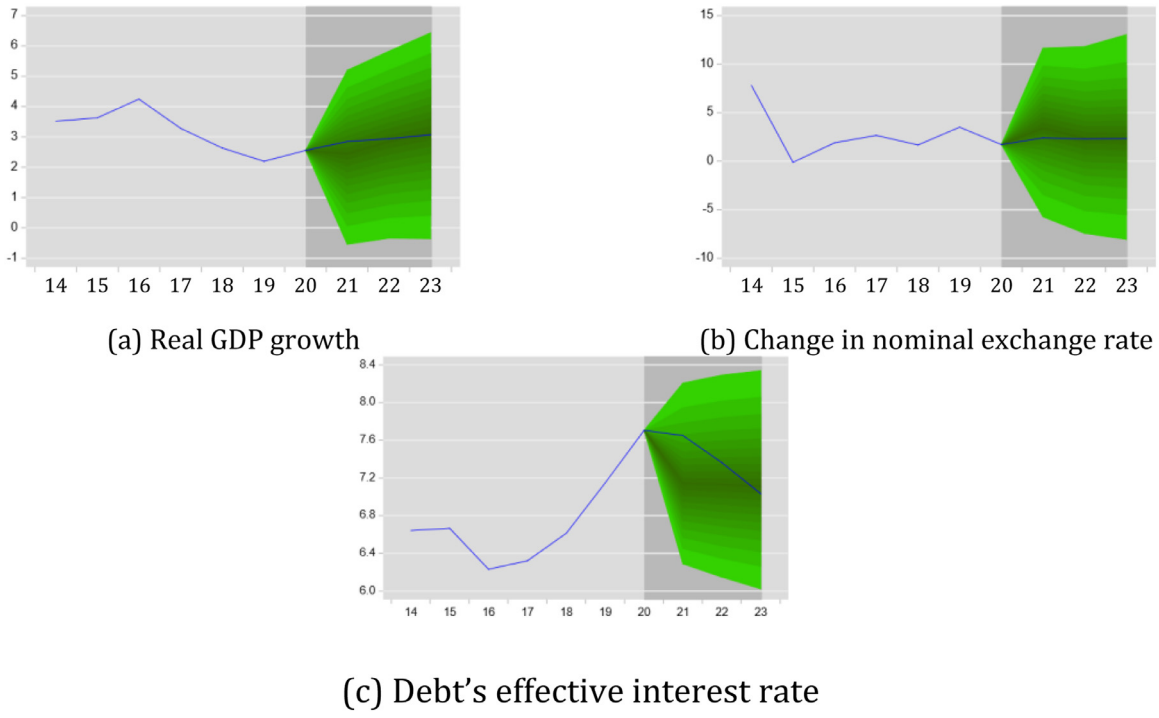


Fig. 17. Non-fiscal determinant forecast under uncertainty
Note: Treasury forecast in blue, this study's mean forecast in dark green.
Source: Authors, with BCCR and treasury data.

What happens with the debt's effective interest rate in 2023? As Fig. 17c shows, its future path presents a different story: The treasury's forecast shows that debt will pay a real interest of about 7.03%, which is near the 41st percentile from our forecast, while our average debt real interest rate is 7.11%. When analyzing the forecast until 2030,[35] the treasury forecasts an interest rate of 6.8%, whereas the model's outcome is 8.3%. This difference might be the reason why for 2030, the treasury expects a level of 58% debt-to-GDP ratio, while this model predicts 66%. For us, the maximum level of the debt ratio will be 68% in 2026, after which this upward trend reverses.

[35] In Appendix C, we show forecasted paths for all variables until 2030.

Intuitively, the interest rate path is influenced by the uncertainty of fiscal outcomes, the increasing past debt levels, and agents' expectations on whether the government will be able to effectively cut public expenditure in the next few years. Also, the decrease in disposable income caused by the increase in taxes, the increment of the international interest rates given the normalization of international monetary policy, the negative effects of the measures on international trade implemented between China and the USA, and a lower forecast of international economic activity, add uncertainty to the debt's interest rate, the primary balance, and the future debt path.

