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Assessing Public Debt Sustainability for Costa Rica using the Fiscal Reaction Function

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Photography on the title page: “Presentes”, copper set of sculptures from the Costa Rican artist Fernando Calvo Sánchez, 1983. Collection of the Central Bank of Costa Rica.

Estimación de la función de reacción fiscal para evaluar la sostenibilidad de la deuda costarricense

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Resumen

Esta investigación hace un análisis empírico sobre la sostenibilidad de la deuda soberana costarricense con base en tres enfoques complementarios: el cálculo del balance primario estabilizador del balance fiscal, que se obtiene de la restricción presupuestaria inter temporal del gobierno; la estimación de los parámetros de la función de reacción fiscal (FRF), con base en la metodología propuesta por Bohn (2007) y la estimación de gráficos de abanico para el balance fiscal primario y la deuda pública, como porcentajes del PIB, con base en la propuesta de Celasun et al. (2006). Con datos anuales desde 1974 hasta 2018, se muestra que el comportamiento de la deuda ha sido insostenible en diferentes momentos bajo el indicador de largo plazo, lo que se refleja también en la conducta de corto plazo. Para las observaciones más recientes, la conclusión es que la deuda tiene una trayectoria insostenible. Sin embargo, dado que a finales del 2018 se aprobó una reforma fiscal con cambios en ingresos y gastos, se agregó el análisis bajo incertidumbre de la trayectoria esperada de la deuda hasta el 2023 y 2030 con base en las proyecciones de dicho cambio regulatorio. El resultado muestra que el nivel más alto de la razón de deuda al PIB sería 68% en el 2026, momento a partir del cual se revierte la tendencia (al alza).

Palabras clave: sostenibilidad de la deuda, balance primario, función de reacción fiscal, análisis de riesgo, gráfico de abanico.
Clasificación JEL.: C22, H63, C15, E62

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

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Abstract

This paper empirically assesses 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; the estimation 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, both expressed as shares of GDP, following the approach proposed by Celasun et al. (2006). With annual data from 1974 until 2018, this paper finds that debt has been unsustainable for specific episodes in the long and short run. For the most recent observations, the conclusion is that 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, year from which its upward trend is reverted.

Key words: debt sustainability, primary balance, fiscal reaction function, risk assessment, fan chart.
JEL codes: C22, H63, C15, E62

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1 Introduction

Within 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 other Latin American countries but with weak fiscal outcomes.

In fact, Costa Rica is one of the countries in the region that spends the most on social policies and also, has the least flexible[1] expenditure after Brazil. According to OECD (2018), about half of public expenditures of this Central American government are dedicated to social spending, which focus on benefits in kind (about two-thirds are in kind, near 67%, while the OECD's average is 40%).

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

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

Even when this negative fiscal balance is long-standing, it was strengthened when, as a response to the financial crisis of 2008, an expansionary fiscal policy was adopted as a counter-cyclical measure[2].

[1] According to the Expenditure flexibility index, OECD (2020, p.38).
[2] This policy was centered on permanent changes of current expenditure.

Specifically, in 2009, among other policies[3], the incumbent decided to raise public wages by implementing a fifty-percentile policy to level the wages between the central government professionals and the non-financial autonomous public sector, who earned higher remunerations, and step up current transfers to decentralized institutions.

Given their structural nature, both measures were impossible to revert, increasing the rate of growth of public expenditure significantly without a counter-balance on income. Before the crisis, in the year 2007, total expenditure was 14.7% of GDP, and by 2018 it was already 20% of GDP (the largest of the last three decades); while total income was on average 14.3% of GDP (from 2007 until 2018). As a result, the headline deficit averaged 5% of GDP, from 2009 until 2018, and the primary balance -2.5% of GDP for the same period.

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

When compared with other countries of Latin America, Costa Rica's fiscal position deteriorated more sharply. Its government debt ratio as percentage of its GDP, grew at one of the fastest rates of the region: the central government debt increased from 24% of GDP in 2008 to 49% of GDP in 2017, representing a change of 102%. For 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) state that for emerging economies, debt levels over 50% of GDP have negative effects on growth.

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

[3] Such as an increase to 15% in the non-contributing retirement regime of the "Caja Costarricense del Seguro Social" (Costa Rican social security), and spending 5% of GDP in investment in order to stimulate the economy.

