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Sustainability Analysis under Uncertainty

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Abstract[*]

This paper analyzes the sustainability of Costa Rican sovereign debt within the intertemporal budget constraint framework, which is complemented with the estimation of the fiscal reaction function and a risk assessment under the fan chart methodology using annual data from 1974 until 2018. Results show that fiscal behavior has been unsustainable for specific episodes in the long run, and in the short run there have been few instances of debt sustainability since the economic crisis of the early 1980s. Given that a major fiscal reform was approved at the end of 2018, an evaluation of its impact on the path of adjustment of primary balance, considering uncertainty, is included.

JEL classifications: C22, H63, C15, E62
Keywords: Debt sustainability, Primary balance, Fiscal reaction function, Risk assessment, Fan chart

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1 Introduction

Within global economic conditions, fiscal sustainability is key for macroeconomic stability. This is especially true for Costa Rica, a country with strong economic and social indicators relative to the rest of Latin America but one with a weak fiscal stance.

Over the last decade, this economy's government debt, measured as a percentage of its GDP, has grown at one of the fastest rates in the region, and only minor fiscal changes have been implemented in the last four decades. Costa Rica's public finances represent a cause of growing cause, as debt as a percentage of GDP reached a critical level in 2018.

By the end of that year, both Moody's and Standard and Poor's downgraded Costa Rica's long-term debt in foreign and local currency from BB- to B+, weighting the vulnerabilities of a high debt load and its management, a growing proportion of the Government's debt denominated in foreign currency, and a high level of dollarization in its financial system.

Given this context and the urgency in terms of the fiscal balance by December 2018, Congress approved a fiscal reform with changes in government income and expenditure, which included a current expenditure fiscal rule, the change from sales tax to a value added tax and an increase in the income tax rate.

The need to determine whether this reform's effects on sustainability are sufficient can hardly be disputed. Therefore, our research undertakes an analysis of the primary balance. First, we use two different methodologies to determine if the current debt level may be considered to be within the government's fiscal space. We then assess the impact of the fiscal reform with a risk assessment. While the Treasury has published some estimations of the reform's impact, this study includes different scenarios involving different key variables to assess their impact on growth, primary balance, interest rate and exchange rate.

Until now, two macroeconomic programming models were used at the Central Bank of Costa Rica (BCCR) to assess fiscal sustainability. In the first, based on the accounting approach (Rojas and Sáenz, 2003), sustainability is understood as a long-run primary surplus level that stabilizes the debt-to-GDP ratio to zero (Buiter, 1985). The second is built on the deterministic Intertemporal Government Budget Constraint (IGBC) approach (Hoffmaister et al., 2001). The latter states that fiscal policy achieves sustainability if, at any given period of time, the debt level is equal to the present value of the future primary surpluses (Blanchard, 1990). Both methods require the inclusion of expected future trajectories of the main variables, which can be strong

assumptions. Therefore, we intend to revise those models and complement their results with an analysis under uncertainty.

The IGBC gives the response of the primary balance to the level of past debt, and its estimation is the starting point for our study. As mentioned by Bohn (2007), however, the IGBC holds under very weak time-series assumptions, which are typically satisfied in the data. Hence, we complement the results of the IGBC model with an estimation of the fiscal reaction function (FRF), which provides long and short-run indicators of sustainability. For both, we include a risk assessment considering the natural uncertainty of future behavior. In general, this dimension is important, but we believe it is especially important for Costa Rica at this time.

In the next two sections we briefly explain the relevant theoretical and empirical framework, to continue with the description of the specific methodology and data. We subsequently explain the results from the FRF estimations, the standard Debt Sustainability Analysis, and the Risk Assessment. Lastly, we present conclusions and final remarks.

2 Literature Review

There is vast 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 be found in Buiter (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).

As mentioned by D'Erasmo et al. (2016), the classic public debt sustainability analysis studies extend the long-run implications from a deterministic Intertemporal Government Budget Constraint (IGBC). The IGBC is evaluated at the steady state and hence relates the long-run primary balance as a share of GDP with the ratio of debt to GDP, defining the latter as the sustainable debt level (Buiter, 1985; Blanchard, 1990; Blanchard et al., 1991). This approach, known as the Blanchard ratio, resembles the government accounting approach where deterministic bounds for the debt and primary balance are defined under which there is fiscal sustainability (IMF, 2013).

Bohn (1995) proposed another framework for debt sustainability analysis, as he showed that the correct discount factors for debt sustainability are the state-contingent equilibrium pricing kernel and not the risk-free rate, as was understood until then.

Years later, the same author, Bohn (2007) showed that the traditional test for debt sustainability has significant flaws, as the IGBC holds under weak assumptions for the time series processes of fiscal data, which therefore, are generally satisfied. Sustainability tests that rely on stationarity or cointegration conditions between the primary balance and debt's ratios to GDP do not capture any information about fiscal crisis, because the IGBC holds if either debt or revenue and spending (including debt service) are integrated of finite but arbitrarily of high order.

D'Erasmo et al. (2016) also describe other flaws of this methodology, as it only defines what long-run debt is for a given long-run primary balance if stationarity holds. It does not link the initial debt level with the steady state. In fact, there are multiple dynamic paths for the primary balance that would satisfy the IGBC. Also, this method does not reckon uncertainty for the real economy, or the domestic and foreign assets market.

Given such characteristics, the use of fiscal reaction functions (FRFs) has become more relevant when analyzing debt sustainability. As Bohn (1998 and 2008) showed, a linear FRF for which a positive and statistically significant response of the primary balance to debt is enough to satisfy the IGBC. The proof of this result only requires the additional determinants for the primary balance to be bounded and the present valued of GDP to be finite. This is similar to a derived standard transversality condition for debt as it converges to zero. In this case, debt is sustainable if the response coefficient in the FRF is positive and significant.

One advantage of this methodology is that with the use of a FRF that exhibits "fiscal fatigue" it is possible to compute a "debt limit": a level of debt beyond which debt cannot be rolled over. Building upon this concept, Ostry et al. (2015) used the FRFs estimated by Ghosh et al. (2013) to construct measures of what they called "fiscal space" in order to show the dimensions a country has when defining different debt ratios which still satisfy the IGBC. The degree of sustainability is then given by the distance between outstanding debt and the debt limit. Linear and non-linear FRFs have been analyzed by recent studies such as Mendoza and Ostry (2008), Ostry et al. (2010) and Ganiko et al. (2016).

A complementary branch of the literature uses time series tools to examine debt dynamics. IMF (2013) estimates nonstructural VAR models that include primary balance components jointly with key macroeconomic variables (output, growth, and inflation) and a set of exogenous variables.

This research computes the probability density function for possible debt-output ratios based on forward simulations of the time series. As a result, fan charts are built which summarize the confidence intervals for future debt. The FRF approach has been extended with the inclusion of uncertainty.

In an application to developing countries, Jooste et al. (2011) measure how the South African government reacts to changes in its debt position. Using various methods for the FRF estimation they forecast the debt to GDP ratio with the construction of fan charts.

Furthermore, Celasun et al. (2006) for Argentina, Brazil, Mexico, South Africa, and Turkey propose a probabilistic approach with the use of 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. They constructed fan charts for debt from these interactions between the pure economic shocks and the fiscal variables' paths.

To date there have been few studies and little evidence on this topic for Costa Rica. Among those studies Espinosa-Rodríguez and Valerio-Berrocal (2014) estimated the natural debt limit following Mendoza and Oviedo (2004), and with Monte Carlo simulations, computed the probability of surpassing this limit. They estimated that the limit was going to be surpassed after three years with a 76.0 percent chance.

In addition, Rojas and Sáenz (2003) studied Costa Rica's public sector's financial position with the deterministic accounting approach. They performed debt 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 percent in the long run. For them, the debt to GDP ratio would be relatively stable for the period between 2004 and 2010.

Finally, Hoffmaister et al. (2001) used a deterministic IGBC framework, which is also based on the solvency concept: fiscal policy is sustainable if the debt level is equal to the present value of the future primary surpluses. The author 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 this probability could be upward biased given that government expenditure is highly inflexible, as the fulfillment of specific spending destinations has been defined by law or constitution, which suggests the primary balance would be lower than the historically observed one.

3 Empirical Methodology

For this research, the IGBC methodology is our starting point. Its results are complemented with the estimation of the FRF proposed by Bohn (2007), and then a risk assessment is performed. For the latter, we follow the fan chart approach proposed by Celasun et al. (2006). Therefore, this section intends to briefly explain the methodological framework for each approach and provide the intuition for the interpretation of the results presented in Section 4.

3.1 Intertemporal Budget Constraint and Solvency

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

In any given period, total government spending must be covered by revenues and bond issuance. 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 interest due. The period-t government budget constraint is given by:

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

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 to which interest payment should be added.[1] Given that the primary balance is defined as primary expenditure minus total revenues, $PB_t = G_t - T_t$,

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

Considering that the economy's taxable income grows in line with nominal GDP, it is common to scale the nominal amounts in the above equation as ratios of nominal GDP, Y_t,

[1] 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 by Law 7558 Art 59 the Central Bank of Costa Rica has been forbidden to lend to the Treasury since 1995. Previously, since 1970 (accounting for all the time span used for estimation) Law 1552 Art 71 allowed the Central Bank to buy up to (near) 8 percent of its budget in Treasury bonds but not for debt payment. The latter is not of interest for the current evolution of debt evolution, as we control for the 1980s debt crisis in the estimation.

$$D_t/Y_t = (1 + r_t)((D_{t-1}/Y_{t-1})(Y_{t-1}/Y_t) + PB_t/Y_t \quad (3)$$

The intuition behind is that if government's revenues can grow indefinitely, so could expenditure and debt. If GDP grows at an annual rate of θt,

$$d_t = ((1 + r_t)/(1 + \theta_t))d_{t-1} + pb_t \quad (4)$$

At any given 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.

For the implementation of this methodological approach it is necessary to have an assessment of future trajectories of government expenditure, public revenues, economic growth and interest rates.

3.2 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. Therefore, the model is specified as follows:

$$pb_t = \alpha_0 + \alpha_1 d_{t-1} + \alpha_2 Y_t + X_t\beta + \varepsilon_t \quad (5)$$

where pb is the ratio of primary balance to GDP, d is the ratio of public debt to GDP, Y is the output gap estimated with the Hodrick-Prescott filter using data from 1975 to 2018, and X_t is a vector of control variables.