Given the results of this model, we conclude that it is necessary to include economic feedback in the estimations. The inclusion of other determinants such as the interest rate helps forecast the debt path more accurately. Recall that including the VAR model in the fan chart estimation implies adding the exchange rate and the foreign interest rate; jointly, they could provide a reasonable forecast for the debt interest rate due to the uncovered parity of interest rates, despite empirical limitations.

7. Final remarks

The main goal of this research was to determine whether Costa Rica's debt path is sustainable. Therefore, we empirically assessed Costa Rica's public debt sustainability through three complementary approaches: the calculation of the debt-stabilizing primary fiscal balance obtained from the government's intertemporal budget constraint, IGBC; the estimation the of a fiscal policy reaction function (FRF); and the estimation of fan charts for the primary fiscal balance and public debt, both expressed as shares of GDP.

Along the way, it became evident that the IGBC provided valuable information on the topic, but the approach was somewhat limited: Its conclusion on sustainability holds even under weak unit root test results, the methodology demands assumptions that can be unrealistic for the future trajectories of the main variables, and the solvency condition does not necessarily imply that debt is sustainable in the long run.

Therefore, we decided to complement those results with the FRF estimation, which, to the best of our knowledge, has not been done before for Costa Rica, probably due to data limitations. Following Bohn's research,[36] we were able to define, under different estimations and specifications, that the debt level is sustainable in the long run, by observing that the debt coefficient was positive and significant.[37] For the short run, the estimated fiscal reaction states for each 1% increase in debt-to-GDP ratio a primary balance increase near 0.05%, which accumulates to a long-run reaction of 0.17% two and a half years later.

However, in the last few years, Costa Rica's fiscal performance was not conducive to sustainability, except for the recent fiscal rule passed through Congress. Most likely, Costa Rica's history of small responses to fiscal imbalances influences this result. Also, the permanent increase in fiscal stimulus since 2008 and the lack of political consensus on previous fiscal reforms shaped the debt-to-GDP path upward.

For this reason, we studied the short-run sustainability behavior by conducting analyses using different data time windows. On one hand, we started with a sample from 1974 until 1985 and added observations one by one. On the other hand, we started with a sample from 2009 back until 2018 and added observations at the beginning of the sample. By analyzing the estimated α coefficient in terms of sign and significance, we were able to define that recent data signals that Costa Rica is heading toward unsustainability, meaning it had run unsustainable policies in the past. This is why the implementation of the new fiscal rule is key. It was an important first step towards sustainability approved on December 5^{th}, 2018.

Moreover, given the importance of an analysis of the likelihood of compliance with the new fiscal rule, we complemented our risk assessment by including the expected changes in government income and expenditure estimated by the treasury from 2019 until 2023. This means our projected series include policy changes in terms of taxation increases and expenditure cuts to comply with the rule.

Broadly, given our fan charts from the FRF—which consider the VAR behavior, or as we called it, economic feedback—it seems the path to sustainability may take longer than what has been projected by the treasury. The Costa Rican Treasury expected 0.1% for the ratio of primary balance to GDP in 2023 relative to our average of near -0.7%. Nevertheless, it is not the optimism in the primary balance, but in the effective interest rate that accounted for the difference in timing. This interest rate is expected by the treasury to be 6.8% in 2030, whereas we found it should be 8.3%, 1.5 percentage points above. Thus, our estimates for the debt-to-GDP ratio state its peak might be reached near 2026-27, almost four years later than the treasury's expectations.