Based on this context it is unavoidable to question debt sustainability. Weighting the vulnerabilities of a high debt level and its management, a growing proportion of the Government's debt denominated in foreign currency[4], and a high level of dollarization in the financial system[5], signals that Costa Rica's debt dynamics are on an unsustainable path and that the country might be particularly exposed to sudden stops, capital flow reversals and financial instability.

It is a safe bet to state that the high and rising fiscal deficit and mounting debt are Costa Rica's economy main weaknesses. Therefore, in the short term, tighter financial conditions which may potentially reduce private investment and curb growth are expected. Whilst, in the long run, a reduced scope for counter-cyclical policies could harm its comparative advantage vis-a-vis other emerging markets in attracting and even keeping FDI (OECD, 2018).

In fact, as time went by, the lack of consensus for a fiscal reform, increased the vulnerability and uncertainty of the country's fiscal balance and drove up the risk premia, which translated into a downgrade from the 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 finances reform was passed by Congress and approved by the Constitutional Court (in December 2018). The credit agencies explained that even when the law No.9635, "Ley para el Fortalecimiento de las Finanzas Públicas" had changes on the income and expenditure side[6], they were coming a bit too late and with a slow pace for rebalancing the public finances.

Given this context and the need to characterize Costa Rica's fiscal balance in the short and medium term from different angles, our research intends to empirically assess its public debt sustainability through three complementary approaches: the calculation of the debt-stabilizing primary fiscal balance obtained from the government's intertemporal budget

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

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

[6] 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).

constraint (this balance being a function of the debt stock, the real interest rate and the growth rate of real GDP); the estimation 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, both expressed as shares of GDP, following the approach proposed by Celasun et al. (2006).

To pursue this line of work, the section 2 provides a more detailed description of the main fiscal indicators for recent years under a comparative view with a medium term (last two decades) and a long term (four decades ago). Afterwards, Section 3 briefly explains the relevant theoretical, while 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.

2. Costa Rica's public finances

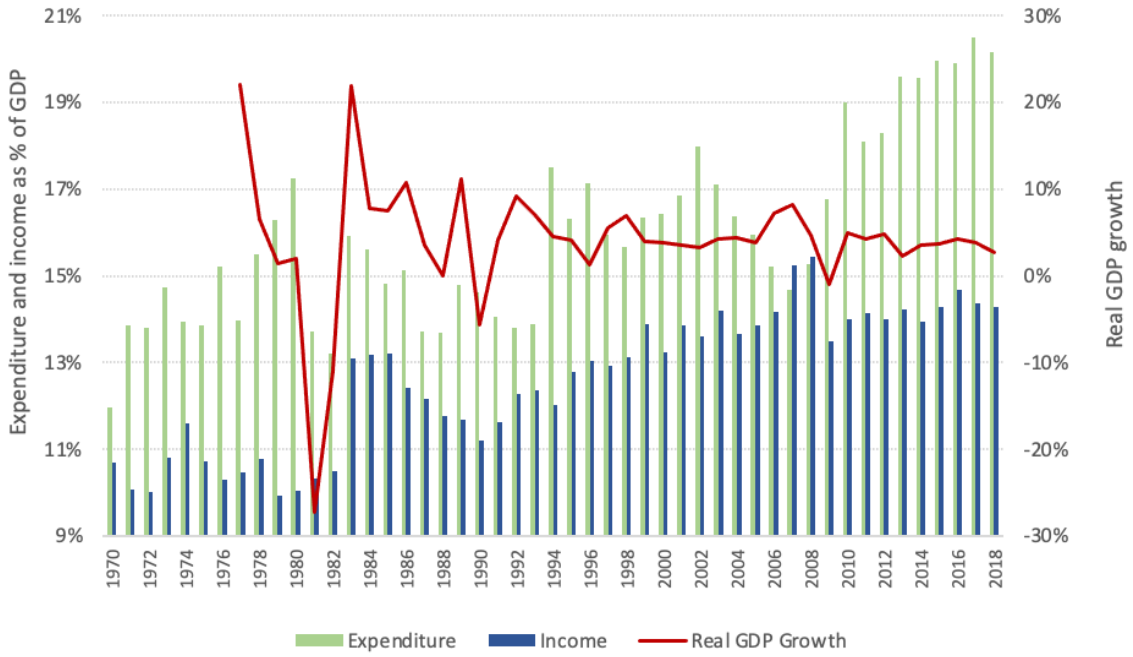
By the end of 2018, Costa Rica's parliament approved a long-waited fiscal reform[7], "Ley de Fortalecimiento de las Finanzas Públicas". It took this country almost two decades to legally implement changes recognized as necessary on income and expenditure since early 2000's. It was not costless. From the year 2008 until 2018, the fiscal balance went from 0.2 to 5.8% of GDP, the total debt went from 23.8 to 53.6% of GDP, and the interests' payment grew, on average, 14% year over year.