For the Costa Rican case, we include three dummy variables: the first accounts for the economic crisis of the early eighties, the second for the year 1994, as one of the state banks was closed and represented an extraordinary expenditure for the government, and the third accounts for the period after the financial crisis, given the structural change in government expenditure because of the expansionary fiscal policy measures implemented as response.

To understand how the FRF works, we may assess the debt sustainability efforts made by the Costa Rican government over the last forty years. We start with the theoretical framework used by Jooste et al. (2011), who applied the solvency concept mentioned before and obtained the following debt equation:

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

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

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

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

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

In this equation, the persistence of the primary balance is included with its lags, and from it, we characterize the primary balance's reaction to debt changes, in the short run with α_3, and in the long run with $\frac{\alpha_3}{1-\alpha_2}$. To assess sustainability under this framework, debt should not have an exploding behavior. Jooste et al. (2011) 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 corrections of the primary balance for debt stabilization are done in the next period; even when $\frac{\alpha_3}{1-\alpha_2} > \alpha^* = \frac{r-g}{1+g}$, as d and pb ratios would be level stationary, implying a stable relationship.

Given that the unit root evidence on the Costa Rican data series is not conclusive,[2] we will extend the analysis by including estimations under VAR and VECM models. For the VAR models, we use the same specification as above, with the output gap as exogenous variable, and for the VECM, we define the following:

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

From this specification, the primary balance equation may be rewritten as a VAR in levels:

$$\begin{aligned} pb_t = c_{11} - \alpha_{12}\beta_{13} + (1 + \alpha_{12} + \Sigma_{11})pb_{t-1} - \Sigma_{11}pb_{t-2} \\ +(-\alpha_{12}\beta_{12} + \Sigma_{12})d_{t-1} - \Sigma_{12}D_{t-2} + \psi_{11}Y_t + \epsilon_{11t} \end{aligned} \tag{10}$$

From the equations of the OLS/VAR and the VECM models, we can define the FRF as:

$$\begin{aligned} \alpha 1 &= c11 - \alpha 12\beta 13 \\ \alpha 2 &= 1 + \alpha 12 + \Sigma 11 \\ \alpha 3 &= -\alpha 12\beta 12 + \Sigma 12 \end{aligned} \tag{11}$$

Given the coefficient estimations, we compare these results with the previously defined α^* to assess fiscal sustainability. Following the intuition explained above, for the periods when

[2] As shown in Table 2.

$\frac{\alpha_3}{1-\alpha_2} \geq \alpha^*$, the primary balance behaves in accordance to debt sustainability in the long run. For the short run we directly compare the coefficient, when $\alpha_3 \geq \alpha^*$ the primary balance changes in accordance with debt sustainability considering the result of the next period.

Differentiation between short and long run, jointly with changes in sample used for estimation, are especially relevant for the Costa Rican case. It will be evident when analyzing the sustainability conclusion resulting from the respective estimate coefficients comparison with the α^* computed value.[3]

Also, given the previous evidence for non-linearities in fiscal reaction functions (Mendoza and Ostry, 2008; Ostry et al., 2010; Ganiko et al., 2016), we compute gaps with the Hodrick-Prescott filter for government expenditure, real exchange rate, and debt to use them as controls for estimation. These variables are important to assess whether the fiscal reaction is stronger or weaker conditional on periods of high/low expenditure, debt, and real exchange rate, which corresponds to different pressures on the IGBC. A linear trend is also used in some specifications to control for population growth (recall debt and primary balance are used as GDP proportion).

At first, the results suggest that Costa Rica's fiscal policy has been sustainable in the long-run, with few episodes of either short or long-run unsustainability. Still, such results call for further exploration based on Bohn (2007). He expressed that sustainability may be attained under the IGBC even under weak assumptions about the fiscal data time series processes, which are generally satisfied. Hence, this author argued that the IGBC is satisfied even if the debt or income, and the expenditure including the debt service are integrated variables of finite order, even if this order is arbitrarily large.

According to these ideas, there are important flaws in literature that supports that the cointegrating relation between variables evidences sustainability, given that it is not the integration order of the debt data, nor the income-expenditure cointegration that warrants debt sustainability. Basically, the result responds to the condition where the discount factor dominates the expected value of the series when taking the limit to infinity, similar to a transversality condition. Moreover, Bohn (2008) showed that a linear FRF with a conditional and statistically significant positive response of the primary balance (*pb*) to debt (*d*) is sufficient to ensure that the IGBC is satisfied.

[3] Figures 7, 8, and A2 show the contrast between these results.

In other words, we could use equation (5) and state that, as long as all the variables are bounded, changes in *pb* by a positive factor α_1 when debt rises, implying that the rate of growth of debt, *j* periods ahead, is lowered by $(1 - \alpha_1)^j$ which in turn implies the IGBC holds.

As well, the author stated that even when debt sustainability holds for any $\alpha_1 > 0$, the long-run behavior of the debt ratio to GDP differs considerably depending on the relative values of the mean interest rate, *r*, and α_1. We could infer this from combining the IGBC,[4] $dt - (1 + rt)dt - 1 = -pbt$, and the FRF shown in equation (5), as together they provide the "law of motion" for the debt ratio

$$d_t = -\mu + (1 + r_t - \alpha_1)d_{t-1} + \epsilon_t \tag{12}$$

For this equation, μ represents other determinants of the primary balance. Here, the debt ratio would be stationary when $\alpha_1 > r$, if not the debt ratio explodes, but still, as long as $\alpha_1 > 0$ the debt growth rate will be sufficiently small and will satisfy the IGBC.

Additionally, Bohn (2008) stated the IGBC holds for the same initial debt level for any $\alpha_1 > 0$, but if $\alpha_1 > r$, debt is sustainable; as α_1 decreases (there is less reaction to debt), debt converges to a higher long-run mean value.

In our analysis, to check if historical or political economic non-observed events biased the standard debt sustainability results and as robustness, we estimated time-varying coefficients of the FRF. From the original model specification, we estimate the α's of expression (11) by varying the sample time span, in order to compare them with α^*.

To start, we consider a 10-year window; for the first estimation the data goes from 1975 until 1985. Afterwards, we expand the window year by year, so for the second run, we add one year to the sample, 1986, and estimate again. This process is continued until the whole sample is included. In the same manner, we estimated the time varying α but starting with the sample from 2009 until 2018, and then expanding the time window year by year, 2008, 2007, and so on until the whole sample is included. Based on this process, we obtain two series of time-varying α, which are compared to their corresponding α^*, with the purpose of analyzing short and long-run debt sustainability behavior. We add as a control variable an interaction dummy with debt after the year 2008, given the structural change on the expenditure path explained above (expansionary fiscal

[4] This expression is different to the one explained before as the latter referred to the primary deficit $(g - t)$, while this one refers to the primary surplus $(t - g)$.

policy). As expected, this diminishes the reaction of the primary balance to debt, but overall the coefficient continues to be positive.

From the previous argument on the IGBC, the solvency framework and the strong assumption of knowing the variables' future trajectories, it is evident that a sound analysis on fiscal sustainability must include a risk assessment which we include using the fan chart methodology proposed by Celasun et al. (2006).

3.3 Risk Assessment

As the debt risk assessment attempts to measure expected and unexpected impacts on debt dynamics, we estimate an unrestricted VAR with its non-fiscal determinants.

Given the fiscal context of Costa Rica and its recently approved fiscal reform, we are interested in including the estimated effects of the latter. Hence, as starting point we include the estimations by the Treasury of the impact of the reform on the main fiscal and non-fiscal debt determinants to obtain different probable debt paths, given the uncertainty in the future behavior of its determinants. We also, estimate the debt forecast with feedback from the economic activity.

Both angles are important, as increments in taxes decrease disposable income, but at the same time, they may have a positive effect on the individual's confidence of future sustainability leading to higher economic growth, all of which affect the debt's future behavior. We start with the following specification

$$\Psi_t = \gamma_0 + \sum_{k=1}^{p} \gamma_k \Psi_{t-k} + \xi_t \qquad (13)$$

where $\Psi_t = (g_t, r_t^{US}, r_t, z_t)$. As expected, r^{US} is the foreign interest rate, r is the domestic overall debt interest rate, g is the real GDP growth rate, z is the nominal exchange rate, γ_k is a vector of coefficients, and ξ is a vector of error terms $\xi_t \sim N(0,\Omega)$.[5]

[5] As we do not distinguish between foreign and domestic debt, we prefer here to use the nominal exchange rate instead of the real effective exchange rate, as we think there is no estimation gain. 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 any estimation error. On the other hand, the Banco Central of Costa Rica used as inputs for the "Programa Macroeconómico 2019" yearly forecasts for the nominal exchange rate. We stick to this official source. As there is only an aggregate for debt, the Central Bank looks for low variance in nominal exchange rate movements, and there is inflation control, we think the nominal exchange rate use is appropriate. For future research, the distinction between foreign and domestic debt will open an important channel where the effective exchange rate would be of use.

Following Celasun et al. (2006), we use the VAR model to recover the variance-covariance matrix of residuals, Ω, to characterize the joint contemporaneous co-movements between the non-fiscal shocks of debt dynamics.

The uncertainty assessment of debt dynamics and its components is undertaken through fan charts estimated with random vectors $\widehat{\Lambda}_{t+1}, \ldots, \widehat{\Lambda}_T$ such that $\tau \epsilon [t+1, T], \hat{\Lambda} = W \nu_t$, where $\nu_t \sim N(0,1)$ or ν is bootstrapped, and W is the Choleski factorization of Ω, $\Omega = W'W$.

The VAR model generates forecasts of the non-fiscal debt determinants and hence allows us to obtain the economic activity feedback for the uncertainty assessment. As shocks occur in each period, the VAR model generates joint dynamic responses of the non-fiscal debt determinants, which are not sensitive to the variables' ordering as we are not looking for causal relationships but the overall dynamics. Also, it is not necessary, in this case, to use quarterly data.

With annual frequency, in a reduced-form VAR, we consider both expected and unexpected changes in the medium term (1-2 years) in the non-fiscal and fiscal debt determinants (the latter through the FRF), and their interactions. For example, the central government's budget could be changed in the following year so expenditure may react to the economic activity in the previous year(s).

Second, the estimated FRF is included as reference of the interaction between the primary balance, debt and output gap which depends on the VAR's output growth path. Finally, each of the forecasts of growth and interest rates with the VAR, and the forecasts of the primary balance with the FRF will bring the correspondent paths for annual debt. These paths can be computed recursively with the FRF and the conventional stock-flow identity:

$$d_t \equiv \left(\frac{r-g}{1+g}\right) d_{t-1} - pb_t + s_t \quad (14)$$

where s_t is the stock-flow adjustments for the recognition of contingent liabilities or the realization of assets. For this specification, equation (14), we do not differentiate between domestic and foreign debt. What is included is the total debt and its implicit interest rate.[6]

The fan charts forecast the debt path including the interactions between non-fiscal debt determinants, and a standard FRF. To allow for non-symmetrical paths we use bootstrapped errors.