In sum, we find that Costa Rica's debt has been unsustainable for specific episodes in the long and short run. For the most recent observations, the conclusion is that the debt trajectory is unsustainable. Given that a major fiscal reform was approved by the end of 2018, an uncertainty evaluation of its impact on the path of adjustment of primary balance until 2023 and 2030 is included using the official estimated projections of the reform. The result shows that the maximum level of the debt ratio will be 68% in 2026, and a year later, its upward trend should revert.

These results support the idea that for policymakers, an integral approach that analyzes fiscal sustainability must always be pursued in order to grant a broader and more complete overview of what can be expected in the short and long run on debt sustainability.

There are other important aspects to discuss built upon the results of this research. The recent approval of the fiscal reform in Costa Rica implies a substantial change in the expected trend of the fiscal variables. Still, as mentioned, this country has a high degree of inflexibility for its expenditures: More than 80% are defined by law or constitution, and most of the budget goes to current

[36] Bohn (1995), Bohn (1998), Bohn (2007).

[37] Even though, as shown, we had contradictory results when comparing the α estimation of the OLS and the VECM.

expenditures. Also, there are automatic expansion factors on public sector wages, which may signal that the sustainability attained with this reform could reverse in the long run.

Also, there must be a discussion to determine whether the cuts in current expenditures will strengthen public investment, turning into a virtuous path for future growth. In terms of policymaking, it is necessary to include analyses of cost-benefit and return over investment along with the sustainability analysis, to determine whether the constricting fiscal policy might be compensated for by growth-friendly policies towards capital expenditure.

Going forward, a debt crisis would force Costa Rica to undertake damaging emergency cuts and freezes to public spending, including the downsizing of a welfare system that is a model for the region and for emerging countries more broadly. It would also mean deferring once more the nation's much-needed upgrade in public infrastructure.

However, larger fiscal deficits not only lead to larger and more painful adjustments, they tend to limit the ability to implement much-needed reforms, as they require emergency measures to first bring the fiscal situation under control. Only well-planned and designed spending, as well as structural tax reforms, can put debt on a sustainable path while preserving or even enhancing long-term growth and inclusiveness. There is still time for Costa Rica to take such a path, but time is quickly running out .

Declaration of Competing Interest

None.

Appendices

A. *Standard log-run sustainability analysis*

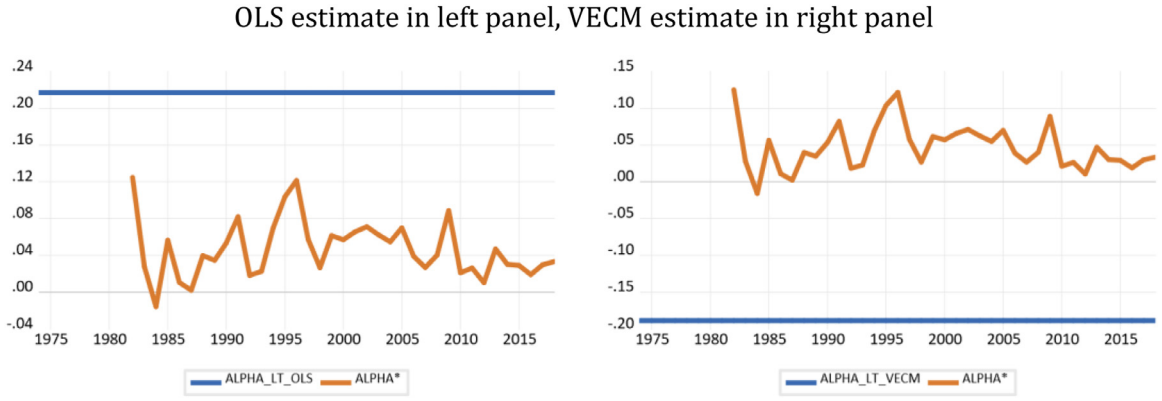


Fig. A1. Long-term debt sustainability
OLS estimate in left panel, VECM estimate in right panel
Source: Authors.