Because the aim of this work is to assess Costa Rica's debt sustainability, it is necessary to have a better understanding of its fiscal behavior. This section intends to provide a more detailed description of the fiscal variables that will be included in the empirical model for the reader to have a better sense of how the country reached a critical point in 2018, where

[7] It is a comprehensive fiscal reform package, with measures on both the revenue (creates a VAT and two new income brackets in the personal income tax scheme and reduces earmarking) and the spending side (rationalizes some remuneration incentives), as well as a fiscal rule (constrains gradually the growth of current spending). For more detail, please refer to annex E.

the fiscal vulnerabilities are coming from, and also the risks to debt sustainability it may face in the near future.

Figure 1: Central government[8] expenditure and income as percentage of GDP and real GDP growth, 1970-2018



Source: authors with information from Treasury (Ministerio de Hacienda).

Figure 1 shows that the government's fiscal balance has always being negative, with the exception of the years 2006 and 2007. In Costa Rica, public income is constituted mainly by taxes[9], as they represent more than 95% of it, but also by non-tax entries, cash/current

[8] We will only analyze the central government's variables as in Costa Rica, since the crisis of the 80's there is no debt at the subnational level, and the debt by the non-financial public sector is not significant either.
[9] There are a number of 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.

transfers, and capital income. Within expenditure, current expenditure[10] (salaries, public debt interest, and transfers to the public, private, and external sectors) represents more than 90% of it, while the rest is spent on capital.

A bit of the history behind this figure (1), starts in the late 1970s when public finances were distressed by an oil shock, which reduced revenues (due to higher prices of imports, and decreases of exports) significantly, and by the acquisition of short-term loans in foreign currency to accumulate reserves that took place around those years.

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

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

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

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

The situation changed in 2008, when the financial crisis caused a lower economic growth, and the government's responded with an expansionary fiscal policy, that structurally changed the expenditure composition and growth as has been mentioned before (increments were permanent in wages and current transfers).

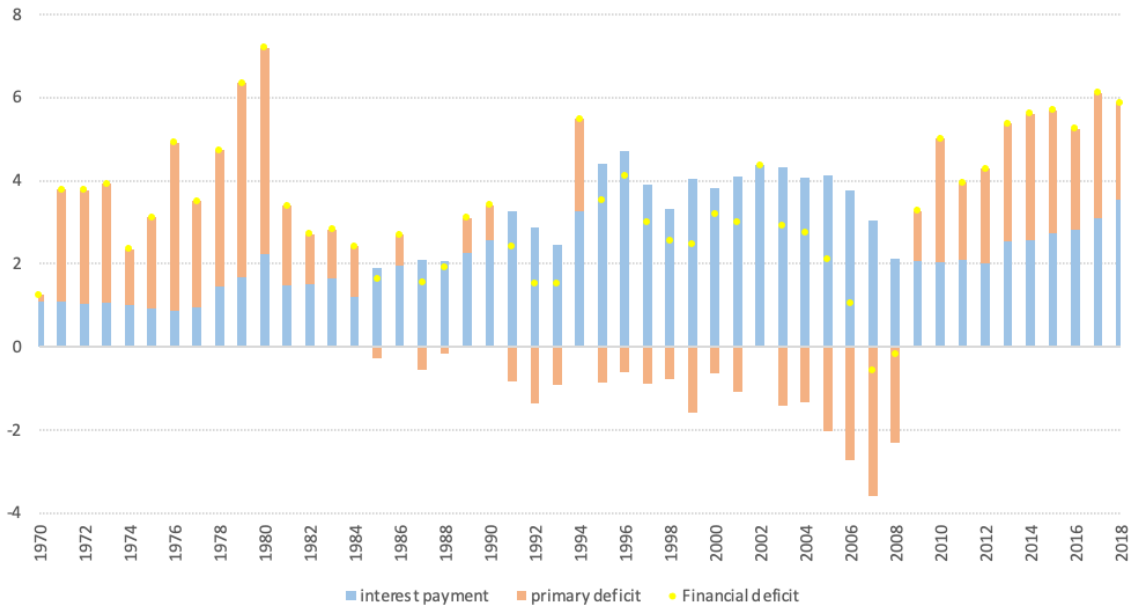
[10] Between 70-75% of current expenditure is comprised by wages and current transfers.