[6] 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.

Observed data were available for 2018 and half 2019. As we want to depict the possible debt path given the fiscal reform approval, risk assessment drawn in the fan charts begin in 2020.

In order to understand how the fan chart dynamics work, for simplicity, the interactions of equations (5), (13), and (14) are summarized in the following AR(1) model for debt

$$d_t = a_0 + a_1 d_{t-1} + \varepsilon_t \qquad (15)$$

where

$$\varepsilon_t \sim i.i.d(0,\sigma^2)$$

Given that the coefficient a_1 reflects the effect from the fiscal and non-fiscal debt determinants, conditional on t, data on the period ahead, will be projected as $\hat{d}_{t+1} = a_0 + a_1 d_t$, with an associated forecasting error, $FE_1 = \hat{d}_{t+1} - d_{t+1} = \varepsilon_{t+1}$, and a variance equal to $Var(FE_1)=\sigma^2$.

The results are depicted within a 95% confidence interval, defined when assuming normality, as $a_0 + a_1 D_t \pm 1.96\sigma$.[7]

3.4 Data

For the estimations, yearly data from 1974 until 2018 were obtained from different sources: the series of central government debt, primary balance, expenditure, income and interest payments are from the Treasury, Ministerio de Hacienda, while the implicit interest rate was estimated, and the GDP, inflation and real exchange rate series were gathered from the Central Bank, BCCR.[8] The one-year US Treasury rate comes from the Saint Louis Fed, and the control variable schooling years, used in some of the specifications, was obtained from the National Institute of Statistics and Census.[9] The output gap was obtained with the Hodrick-Prescott filter.[10]

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 as some were available since 1950, but others from 1970 or further in time. From the data, it should

[7] When forecasting two periods ahead, the respective values would be $\hat{d}_{t+2} = a_0 + a_1(a_0 + a_1 d_t)$, $FE_2 = \hat{d}_{t+2} - d_{t+2} = a_1(\hat{d}_{t+1} - d_{t+1}) + \varepsilon_{t+2} = a_1\varepsilon_{t+1} + \varepsilon_{t+2}$, $Var(FE_2) = (1 + a_1^2)\sigma^2 > VAR\ (FE_1)$. For these estimations, the 95 percent confidence bounds are wider, $\hat{d}_{t+2} = a_0 + a_1(a_0 + a_1 d_t = 1.96 \pm (1 + a_1^2)^{\frac{1}{2}}$, which converge to the unconditional bounds.

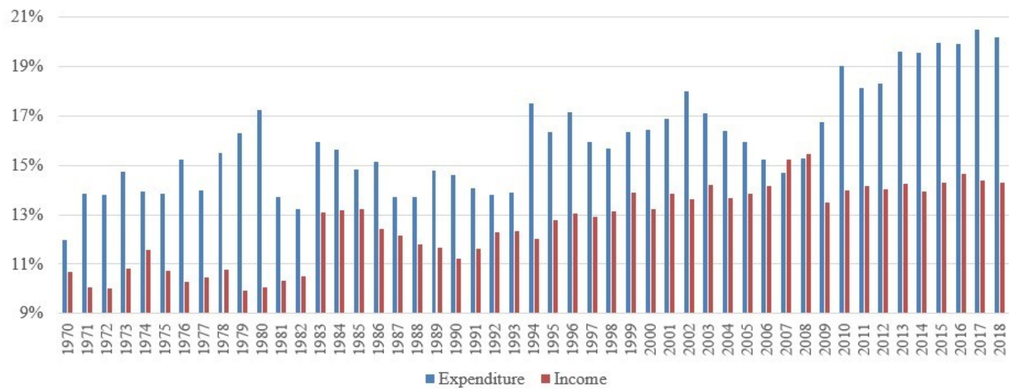
[8] BCCR and MH, by their acronyms in Spanish.

[9] INEC, by its acronym in Spanish.

[10] With a lambda value of 26, specific for the Costa Rican business cycle according to Álvarez Corrales (2017).

also be noted that in Costa Rica, at the subnational level, financial needs have not been covered by issuing debt.[11] Therefore the focus of this research is on the central government's behavior.

Figure 1. Government Expenditure and Income as Percentage of GDP, 1970-2018



Source: Authors' calculations based on Treasury Ministry data.

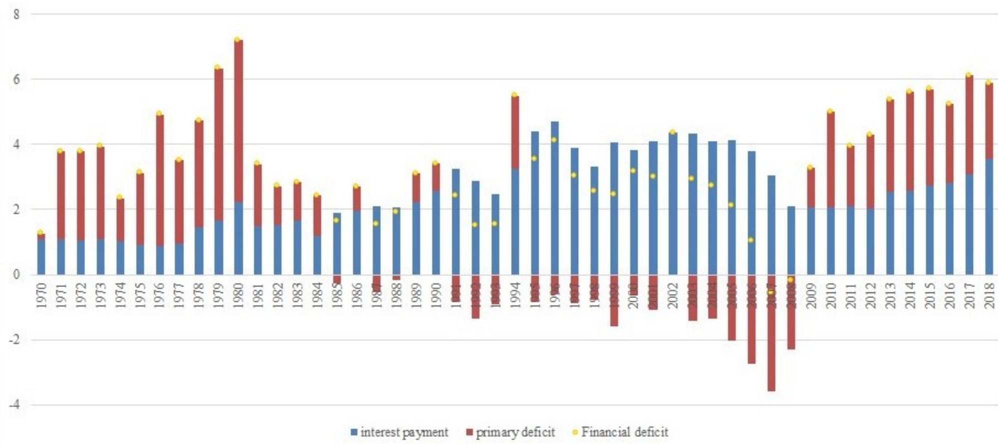
As context, we briefly explain some relevant aspects of the fiscal variables considered in the estimations. Firstly, public income comes from taxes, non-tax entries, cash/current transfers, and capital income. Among its components, the composition has maintained stable, as in general, more than 95 percent comes from taxes. There are a number of different taxes, but in terms of their relative importance, the most representative are the general sales tax and the income tax on income.

Secondly, from the expenditure side, current expenditure—which encompasses salaries, public debt interest, and transfers to the public, private, and external sectors—represents more than 90 percent, leaving just 10 percent or less for spending on capital.

Thirdly, for the time frame considered, the government's balance has been negative with two exceptions, 2006 and 2007. These deficits have been financed with public debt, internal and external, as shown in Figures 2 and 3.

[11] There have been a few exceptions in the time span considered for this research; given their amount and frequency they could be described almost as sporadic.

Figure 2. Financial and Primary Deficit as Percentage of GDP, 1970-2018



Source: Authors' calculations based on Treasury Ministry data.

It seems as if the mismatch between income and expenditure, and hence, its financing, could 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 a default in the 1980s crisis, then how the government made a significant reduction in its primary deficit given the policies implemented as response to the crisis, followed by a decreasing trend in the financial deficit for a bit more than a decade, between 1994 and 2006.[12] Afterwards, there were two years of financial surplus, which quickly reversed in response to the financial crisis.

The expansionary fiscal policy decisions in response to the financial crisis of 2008 acted as a structural change in the series. Moreover, as time has passed, the crowding-out effect has affected interest rates and consequently, credit demand, private investment and disposable income.[13]

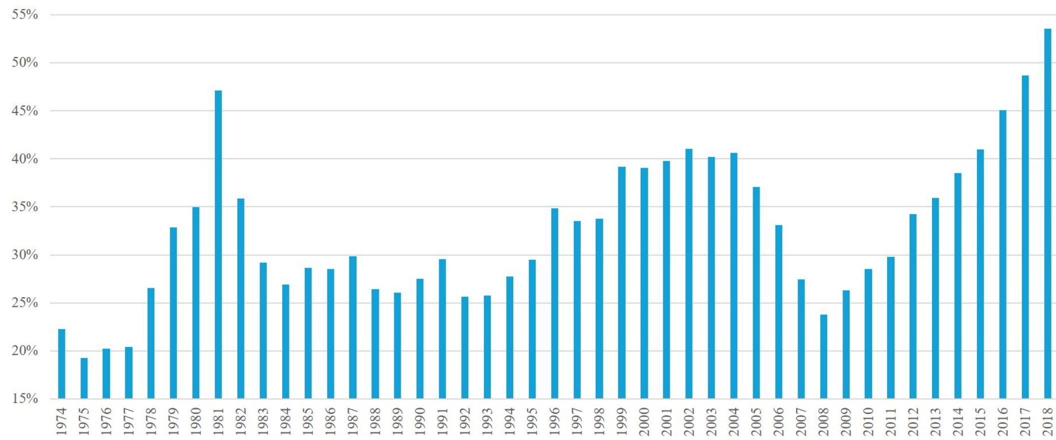
Figure 3 shows a public debt path towards unsustainability as a consequence of unsuccessful structural fiscal reforms. To name the first of two examples, in 2004 the bill "Ley de Pacto Fiscal" proposed changing the sales tax to a value-added estimation, and to adopt a system for global income, but this measure was never voted on in Congress. In addition, during the

[12] In 2004 the government renegotiated a percentage of its debt, changing the slope of the trend to a negative one for the next four years.

[13] Between 2005-2008 when public debt was falling the average real interest rate for loans also fell from 8.7 percent to 2.5 percent. After the public debt increase in 2008, this rate increased to 16.9 percent in 2009, and it has been over 10 percent since then.

Chinchilla-Miranda presidency (2010-2014), an unsuccessful attempt was made to pass the bill "Proyecto de Solidaridad Tributaria," which proposed collecting a uniform tax of 15 percent on passive rents and capital gains as well as ending the general sales tax in favor of a value-added tax. Although this bill was passed by the legislature, it was ruled invalid by the Constitutional Court.

Figure 3. Central Government Debt as Percentage of GDP, 1970-2018



Source: Authors' calculations based on Treasury Ministry data.

It was not until December 2018 that a structural public finances reform was passed by Congress and approved by the Constitutional Court. Law N°9635, "Ley para el Fortalecimiento de las Finanzas Públicas," modified the income tax and the general sales tax (law N°6826), included a fiscal rule for current expenditure, and considered wage caps for the public sector (law N°2166).[14]

4 Results

Given the evidence from the section above, it is necessary to carefully examine debt sustainability for Costa Rica, which we start with the analysis within the IGBC framework.