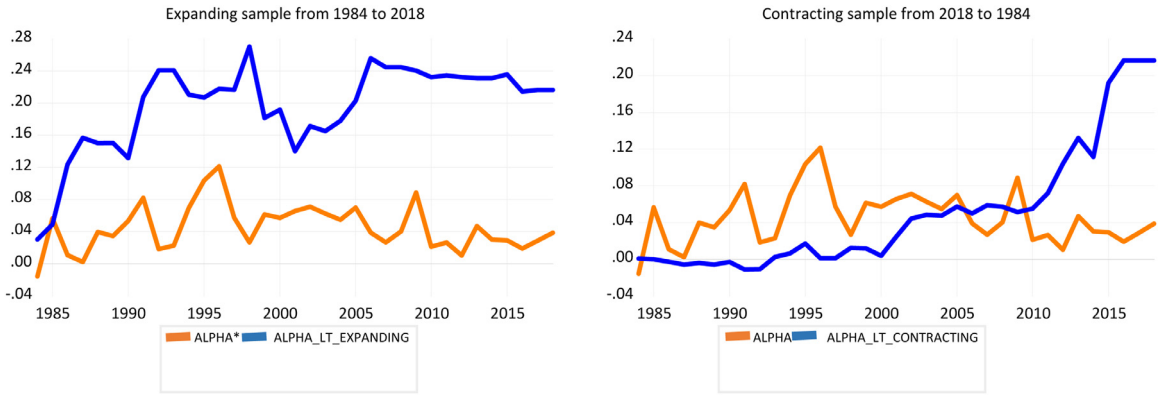


Fig. A2. Long term debt sustainability analysis with time varying alpha, from 1984 until 2018

B. Other FRF estimations

Table B1
Threshold Autoregressive Estimation: Using Output Gap.

Dependent variable: Primary Balance (Pb)			
Variable	TAR 1	TAR 2	TAR 3
Constant	-1.84*	-2.19*	-1.77
	(1.02)	(1.16)	(1.42)
Pb_{t-1}	0.58***	0.52***	0.47***
	(0.11)	(0.12)	(0.15)
$Debt_{t-1}$	0.07**	0.07**	0.07**
	(0.03)	(0.03)	(0.03)
Output Gap^{+}	-0.09	0.04	0.07
	(0.16)	(0.20)	(0.21)
Output Gap^{-}	0.13	0.02	-0.02
	(0.08)	(0.09)	(0.10)
Expenditure Gap		-0.08***	-0.09***
		(0.02)	(0.02)
RER Gap		0.01	0.01
		(0.03)	(0.03)
US Treasury			-0.07 (0.07)
Dummy 80s	-1.31	-2.10	-1.84
	(1.03)	(1.32)	1.33
Dummy 1994	-2.59	-1.52***	-1.47***
	(0.32)	(0.46)	(0.43)
Dummy Post Crisis	-1.93	-1.83***	-2.25***
	(0.42)	(0.53)	(0.69)

Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels. Source: authors with Central Bank of Costa Rica, Costa Rica's Treasury, and United States Treasury data.

Table B2
Ordinary least squares estimation.

Dependent variable: Primary Balance (Pb)			
Variable	OLS 1	OLS 2	OLS 3
Constant	-3.48***	-4.26**	-4.09**
	(1.41)	(1.22)	(1.80)
Pb_{t-1}	0.32***	0.53***	0.31***
	(0.11)	(0.10)	(0.12)
$Debt_{t-1}$	0.14***	0.07**	0.14***
	(0.05)	(0.04)	(0.04)
Output Gap	0.10	0.02	0.10
	(0.09)	(0.07)	(0.09)
Expenditure Gap		-0.10***	-0.10***
		(0.03)	(0.03)
RER Gap		0.01	0.01
		(0.02)	(0.03)
US Treasury			-0.02
			(0.07)
Dummy 80s	-3.16***	-1.93***	-3.05**
	(0.78)	(0.63)	(0.77)
Dummy 1994	-2.41***	-0.86*	-0.85***
	(0.36)	(0.49)	(0.50)
Dummy Post Crisis*$Debt_{t-1}$	-0.10	-0.16***	-0.16***
	(0.06)	(0.04)	(0.05)
Dummy Post Crisis	1.13	3.13**	2.95***
	(1.81)	(1.39)	(1.98)
Obs.	44	44	44
R^2	0.80	0.88	0.88

Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels. Source: authors with Central Bank of Costa Rica, Costa Rica's Treasury, and United States Treasury data.