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

The mismatch between income and expenditure, and hence, its financing, shown in Figure 2, could also be described by dividing the sample in 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 80's crisis. After that, there was a significant reduction in primary deficit given the policies implemented in response to the crisis. It was followed by a decreasing trend in the financial deficit for a bit more than a decade, between 1994 and 2006. Afterwards, there were two years of financial surplus, but due to the financial 2008 crisis and the adopted fiscal stimulus measures, it quickly reverted after 2008.

Figure 2: Financial and primary deficit as percentage of GDP, 1970-2018

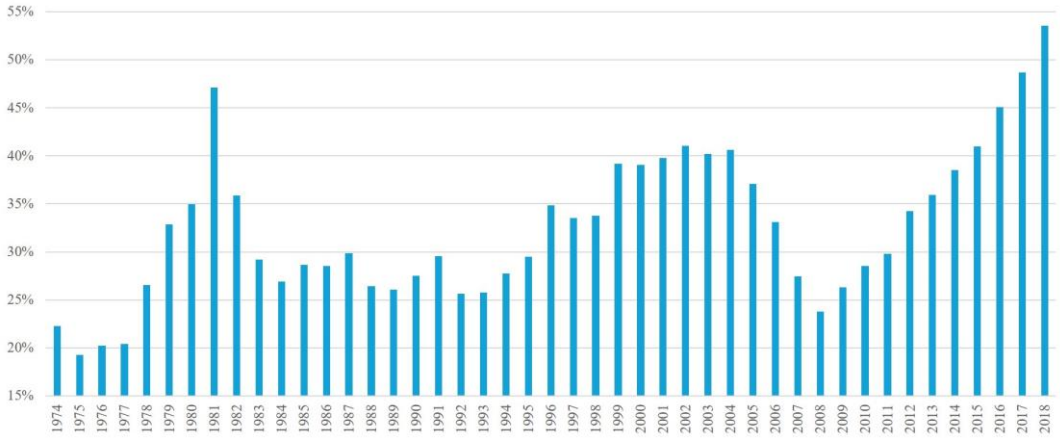


Source: authors with information from Ministerio de Hacienda.

From Figure 2 we also observe a primary surplus from 1991 until 2008, with the exception of 1994 due to the closure of the state-owned mentioned before. During this time span, financial deficit resulted from interest payments on debt, but the level of debt decreased significantly, as shown in Figure 3.

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

Figure 3: Central government debt as percentage of GDP, 1970-2018



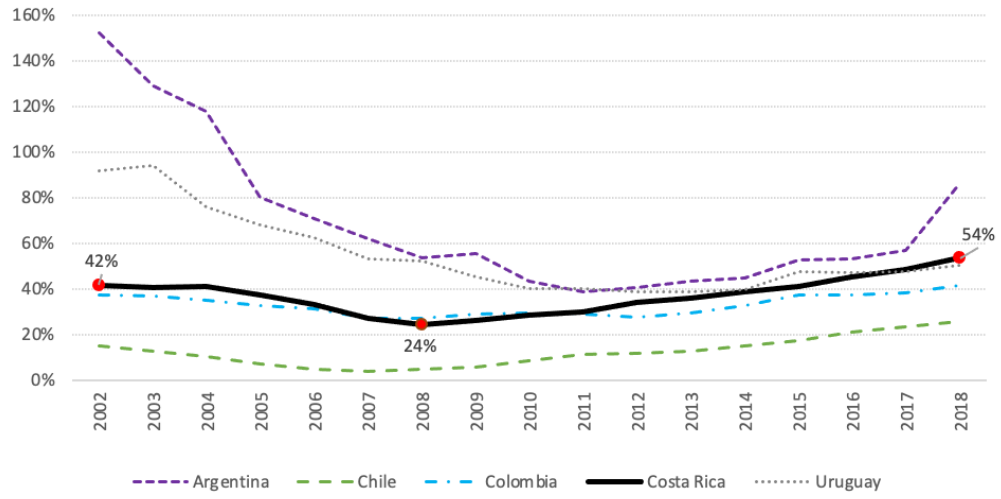
Source: authors with information from Ministerio de Hacienda.