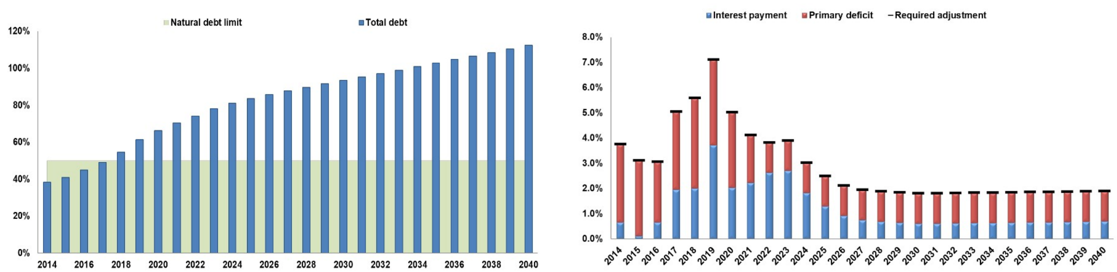
Within the Costa Rican context, the results of this appraisal changed significantly before and after December 2018, when the fiscal reform was approved. Until mid-2018 it was highly uncertain whether this reform was going to pass in the legislature. Moreover, there was no clear idea on the cost of financing the deficit of the Central Government in case the reform was rejected. The intense debate on this issue generated tensions and, in some instances, led to strikes. The

[14] For a detailed explanation of the fiscal reform, please refer to the criterion of the law project N°20580, published by the Central Bank of Costa Rica, in url: https://activos.bccr.fi.cr/sitios/ bccr/noticias/Documentos

largest involved the education and health sectors. This strike had a large social and economic impact: students lost three months of classes, and there were important delays in scheduled surgeries and other activities.

At this time, the IGBC sustainability analysis showed an exponential growth of the debt ratio, as seen in Figure 4, in which clearly there was clearly a large and sustained primary balance adjustment. These conditions seemed unfeasible.

Figure 4. Intertemporal Budget Constraint, July 2018



Source: Authors' calculations.

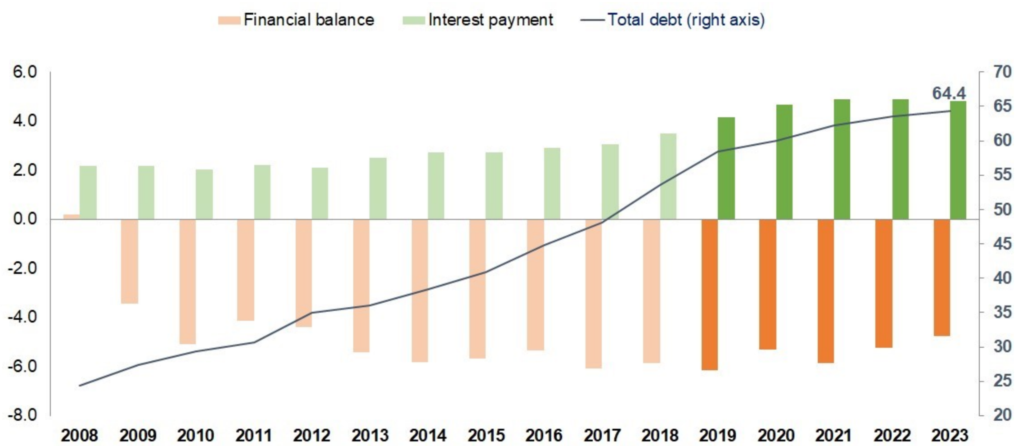
Table 1. IGBC Results, Considering the Impact of the Fiscal Reform, 2019-2023

	2018	2019	2020	2021	2022	2023
Debt ratio	53.6%	58.5%	60.1%	62.2%	63.6%	64.4%
Change in debt ratio	5.5%	4.9%	1.6%	2.2%	1.4%	0.8%
Primary balance	-2.3%	-2.0%	-0.6%	-0.9%	-0.3%	0.1%
Real interest rate (implicit)	8.0%	6.3%	5.1%	4.9%	4.6%	4.4%
GDP growth	2.6%	2.2%	2.6%	2.8%	2.9%	3.1%
Deposits (National Bank System)	-0.3%	0.8%	-0.5%	0.0%	0.0%	0.0%
Financial deficit	5.9%	6.2%	5.3%	5.8%	5.2%	4.7%
Interest expenditure (% of GDP)	3.5%	4.2%	4.7%	4.9%	4.9%	4.8%
Nominal interest rate	10.6%	9.3%	8.6%	8.2%	7.8%	7.6%
Inflation (GDP deflator)	2.4%	2.8%	3.3%	3.1%	3.1%	3.0%
External debt	10.2%	12.5%	13.5%	13.0%	12.6%	12.1%
Local debt	43.3%	46.0%	46.6%	49.2%	51.0%	52.3%
Total debt	53.6%	58.5%	60.1%	62.2%	63.6%	64.4%
Required primary balance	4.9%	4.9%	2.1%	2.2%	1.4%	0.8%

Source: Authors' calculations based on Central Bank of Costa Rica and Treasury Ministry data.

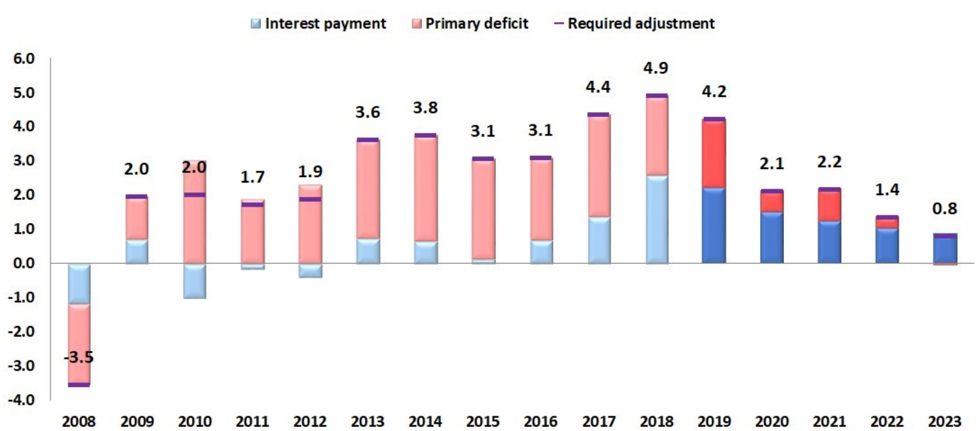
Because Bohn (2007) showed that the IGBC holds under weak assumptions for the time series processes of fiscal data, we follow for the sustainability analysis with the estimation of the FRF. We begin with the results for the presence of unit roots in the variables of the model, as shown in Figures 5 and 6.

Figure 5. Financial Balance, Primary Balance and Total Debt, with Fiscal Reform



Source: Authors' calculations.

Figure 6. Primary Balance Required Adjustment, with Fiscal Reform



Source: Authors' calculations.

Table 2 shows the tests are not conclusive about the statistical nature of the variables. For example, the ratio of debt to GDP behaves as a unit root process, but when structural breaks are taken into account, specifically in 2009, we reject the hypothesis of the presence of unit root for this variable.

Table 2. Results of Unit Root Tests

Variable	Unit root presence			
Augmented Dickey-Fuller	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
Phillips-Perron	Specification*			
	1	2	3	4
Debt/GDP	Yes	Yes	Yes	No
Primary balance/GDP	No	Yes	Yes	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	No	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, 1982	No, 1982	No, 1958
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

Notes: *1: Without intercept and without trend; 2: With intercept but without trend; 3: With intercept and trend; 4: First differences. NAs means the specification does not apply for 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 the structural break tests were done with an innovational outlier.
Source: Authors' calculations based on Central Bank of Costa Rica, Treasury Ministry of Costa Rica and United States Treasury data.

The year 2009 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 responses to the financial crisis. In order to help the economic activity, the Arias government approved an expansionary fiscal policy by permanently increasing public employment and salaries without changes in other expenditure or in income sources. As an unavoidable consequence, the central government's debt trajectory changed accordingly; for example, from 2010 until 2018, total public debt increased by 26 percent of GDP, rising from 28 percent to 54 percent.

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 are likely 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 is lost.

For the period considered in this study, the exchange rate regime was fixed until the beginning of the 1980s, when it changed to a crawling peg (almost fixed). The regime then changed at the end of 2006 to a band system 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. In February 2015, the Central Bank adopted a managed floating regime, which allows this entity to intervene in a discretionary manner and for the rate to float. For this variable, after considering as a structural break the year 2006, no evidence was found of a unit root process.

In addition to the inconclusiveness of these tests, as stated by Bohn (1998) and described earlier, the time series properties of the data should not be taken as indicators of fiscal sustainability. Therefore, we present results from a variety of estimation techniques of the fiscal reaction function.

The estimates of different OLS and VECM specifications of the FRF, for the period 19742018, are shown in Tables 3 and 4, respectively. Also, Appendix Tables B1, B2, and B3 show the estimation results using other methodologies such as VAR, GMM, and Threshold Autoregression respectively.[15]

[15] As we use the same set of variables for each equation, the VAR coefficients are by construction, the same as those from the OLS estimation. Results are on appendix B.

Because of the inconclusive evidence on unit roots processes, we also estimated the FRF with the VECM as robustness. The corresponding coefficient for the debt sustainability analysis is almost the same as the OLS result. However, as will be explained later, the long-run analysis is divergent between the OLS/VAR and the VECM's estimates.

The GMM approach was also done as a robustness test and as a response to the endogeneity problems mentioned by Jooste et al. (2011), but its results were dependent on including the variable schooling, as a measure of the quality of labor, and on controlling the nonlinearities in the debt series with its squared result.[16] Its estimates were statistically significant and higher in magnitude than those of the OLS model.[17]

As we may observe, in most of the regression results, 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 0.17, 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.

As the results show a small, positive and significant effect, they denote fiscal sustainability, which is interpreted as a same-direction reaction of the primary balance when the debt level changes; if it increases, the reaction of the government will be to increase the primary balance in the following year. And the opposite, when initial debt decreases, the authority will ease the fiscal pressure, decreasing the primary balance.

[16] Otherwise, the results were non-significant; mainly explained by the difficulty of defining a valid instrument for fiscal sustainability.
[17] Because this method has been mainly applied to panel data which enhances the consistency properties of the estimates and it is only being estimated with Costa Rican data, we prefer to keep its results just as reference; they are shown in appendix B2.