Table B3
Additional OLS Estimations.

Dependent variable: Primary Balance (Pb)			
Variable	Asymmetric response	Debt squared	Time trend
Constant	-3.55*	-2.32**	-7.17***
	(1.91)	(0.97)	(1.55)
Pb_{t-1}	0.37***	0.36***	0.11
	(0.11)	(0.11)	(0.08)
$Debt_{t-1}$	0.14**	0.10***	-0.07**
	(0.06)	(0.02)	(0.03)
Output Gap	0.04	0.03	-0.16***
	(0.07)	(0.06)	(0.04)
Expenditure Gap	-0.07**	-0.10***	-0.10***
	(0.03)	(0.02)	(0.02)
RER Gap	0.06	0.04	-0.01
	(0.05)	(0.03)	(0.01)
US Treasury	-0.07	-0.05	0.14*
	(0.07)	(0.06)	(0.08)
max(0,Debt*-Debt)	-0.13 (0.08)		
($Debt^*$-$Debt^2$)		-0.006*** (0.001)	
Time Trend			0.20*** (0.04)
Dummy 80's	-2.23***	-2.47***	-0.71*
	(0.70)	(0.71)	(0.41)
Dummy 1994	-1.58***	-1.25***	-1.39***
	(0.48)	(0.45)	(0.23)
Dummy Post Crisis	-2.14***	-2.08***	-5.41***
	(0.60)	(0.50)	(0.73)
Obs.	44	44	44
R^2	0.87	0.89	0.94

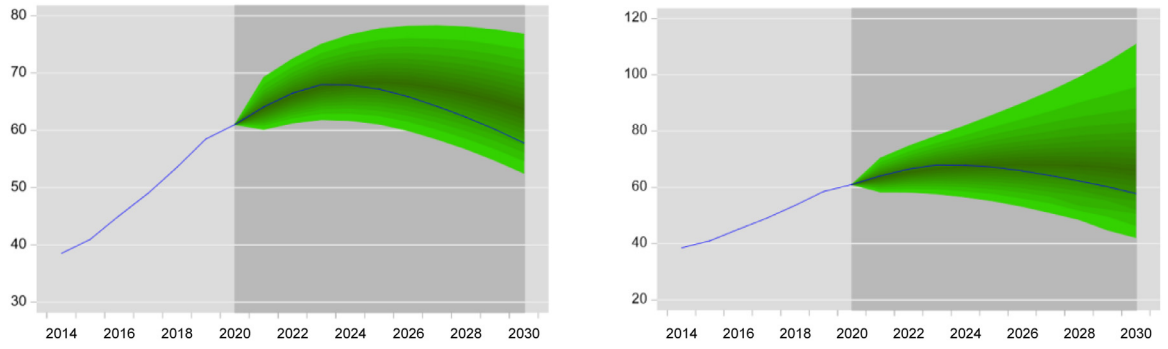
Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels. Debt* refers to debt's trend given by Holdrick-Prescott filter. Source: authors with Central Bank of Costa Rica, Costa Rica's Treasury, and United States Treasury data.

Table B4
Threshold Autoregressive Estimation: Using Debt Gap.