From this figure (3), the hypothesis is 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 given the series of law projects for structural fiscal reforms that were not approved by Congress or by the Constitutional Court. Two examples are: the law project "Ley de Pacto Fiscal" proposed in 2004 and which intended to change the sales tax to an aggregate value estimation, and to adopt the global income tax, but law project was never voted in Congress. And, the law project "Proyecto de Solidaridad Tributaria", endorsed during the presidency Chinchilla-Miranda, 2010-2014, which included a tax of 15% to passive rents and capital gains, and to transform the general

sales tax into an aggregate value one. Even when this project was approved in the legislature process, it was rejected by the Constitutional Court: it was ruled as invalid.

Relatively to other countries in Latin America, the observed rate of growth of the Costa Rican public debt since the year 2008, was one of the highest. Figure 4 shows a comparison between a subsample of countries.

Figure 4: Central government debt as percentage of GDP for different Latin American countries, 2002-2018



Source: International Monetary Fund.

In order to have a better sense of the risks to debt sustainability, the next figures show more into detail, different characteristics of Costa Rica's public debt. Figure 5, for example, shows how this debt grew since 2002 by separating internal and external debt.

Figure 5 Central government internal and external debt as percentage of GDP, 2002-2018

Source: authors with information from Ministerio de Hacienda.

In this country, the issuance of external debt has to be approved by Congress. Therefore, the growth observed from 2012 until 2015 of this series, in Figure 5, is attributable to the Law 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.

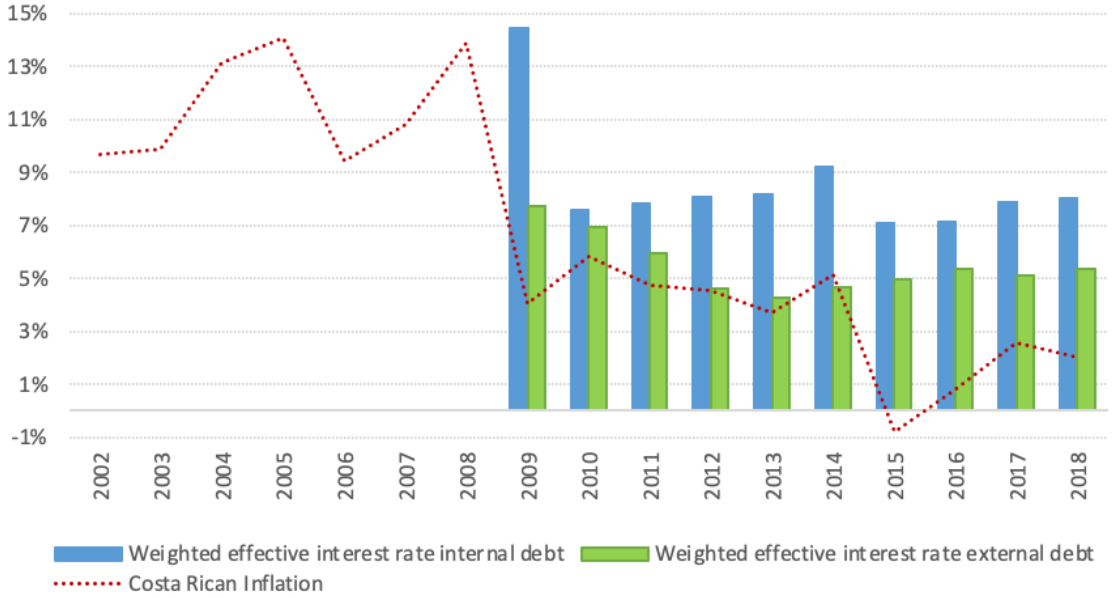
It is also worth mentioning that even when external debt is only issued in foreign currency, internal debt may be issued in local or foreign currency. Therefore, Figure 6 reflects the distribution between currencies of the central government debt by displaying the share of debt in local currency from total debt. This result may be interpreted as a vulnerability indicator as it reveals a degree of dependance between internal financial stability and foreign capital inflows.

Figure 6: Central government debt in domestic currency as percentage of total debt, 2000-2018

Source: authors with information from Ministerio de Hacienda.