Table 3. Ordinary Least Squares Estimation
Dependent variable: Primary Balance (Pb)

Variable	OLS 1	OLS 2	OLS 3
Constant	-2.24**	-2.18**	-1.68
	(0.88)	(1.03)	(1.55)
Pb $_{t-1}$	0.59***	0.53***	0.49***
	(0.08)	(0.10)	(0.13)
Debt $_{t-1}$	0.08***	0.07**	0.07**
	(0.02)	(0.03)	(0.03)
Output gap	0.02	0.02	0.01
	(0.07)	(0.06)	(0.07)
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)
D 80's	-1.59***	-1.93***	-1.59**
	(0.58)	(0.54)	(0.62)
D 1994	-2.62***	-1.50***	-1.47***
	(0.29)	(0.42)	(0.41)
D post 2008	-1.83***	-1.80***	-2.19***
	(0.33)	(0.42)	(0.69)
Observations	44	44	44
R^2	0.79	0.85	0.85

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

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)
D(Debt$_{t-1}$)	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)
D 80's	-1.58**	-1.75***	-1.47*
	(0.77)	(0.63)	(0.80)
D 1994	-2.75***	-1.32	-1.28
	(1.06)	(0.94)	(0.95)
D 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 the comparable coefficient with respect to the OLS and VAR estimations for the fiscal reaction function.
Source: Authors' calculations based on Central Bank of Costa Rica, Treasury Ministry of Costa Rica and United States Treasury data.

For example, a 1 percent increase in the ratio of debt to GDP in $t-1$ is associated with an increase of 0.05 percent (or 0.17 percent as two examples) in the ratio of primary balance to GDP. Although the magnitude may seem small, this is consistent with Bohn's approach of debt sustainability: even if the debt could be on an exploding future path its growth rate might not be fast enough, though the IGBC condition for sustainability holds.

Moreover, the coefficient that controls for the inertia, the lagged primary surplus as a percentage of the output, is always positive and significant.

Regarding output gap, none of the estimations has a significant coefficient, and in some cases it even has a negative sign. This could be a clue in regard to how the business cycle has not been a determinant of the level of primary surplus, and hence, it is weak evidence in favor of fiscal policy not being used as a stabilization tool. The unresponsiveness of the primary balance to this variable may be explained by the country's high degree of inflexibility in expenditure.

Other variables include the expenditure gap and the real exchange rate gap. The former is in all the cases a highly significant variable and has a parameter that fluctuates between −0.8 and −1.05. As long as government expenditure is above its own trend, as expected, it is going to determine a decrease in the primary balance.

The real exchange rate gap, however, is not statistically significant for all cases. While the one-year US Treasury rate was included as a explanatory variable, it was not significant in any estimation, even though it has the expected (negative) sign.

In addition, a set of dummy variables related to specific events for Costa Rica's fiscal policy, fiscal position or the state of the economy were included in all the estimations.

The fiscal events considered include the debt and economic crisis of the beginning of the 1980s and the 1994 closure of the most important state-owned commercial bank, whose financial commitments had to be assumed by the government. Finally, there is a a dummy variable after 2008 to identify the effect of the recent financial crisis, which also corresponds to structural changes in public expenditure and debt. As shown in the estimates in Table 3, these three events are highly significant and determine a negative influence on the primary balance level.

In Table 5, we perform three additional estimations as presented in Bohn (1998) and D'Erasmo et al. (2016), including other variables that can shed some light on the fiscal reaction dynamics. For instance, the asymmetric response estimation introduces a non-linear 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 indicates a clear non-linear effect on the FRF. When debt is decreasing (it is below its historical average), the primary balance's reaction doubles with respect to the OLS estimates (0.07) but increases in debt over its average, implying no reaction.

Table 5. 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 (-1)	0.37***	0.36***	0.11
	(0.11)	(0.11)	(0.08)
Debt (-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)
Exp. 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,d*-d)	-0.13		
	(0.08)		
(d*-dˆ2)		-0.006***	
		(0.001)	
Time Trend			0.20***
			(0.04)
D 80s	-2.23***	-2.47***	-0.71*
	(0.70)	(0.71)	(0.41)
D 1994	-1.58***	-1.25***	-1.39***
	(0.48)	(0.45)	(0.23)
D 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.
Source: Authors' calculations based on Central Bank of Costa Rica, Treasury Ministry of Costa Rica and United States Treasury data.

The second estimation adds the squared mean deviation of the debt ratio as a variable. As we can notice, the coefficient obtained for this variable is -0.01, which is highly significant but

close to zero. It means 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 to be not significant. Even debt's coefficient changes its sign, implying there is no sustainability as Bohn defines it.

One concern with the inclusion of the time trend is that the variables are measured in nominal terms (as it is usual for ratios to GDP), so the time trend captures the positive effect of price level, GDP, and population increases on both the debt and primary balance, and also takes away the autoregressive process for the primary balance. Therefore, as the primary balance decreases it corresponds to debt increases, especially for the last years of the sample. Then the debt coefficient becomes negative given the absence of feedback from the previous primary balance. We prefer to discard results concerning time trend as exogenous variable.

With the Threshold Autoregressive Model (TAR), using debt gap as transition variable, we attempt to show the reaction function during different phases of the cycle related to the debt.

These estimations, presented in Table 6, are robust and similar to the OLS estimations. For the purposes of this discussion we focus on two new coefficients, $D{*}DebtGap(-1)$ and $(1-D){*}DebtGap(-1)$. The former are related to the positive lagged debt gap observations, and the latter to the negative lagged debt gap observations.

Table 6. 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 (-1)	0.55***	0.47***	0.43***
	(0.10)	(0.12)	(0.14)
Debt (-1)	0.06**	0.05**	0.05*
	(0.02)	(0.02)	(0.02)
D * Debt Gap (-1)	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)
(1-D) * Debt Gap (-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)

Table 6, continued

Variable	TAR 1	TAR 2	TAR 3
Exp. 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)
D 80s	-1.59***	-1.94***	-1.62**
	(0.53)	(0.64)	(0.67)
D 1994	-2.85***	-1.60***	-1.56***
	(0.27)	(0.38)	(0.41)
D Post Crisis	-2.195***	-2.18***	-2.54***
	(0.31)	(0.40)	(0.56)
Obs.	44	44	44
R2	0.82	0.89	0.89

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

When the debt level is above its long-run trend (positive gap) the coefficient is negative, meaning the fiscal reaction of the government will be less effective. The opposite occurs for the negative gap observations, where the reaction function is more efficient. Overall, this represents additional evidence for non-linearities. Again, when debt is high or is increasing above its long-run trend, the FRF loses strength, and the primary balance is less responsive to past debt changes with an effect of 0.02,[18] almost a fourth of the OLS estimates. On the other side, there are almost no improvements in the FRF when debt is below its long-run path, a serious problem for Costa Rica's fiscal policy.As we can see in Table 6, the coefficients for the negative lagged debt gap are very small but statistically different than zero. In order to elucidate TAR parameters related to the lagged positive and negative debt gap are different than zero, a Wald test was run, in which the null hypothesis of $\theta = \omega = 0$ was assessed, where θ and ω are the coefficients for $D{*}DebtGap(-1)$ and $(1 - D){*}DebtGap(-1)$, respectively. The Wald test showed those parameters are different than

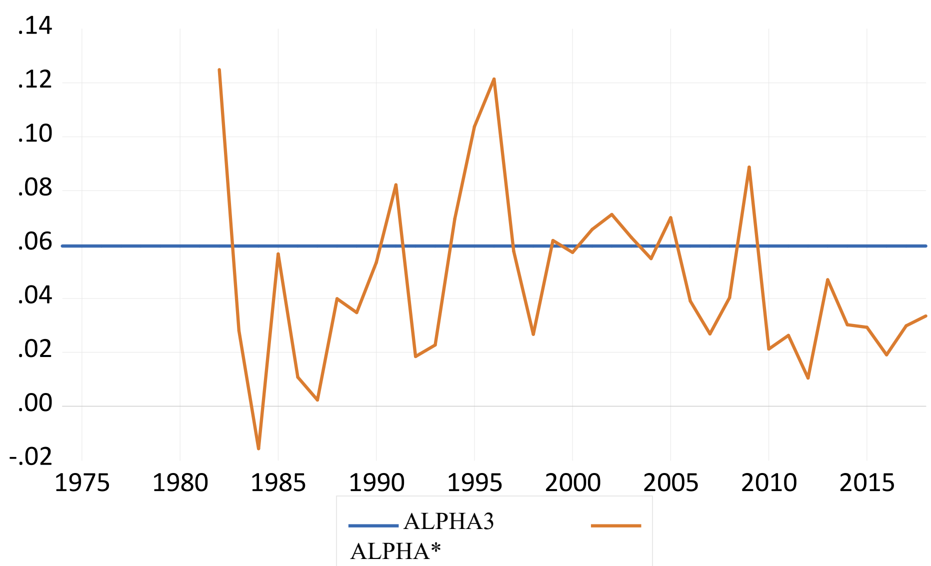
[18] In order to make this inference, we are assuming both coefficients could be added, even though the related variables are not exactly the same. While one parameter is related to debt as ratio of GPD, the other is related to Debt gap.

zero, even at 1 percent significance in the three estimations. Given that coefficient ω is the one that is closer to zero, a Wald test was run for the case of $\omega = 0$. In the same way, the result shows at least 1 percent significance, a parameter different than zero.

The TAR estimation using output gap as a transition variable was also estimated. The results are found in Table B3. We found there is no significant coefficient for this transition variable, which could be interpreted again as evidence of fiscal policy not being responsive to the business cycle.

The next step after the FRF estimation is the definition of periods where fiscal policy had been sustainable according to the standard DSA framework as in Jooste et al. (2011), but here with only the short-run parameter. The estimate for $\alpha_3 = 0.7$, obtained from OLS, is compared with $\alpha^* = \frac{r-g}{1+g}$ presented in equation (7). As mentioned before, if α^* is over α_3, the short term fiscal situation is not sustainable. Figure 7 shows several instances of non-sustainability: the period in the 1980s corresponding to the debt crisis, the Anglo Bank's closure in 1994-95, and in 2009 with the international financial crisis and the structural break in the debt path.