Dependent variable: Primary Balance (Pb)			
Variable	TAR 1	TAR 2	TAR 3
Constant	-1.23*	-1.01	-0.56
	(0.67)	(0.80)	(1.04)
Pb_{t-1}	0.55***	0.47***	0.43***
	(0.10)	(0.12)	(0.14)
$Debt_{t-1}$	0.06**	0.05**	0.05*
	(0.02)	(0.02)	(0.02)
Debt Gap_{t-1}^{+}	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)
Debt Gap_{t-1}^{-}	0.001***	0.001***	0.001***
	(0.00)	(0.00)	(0.00)
Output Gap	-0.08	-0.09	-0.10
	(0.09)	(0.06)	(0.06)
Expenditure Gap		-0.09***	-0.09***
		(0.03)	(0.03)
RER Gap		0.01	0.01
		(0.02)	(0.02)
US Treasury			-0.06 (0.06)
Dummy 80s	-1.59***	-1.94***	-1.62**
	(0.53)	(0.64)	(0.67)
Dummy 1994	-2.85***	-1.60***	-1.56***
	(0.27)	(0.38)	(0.41)
Dummy Post Crisis	-2.20***	-2.18***	-2.54***
	(0.31)	(0.40)	(0.56)
Obs.	44	44	44
R^2	0.82	0.89	0.89

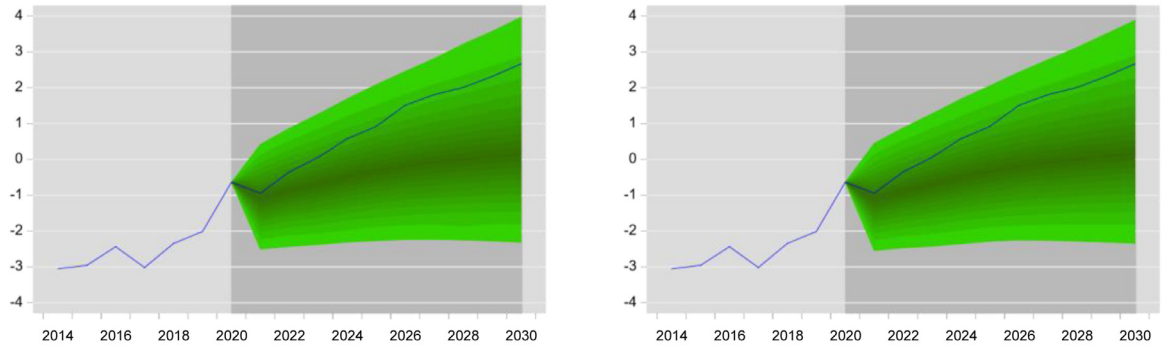
Source: authors with Central Bank of Costa Rica, Costa Rica's Treasury, and United States Treasury data.
Note: Standard errors in parenthesis. * 10%, ** 5%, and *** 1% statistical significance levels.

C. Risk assessment until 2030



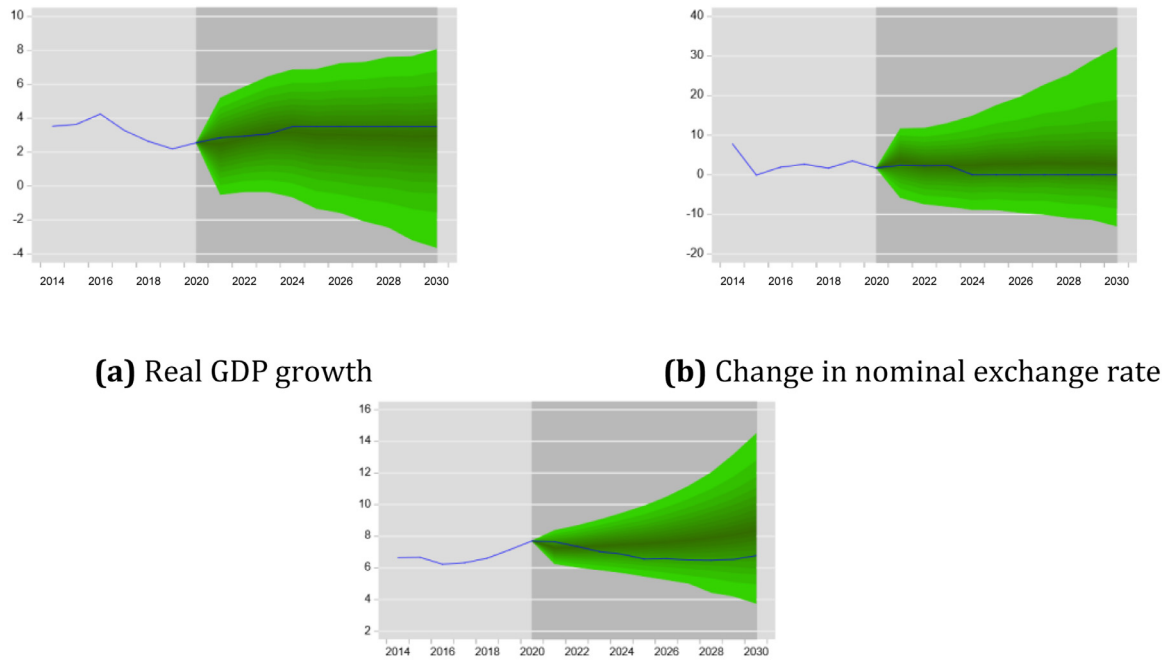
(a) Only FRF **(b)** FRF and VAR

Fig. C1. Debt's uncertain forecast until 2030
Source: authors.



(a) Only FRF **(b)** FRF and VAR

Fig. C2. Primary balance's uncertain forecast until 2030
Note: in blue treasury forecast, in dark this study mean forecast.
Source: Authors with BCCR and Treasury data.



(a) Real GDP growth

(b) Change in nominal exchange rate

(c) Debt's effective interest rate

Fig. C3. Non fiscal determinant's uncertain forecast until 2030.
Note: in blue treasury forecast, in dark this study mean forecast. Source: authors with BCCR and Treasury data.

D. Comparison fiscal reaction function estimates

Table D1
International comparison for FRF estimates.

Study	Data	Countries	Coefficient on lagged debt	Coefficient on primary balance	Method and details
This study	Primary balance. Period 1974-2018	Costa Rica	0.05-0.17	0.31-0.59	OLS with Newey-West S.E., VAR, VECM, TAR with AR(1) coefficient, and control variables as the output gap and dummies for periods of fiscal stress.
Bohn (1998)	Primary balance. Period 1916-1995	United States	0.054	0.78	OLS with Newey-West S.E., GVAR and YVAR fiscal variables.
Bohn (2008)	Primary balance. Period 1792-2003	United States	0.094-0.121s	NA	OLS with robust standard errors, with time trend; extensions: debt squared, AR(1) process for outlays, public debt is not lagged.
Celasun et al. (2006)	Primary balance. Period 1990-2004	Argentina, Brazil, Mexico, South Africa, Turkey	0.030-0.121	NA	Several specifications with and without country fixed effects. OLS, LSDV, GMM, LIML, System GMM, first difference or level for primary balance.
Ghosh et al. (2013)	Primary balance. Period 1970-2007	23 developed countries (EU-14)	-0.208 -0.225 (long) -0.081-0.086 (short)	NA	FE country-fixed effect estimator with robust S.E. and with AR(1) error term process; extensions: OLS, PCSE estimators, fiscal fatigue explored (second and third polynomial terms included in both specifications); government expenditure gap; age dependency, IMF arrangement, fiscal rules, oil price, non-fuel commodity price, trade openness.
Mendoza and Ostry (2008)	Primary balance. Period 1980-2005	22 industrial countries and 34 emerging countries	0.033-0.072 0.020-0.038 (only industrial countries)	NA	FE estimator with country-fixed effects, robust S.E. with country AR(1) coefficients; extensions: subsamples (high/low debt countries); spline regression (threshold at 48%); shorter periods for most emerging countries; YVAR and GVAR government expenditure variables.
D'Erasmo et al. (2016)	Primary balance. Period 1972-2014	United States	0.0767-0.105	NA	OLS with HAC standard errors and military expenditures; extensions: time trend, squared debt, asymmetrical response, with AR(1) term, with/without recession.
D'Erasmo et al. (2016)	Primary balance. Period 1951-2013	25 advanced and 33 emerging economies	-0.001-0.692	NA	FE with White cross-section corrected S.E. with output gap and government expenditures; extensions: government expenditure or consumption gap (HP filter), country AR(1) error.
Burger et al. (2012)	Primary balance. Period 1974-2008	South Africa	0.01-0.05	0.53-0.68	OLS, VAR, VECM, TAR, GMM estimates using output gap as control. Output gap is measure both with HP and Kalman filter.