Figure 7. Short-Term Debt Sustainability Analysis with Time-Varying Alpha, 1975-2018



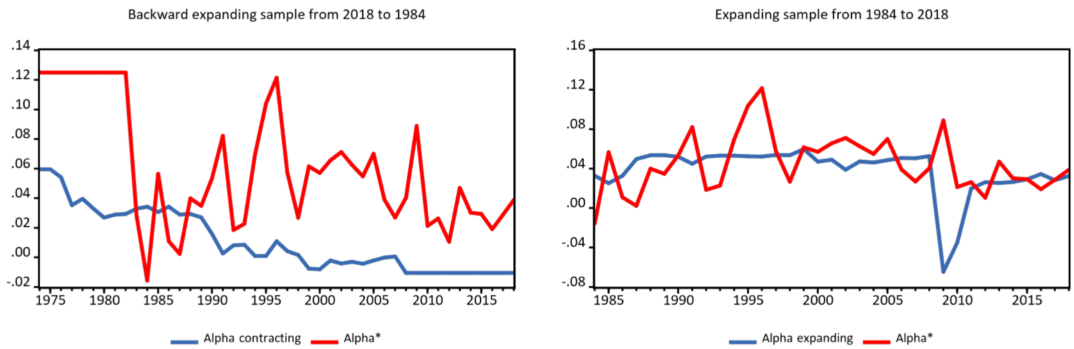
Source: Authors' calculations.

The long-run sustainability computed as in Jooste et al. (2011) is shown in Figure A1 in the Appendix for both the OLS model (equivalent to the VAR) and the VECM model. The sustainability conclusions are completely different with both specifications. The OLS suggests there has been always long-run sustainability, but the VECM indicates the contrary for all periods. The disparity of results raises doubts about the use of the standard DSA with the long-run coefficients.

Additionally, there could be influences from historical periods with divergent macroeconomic and fiscal behavior, as in the case of the 1980s debt crisis, that could be biasing the coefficients. To account for that possibility and give more weight to recent history we compute the short and long-term DSA when we change the sample. First, we begin with 1975-1984 and expand the sample year by year in order to recover the respective debt's coefficient estimate, reported in the date of the last period under the name "Alpha expanding." The 1975-1984 period will report the first coefficient for all these years. This was done to make α^{*} comparable with the coefficient, as they would be on the same date. We additionally performed the same exercise but for a backward-expanding sample, namely 2018-2009, and aggregate year by year at the beginning of the sample. Now the respective coefficient is reported for the first year of the sample (i.e., 2009) under the name "Alpha contracting,, and the 2009-2018 sample will have the same first coefficient estimated.

Figure 8 shows the results for the short-run. On the left, the backward-expanding window (Alpha contracting estimate) performs well in assessing sustainability during the 1980s debt crisis. Nonetheless, the forward-expanding window (Alpha expanding estimate) provides a better DSA analysis in terms of assessing unsustainable historical events. This window also captures uncertainty about fiscal sustainability in 2018 when the fiscal reform was still on the bureaucratic process of approval and the Treasury found it difficult to obtain funds through debt.

Figure 8. Short-Term Debt Sustainability Analysis with Time-Varying Alpha and Varying Sample, 1975-2018



Source: Authors' calculations.

Figure A2 shows the long-run counterparts. Unfortunately, both the backward-expanding and the forward-expanding sample still display biases in favor of the sustainability conclusions.

5 Risk Assessment

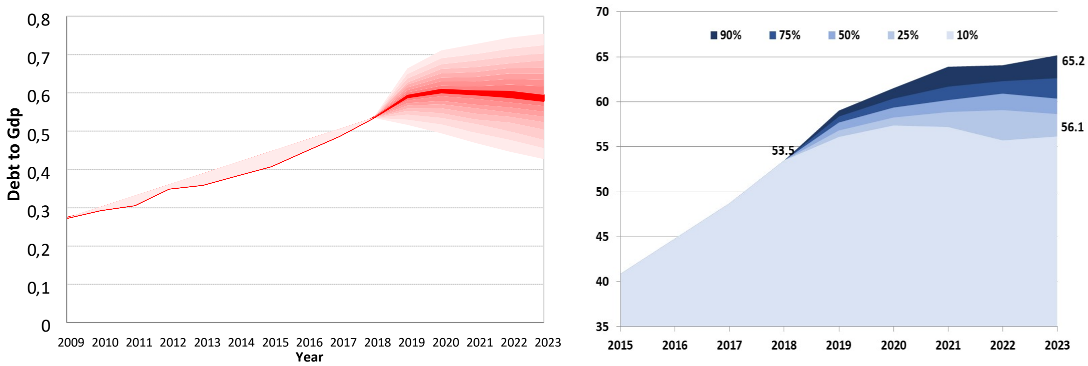
As stated before, we cannot rely completely on standard debt sustainability analysis such as the comparison of α^* and the short and long-run coefficients. There exist multiple sources of uncertainty in the conduct of fiscal policy, the evolution of domestic and foreign economic activity, and private agents' expectations.

Costa Rica suffers from weak public finances but has recently approved fiscal reform. This situation has two contradictory effects. First, the tax increase will reduce agents' disposable income in a context of a slowdown in the economic activity, with the respective negative impact on growth. Second, fiscal reform could improve agents' expectations in regard to the public sector's finances and lead to a decrease in domestic interest rates, which will in turn produce a lower crowding-out effect on private investments.

It is difficult to determine which effect would dominate in the end. Moreover, the increase of international interest rates given the normalization of international monetary policy, the negative effects of the implemented measures on international trade, and lower forecast of the international economic activity, all represent sources of uncertainty in the outcomes of Costa Rica's fiscal policy.

Therefore a risk assessment is necessary. In Figures 9 and 10 we compare the fan charts estimated for the IGBC framework, which are based on a Monte Carlo analysis, with those built as proposed by Celasun et al. (2006).

Figure 9. Fan Chart: IGBC, External Projections

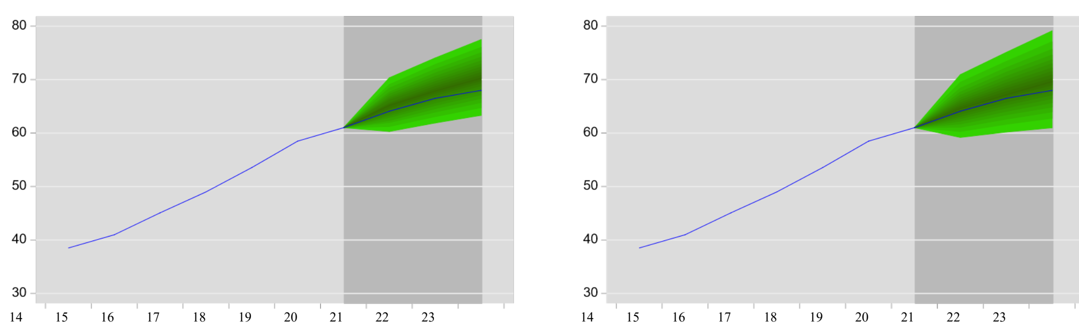


Source: Authors' calculations based on IGBC methodology and IDB fiscal sustainability macro.

Given the recently approved fiscal reform in Costa Rica, we take the forecast with reform for the main fiscal and non-fiscal debt determinants to obtain an uncertain forecast of the debt path, as described in the methodology. Not only do we measure the uncertainty of the debt forecast, but we also perform estimations with feedback from the economic activity. In addition, we compared versions of the uncertain forecast with and without this economic activity feedback in order to show the importance of its inclusion in the debt sustainability analysis.

Figure 11 shows the uncertain forecast for the debt path as a ratio to GDP. The blue line represents Costa Rica's Treasury forecast given the fiscal reform approval. Figure 11a shows the forecast using only the fiscal reaction function, i.e., without feedback from economic activity. We can see for 2023 that the fan chart's average (70 percent) is slightly more pessimistic than the Treasury's forecast (68 percent), the latter inside the lower 45th percentile of debt paths.

Figure 11. Debt Uncertainty Forecast



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

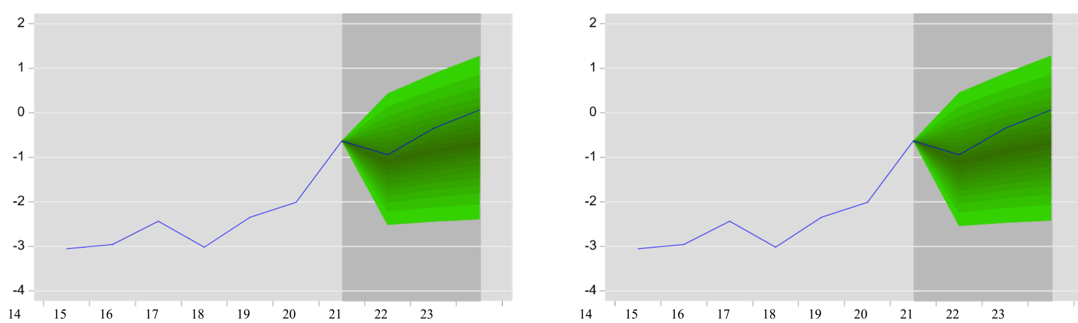
Source: Authors' calculations.

Nevertheless, when we include economic activity feedback in Figure 11b, whereas the mean is the same the uncertainty of the possible debt path increase substantially as the fan chart's confidence interval widens. Now the Treasury's forecast is in the 30th percentile below the fan chart's average of 70 percent for the debt path. Accordingly, the lower and upper bounds for debt without feedback are 63 percent and 77 percent, respectively, in 2023, whereas with economic feedback these values increase to 61 percent and 79 percent, respectively, a difference of 2 percent for each bound.

What, however, is the source of these huge differences in the debt paths? Analyzing the uncertain forecast for the debt determinants would provide an answer and identify the mechanism for debt uncertainty.

Figure 12 shows the primary balance's uncertainty forecast both with and without economic feedback. Beside the fact that the Treasury's forecast is overly optimistic (0.1 percent for the ratio of primary balance to GDP in 2023), even above the 45th percentile of both fan charts, the difference between the fan charts is minimal, with an average near -0.7 percent for the forecast with and without feedback, respectively.