Note: Source authors elaboration based on literature results.

E. The fiscal reform

The main elements on the **revenue side** are:
1. The sales tax is transformed into a **value-added tax**. The standard rate is 13%.
There are three reduced rates: 4% on airfares and private healthcare services (if paid by credit or debit card, healthcare is exempted), 2% on private education, medicines and insurance premiums, and 1% on basic domestic essentials.
2. Two new **personal income** tax brackets for top earners, at 20% and 25%.
3. **Capital gains** starts to be taxed at 15%.
On the **spending side**, the fiscal reform focuses on public employment in central government and decentralized institutions:
1. Establish limits for public wages.
2. Establish that some incentives will be defined in fixed nominal terms rather than as proportion of the salary.
3. Strengthen the eligibility criteria for some incentives for public workers.
4. The Planning Ministry becomes the steering body for public employment issues.
The law also reduced the scope of mandated spending. When central government debt exceeds 50% of GDP, the Ministry of Finance is entitled to reallocate spending from specific legal destinations, taking into account revenues and the level of budgetary execution and the fiscal balance of beneficiary entities.
The **fiscal rule** limits the growth of nominal spending depending on the level of public debt, as follows:
1. When the debt at the end of the previous fiscal year is **under 30% of GDP** or the current expenditure-to-GDP ratio is below 17%, the annual growth of current expenditure should not exceed the average nominal GDP growth in the past four years.
2. When the debt at the end of the previous fiscal year is **between 30% and 45%** of GDP, the annual growth of current expenditure should not exceed 85% of the average nominal GDP growth in the past four years,
3. When the debt at the end of the previous fiscal year is **between 45% and 60%** of GDP, the annual growth of current expenditure should not exceed 75% of the average nominal GDP growth in the past four years.
4. When the debt at the end of the previous fiscal year is **above 60%** of GDP, the annual growth of total expenditure should not exceed 65% of the average nominal GDP growth in the past four years.
The law establishes that the spending of all non-financial entities of the public sector are subject to the rule. This includes the central government, all deconcentrated bodies, the legislature, the judiciary, local governments or non-financial public companies.
Exceptions are the Costa Rican Social Security Fund (CCSS), concerning the resources of the contributory pension regime (IVM regime) and the noncontributory regime, the Costa Rican Refinery of Oil (Recope), concerning the oil bill and state-owned enterprises, concerning the part of their activities subject to competition.
The Finance Ministry is in charge of ensuring that the formulation of the budget for central government and deconcentrated bodies is compliant with the fiscal rule. For the central government, the General Comptroller will verify during the budget approval phase that the budget is in line with the law. Once the fiscal year is over, the General Comptroller will also verify if the fiscal rule has been met. The independent fiscal council will also make an assessment on this. A final report on compliance will be delivered to the General Comptroller Office in April of the following year and published on the website of the Ministry of Finance. The General Comptroller Office will verify that the budget of state-owned enterprises is in accordance with the law.
Source: OECD (2020:33).

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