Figure 12. Primary Balance Uncertainty Forecast



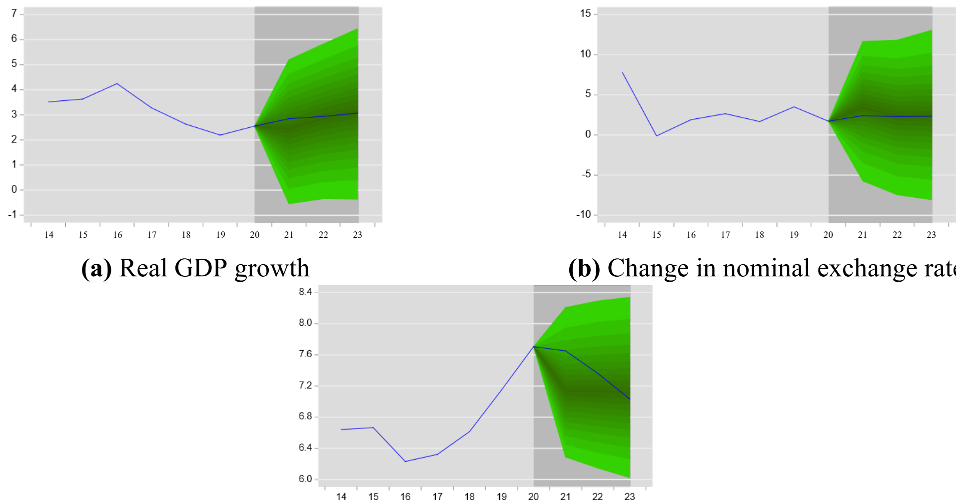
(a) Only FRF **(b)** FRF and VAR

Source: Authors' calculations.

In our estimates, the primary balance does not seem to be leading to the differences in the debt paths. Even the Treasury's highly optimistic forecast for the primary balance is not a relevant factor, as their forecast does not differ greatly from the previous fan charts. When looking at other determinants such as the economy's growth rate and the change in the nominal exchange rate (Figure 13), there are no important differences between the Treasury's forecast and the fan charts

estimated. The sole exception is the long-run potential GDP growth of forecast is 3.2 percent rather than the Treasury's figure of 3.5 percent.

Figure 13. Uncertainty Forecast with Non-Fiscal Determinants



(a) Real GDP growth **(b)** Change in nominal exchange rate

(c) Debt's implicit interest rate

Source: Authors' calculations.

What happens with the debt interest rate in 2023? As Figure 13c shows, its future paths tell a different story. The Treasury's forecast presents an optimistic scenario: debt will pay a real interest rate of about 7.03 percent, below the 9th percentile from our forecast. Our average real interest for debt, however, is 7.11 percent. The difference is even bigger when we extend the forecast to 2030. In the Appendix, we show different possible paths for all the variables analyzed here. It is remarkable that the Treasury forecast calls for an interest rate of 6.8 percent at 2030, whereas our figure is 8.3 percent, or 1.5 percentage points higher. This could account for our long-run differences: a 58 percent debt to GDP ratio in the Treasury's 2030 forecast, compared to our 2030 forecast of 66 percent.

The future interest rate thus seems to be the primary factor in the uncertainty assessment, as the primary balance forecast with and without feedback is almost the same. The debt forecast with only the fiscal reaction function (without feedback), which takes as given the Treasury's forecast on the interest rate, presents a downward-biased result for the debt path, with a magnitude almost equal to the optimistic forecast of the interest rate.

Using economic feedback is necessary to eliminate the bias from the interest rate. The inclusion of those nonfiscal determinants helps to forecast the debt path because we obtain a

forecast of debt's interest rate in the process. Recall the VAR inclusion of the fan charts uses the exchange rate and the foreign interest rate, hence jointly they could provide a reasonable forecast for the debt interest rate due to the uncovered parity of interest rates.

The extent to which the debt forecast depends on the interest rate path is intuitive. Even a higher forecast relative to the Treasury's could be argued, given both the uncertainty of fiscal outcomes and increasing past debt levels together had exerted pressure on the debt's interest rates. In addition, individuals' pessimism regarding the government's ability to effectively cut public expenditure works further against expectations of a low interest rate.

Finally, as mentioned above, a variety of factors create additional uncertainty regarding the debt's interest rate and the primary balance, and in turn regarding the future debt path. These factors include the decrease in disposable income arising from the increase in taxes, the increase in international interest rates given the normalization of international monetary policy, the negative effects of the implementation of measures on international trade, and a lower forecast of international economic activity.

6 Final Remarks

The main goal of this research was to determine if Costa Rica's debt path is sustainable or not. Along the way, it was evident that the IGBC provided valuable information on the topic, but it proved somewhat rigid. We additionally noticed that the methodology demands strong assumptions on the future trajectories of the main variables, and that the solvency condition do not necessarily indicate sustainability in the long run.

We decided to complement, those results with the estimation of the FRF. We are not aware of this exercise having previously been undertaken for Costa Rica, probably because of data limitations. Following Bohn's research,[19] we were able to define, under different estimations and specifications, that the debt level was sustainable in the long run by observing that the debt coefficient was positive and significant.[20] However, in the last few years, Costa Rica's fiscal performance has been conducive to sustainability, except for the recent fiscal rule passed by Congress. Most likely, Costa Rica's past history of responses of the fiscal balance to changes in debt is influencing this result.

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

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

For this reason, we studied short run behavior by conducting the analysis using different data time windows. On one hand, we started with a sample from 1974 until 1985, and added observations one by one, and on the other, we started with the sample from 2009 until 2018. By analyzing the α coefficient, in terms of sign and significance, we were able to determine that the recent data indicate that Costa Rica was heading toward unsustainability, meaning it had undertaken sustainable policies in the past. This is why the implementation of the new fiscal rule is key, and its approval on December 5, 2018 represented an important first step towards sustainability.

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 the Treasury has estimated from 2019 until 2023. This means, that our projected series include the policy changes, in terms of both tax increases and expenditure cuts, to comply with the rule.

In general terms, given our fan charts from the FRF which consider VAR behavior, it seems as if the path to sustainability may take longer than what has been projected by the Treasury. Still, it is needed to express endogenously the behavior of future expenditure defined by the fiscal rule.

The use of FRF estimations, which considered the debt gap, and the TAR methodology provided a first sign of Costa Rica's fiscal space. Whenever the debt ratio is over its trend or its average, the fiscal space reduces. This result is a starting point for future research following Ghosh et al. (2013).

There remain issues to discuss in building on 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, this country has a high degree of inflexibility for its expenditures: more than 80 percent of which is defined by law or constitution, and most of that amount goes to current expenditure. There are also automatic expansion factors in public sector wages, which may signal that the (possible) sustainability attained with this reform can be reversed in the long run.

Finally, there must also be a discussion to determine if the cuts in current expenditure will strengthen public investment and lead to a virtuous path for future growth. In terms of policymaking, it is necessary to include, along with the sustainability analysis, a cost-benefit analysis and return on investment in order to determine if fiscal restraint may be compensated by growth friendly policies towards capital expenditure.

Bibliography

Afonso, A. 2005. "Fiscal Sustainability: The Unpleasant European Case." *FinanzArchiv: Public Finance Analysis* 61(1): 19–44.

Álvarez Corrales, C. 2017. "Parámetro de Suavizamiento del Filtro Hodrick-Prescott para Costa Rica." Documento de Trabajo N.002. San Jose, Costa Rica: Banco Central de Costa Rica.

Blanchard, O.J. 1990. "Suggestions for a New Set of Fiscal Indicators." OECD Economics Department Working Paper 79. Paris, France: Organisation for Economic Co-operation and Development.

Blanchard, O.J. et al. 1991. "The Sustainability of Fiscal Policy: New Answers to an Old Question." NBER Working Paper 1547). Cambridge, United States: National Bureau of Economic Research.

Bohn, H. 1995. "The Sustainability of Budget Deficits in a Stochastic Economy." *Journal of Money, Credit and Banking* 27(1): 257–271.

Bohn, H. 1998. "The Behavior of US Public Debt and Deficits." *Quarterly Journal of Economics* 113(3): 949–963.

Bohn, H. 2007. "Are Stationarity and Cointegration Restrictions Really Necessary for the Intertemporal Budget Constraint?" *Journal of Monetary Economics* 54(7): 1837–1847.

Bohn, H. 2008. "The Sustainability of Fiscal Policy in the United States." In: R. Neck and J-E. Sturm, editors. *Sustainability of Public Debt*. Cambridge, United States: MIT Press.

Buiter, W.H. 1985. "A Guide to Public Sector Debt and Deficits." *Economic Policy* 1(1): 13–61.

Celasun, O., J.D. Ostry and X. Debrun. 2006. "Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries: A 'Fan-Chart' Approach." *IMF Staff Papers* 53(3): 401–425.

Chalk, N.A., and M.R. Hemming. 2000. "Assessing Fiscal Sustainability in Theory and Practice." IMF Working Paper 00/81. Washington, DC, United States: International Monetary Fund.

D'Erasmo, P., E.G. Mendoza and J. Zhang. 2016. "What Is a Sustainable Public Debt?" In: J.B. Taylor and H. Uhlig, editors. *Handbook of Macroeconomics*. Volume 2. Amsterdam, The Netherlands: Elsevier.

Escolano, M.J. 2010. "A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates." Technical Note. Washington, DC, United States: International Monetary Fund.

Espinosa-Rodríguez, J.C., and M.V. Valerio-Berrocal. 2014. "Sostenibilidad Fiscal en Costa Rica, 1991-2013: Una Aproximación a través del Método Montecarlo." *Economía y Sociedad* 19(45): 72–95.

Ganiko, G. 2016. "How Much Is Too Much? The Fiscal Space in Emerging Market Economies." Working Paper 2016-014. Banco Central de Reserva del Perú.

Ghosh, A.R. et al. 2013. "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies." *Economic Journal* 123(566): F4–F30.

Hoffmaister, A.W. et al. 2001. "Solvencia del Sector Público Global: Una Exploración Empírica Preliminar para Costa Rica." Documento de Trabajo N.004 2001. San Jose, Costa Rica: Banco Central de Costa Rica.

IMF. 2003. "World Economic Outlook." IMF Occasional Papers 21. Washington, DC, United States: International Monetary Fund.

IMF. 2013. "Staff Guidance Note for Public Debt Sustainability Analysis in Market-Access Countries." Washington, DC, United States: International Monetary Fund.

Jooste, C. et al. 2011. "Fiscal Sustainability and the Fiscal Reaction Function for South Africa." IMF Working Paper 11/69. Washington, DC, United States: International Monetary Fund.

Mendoza, E.G., and J.D. Ostry. 2008. "International Evidence on Fiscal Solvency: Is Fiscal Policy 'Responsible'?" *Journal of Monetary Economics* 55(6): 1081–1093.

Mendoza, E.G., and P.M. Oviedo. 2004. "Public Debt, Fiscal Solvency and Macroeconomic Uncertainty in Latin America: The Cases of Brazil, Colombia, Costa Rica, and Mexico." NBER Working Paper 10637. Cambridge, United States: National Bureau of Economic Research.

Neck, R., and J-E. Sturm. 2008.*Sustainability of Public Debt*. CESifo seminar series. Cambridge, United States: MIT Press.

Ostry, J.D. et al. 2010. "Fiscal Space." IMF Staff Position Note SPN/10/11. Washington, DC, United States: International Monetary Fund, Research Department.

Ostry, J. D., A.R. Ghosh, and R. Espinoza. 2015. "When Should Public Debt Be Reduced?" IMF Staff Discussion Note SDN/15/10. Washington, DC, United States: International Monetary Fund.

Rojas, M., and M. Sáenz. 2003. "Posición Financiera Neta del Sector Público Global: Aspectos Metodológicos y Ejercicios de Simulación." Documento de trabajo N.005 2003. San Jose, Costa Rica: Banco Central de Costa Rica.

Appendices

A Standard Log-Run Sustainability Analysis

Figure A1. Long-Term Debt Sustainability

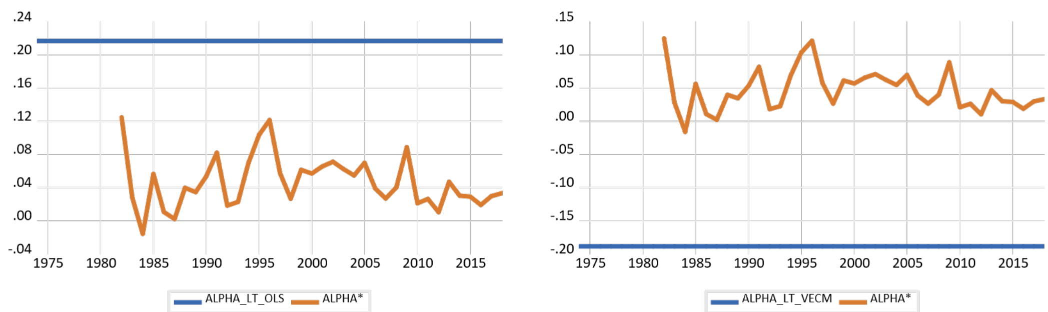
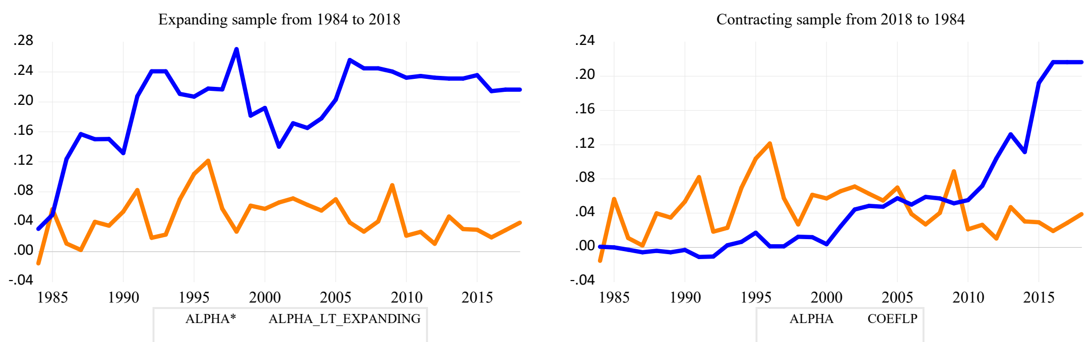


Figure A2. Long-Term Debt Sustainability Analysis with Time-Varying Alpha, 1984-2018



B Alternate Estimations

Table B1. Vector Autoregressive Estimation
Dependent variable: Primary Balance (Pb)

Variable	VAR 1	VAR 2	VAR 3
Constant	-2.24***	-2.18***	-1.68*
	(0.78)	(0.69)	(0.94)
Pb (-1)	0.59***	0.53***	0.49***
	(0.10)	(0.09)	(4.70)
Debt (-1)	0.08***	0.07***	0.07***
	(0.02)	(0.02)	(0.02)
Output Gap	0.02	0.02	0.01
	(0.07)	(0.06)	(0.06)
Exp. Gap		-0.08***	-0.08***
		(0.03)	(0.03)
RER Gap		0.01	0.01
		(0.03)	(0.03)
US Treasury			-0.06
			(0.08)
D 80s	-1.59**	-1.93***	-1.59**
	(0.72)	(0.65)	(1.03)
D 1994	-2.62**	-1.50	-1.47
	(1.05)	(1.02)	(1.03)
D Post Crisis	-1.83***	-1.80***	-2.19***
	(0.46)	(0.40)	(0.64)

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

Table B2. Generalized Method of Moments Estimation
Dependent variable: Primary Balance (Pb)

Variable	GMM 1	GMM 2
Debt (-1)	0.33	0.21***
	(0.20)	(0.05)
Output Gap	-1.20	-0.46***
	(0.94)	(0.14)
Debtˆ2(-1)	-0.01	-0.00**
	(0.01)	(0.00)
US Treasury	-0.41	-0.37***
	(0.29)	(0.10)
D Post Crisis	-3.48	-4.02***
	(3.59)	1.08
IV	Pb(-1 to -7)	Pb(-1 to -7), Schooling(0 to 1)

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

Table B3. 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 (-1)	0.58***	0.52***	0.47***
	(0.11)	(0.12)	(0.15)
Debt (-1)	0.07**	0.07**	0.07**
	(0.03)	(0.03)	(0.03)
D * Output Gap	-0.09	0.04	0.07
	(0.16)	(0.20)	(0.21)
(1-D) * Out Gap	0.13	0.02	-0.02
	(0.08)	(0.09)	(0.10)
Exp. 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)
D 80s	-1.31	-2.10	-1.84
	(1.03)	(1.32)	1.33
D 1994	-2.59	-1.52***	-1.47***
	(0.32)	(0.46)	(0.43)
D 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' calculations based on Central Bank of Costa Rica, Treasury of Costa Rica and United States Treasury data.

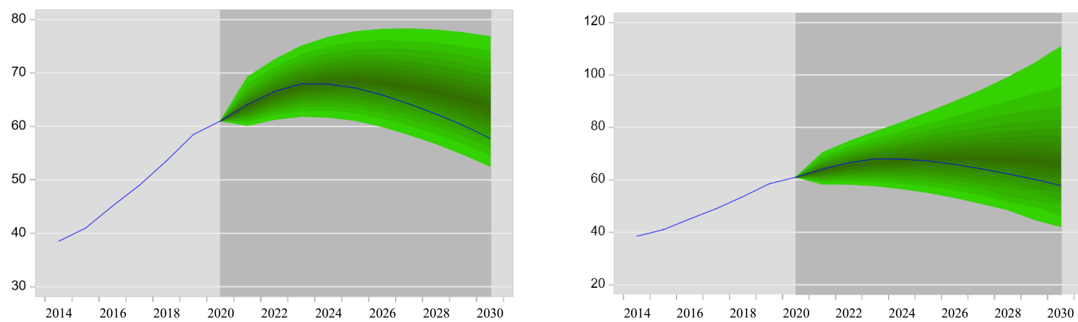
Table B4. Ordinary Least Squares Estimation
Dependent variable: Primary Balance (Pb)

Variable	OLS 1	OLS 2	OLS 3
Constant	-3.48***	-4.26**	-4.09**
	(1.41)	(1.22)	(1.80)
Pb (-1)	0.32***	0.53***	0.31***
	(0.11)	(0.10)	(0.12)
Debt (-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)
Exp. 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)
D 80s	-3.16***	-1.93***	-3.05**
	(0.78)	(0.63)	(0.77)
D 1994	-2.41***	-0.86*	-0.85***
	(0.36)	(0.49)	(0.50)
D Post Crisis*Debt(-1)	-0.10	-0.16***	-0.16***
	(0.06)	(0.04)	(0.05)
D Post Crisis	1.13	3.13**	2.95***
	(1.81)	(1.39)	(1.98)
Obs.	44	44	44
R2	0.80	0.88	0.88

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

C Risk Assessment until 2030

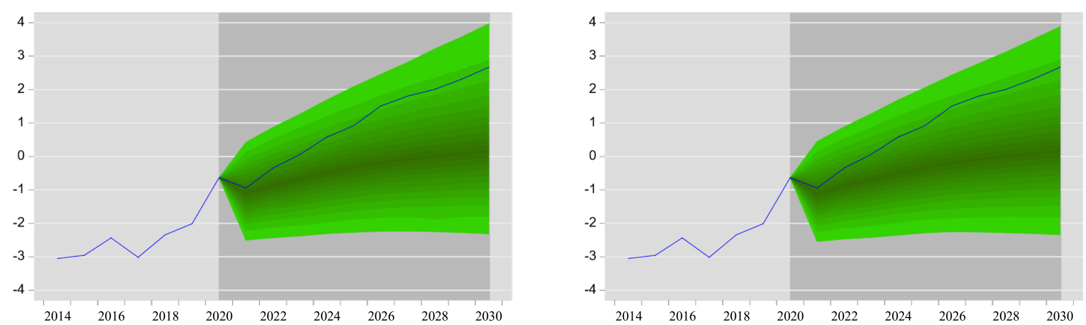
Figure C1. Debt Uncertainty Forecast until 2030



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

Source: Authors' calculations.

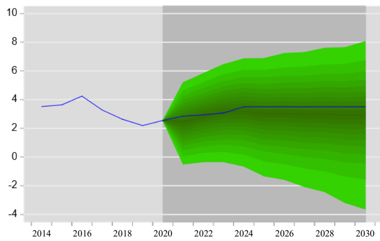
Figure C2. Primary Balance Uncertainty Forecast until 2030



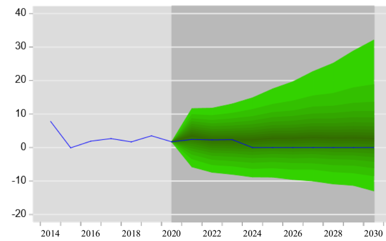
(a) Only FRF **(b)** FRF and VAR

Source: Authors' calculations.

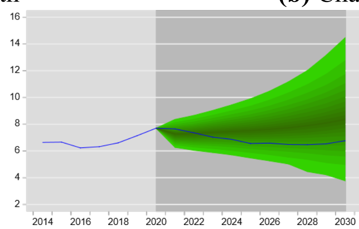
Figure C3. Non-Fiscal Determinants Uncertainty Forecast until 2030



(a) Real GDP growth



(b) Change in nominal exchange rate



(c) Debt's implicit interest rate

Source: Authors' calculations.

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, GMM, 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	0.094-0.121	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
Jooste et al. (2011)	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.

Source: authors' compilation based on works cited.