In terms of how costly it has been for the country to raise its indebtedness during the last decade, Figure 7 shows the weighted effective interest rate for the internal and external debt per year, since 2009. And what may be concluded from the figure is that, in real terms, interest rates for internal and external debt have been consistently higher; the government has cornered itself to rely on more expensive debt. And, the crowding out effect has affected consequently, credit demand and private investment.

Figure 7: Central government debt effective interest rates, and inflation level, 2002-2018.

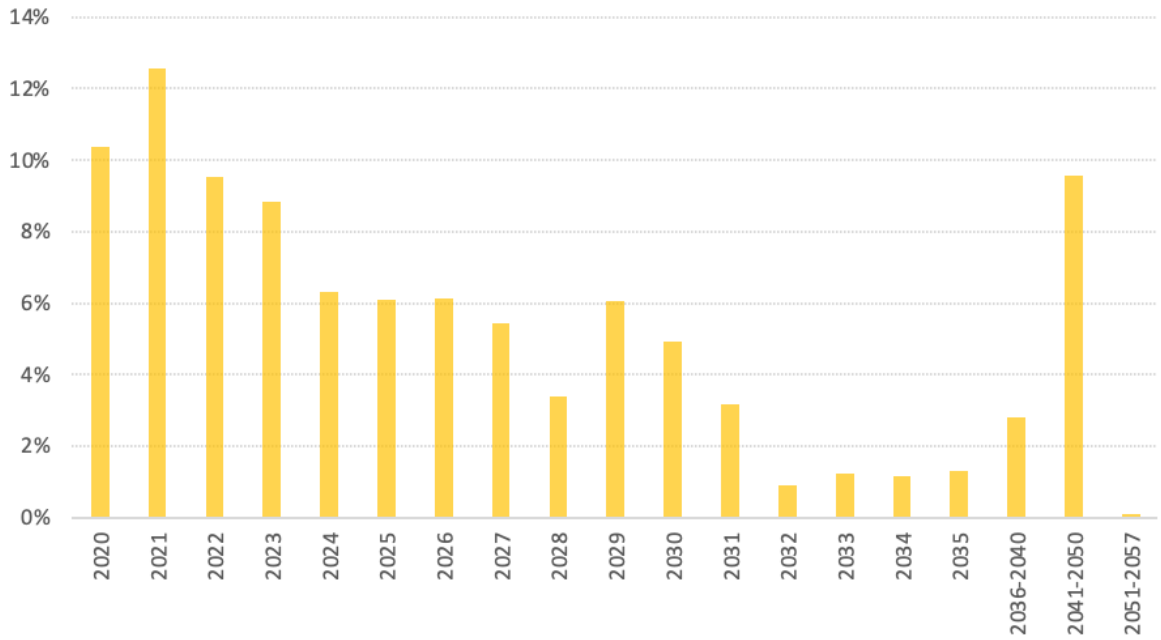


Note: Effective interest rate is the respective weighted average interest rate, however it is available only from 2009 onward.

Source: authors with information from Ministerio de Hacienda.

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

Figure 8: Annual maturity structure as percentage of total debt in 2019.



Source: authors with information from Ministerio de Hacienda.

All the previous analysis poses a difficult stance for the central government and signs the relevance of an integral debt sustainability assessment. As it appears that even when there is a change with the fiscal reform the vulnerabilities in the short run have not been mitigated.

3. Literature Review

There is a 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 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).

As stated 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, 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 where deterministic limits for the debt and primary balance are defined under which there is fiscal sustainability (IMF, 2013).

But even as this approach provides insights about debt sustainability, Bohn (2007) showed that this traditional test had significant flaws, as the IGBC holds even under weak assumptions for the time series process of fiscal data, which therefore means it is generally satisfied. Sustainability tests that rely on stationarity or cointegration conditions between the primary balance and debt 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 high, order.

D'Erasmo et al. (2016) also described another flaw of the IGBC methodology, as it only defines the long-run debt for a given long-run primary balance if stationarity holds, missing the link between the initial debt level and the steady state. In fact, there are multiple dynamic paths for the primary balance that would satisfy the IGBC. Another critique is that this method does not reckon uncertainty for the real economy, or the domestic and foreign asset markets.

Given these weaknesses of the IGBC approach, the use of fiscal reaction functions (FRFs) has become more relevant when analyzing debt sustainability.

Bohn (1998) and Bohn (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 to the debt sustainability analysis, and allows for linear and non-linear specifications (Mendoza and Ostry (2008), Ostry et al. (2010), and 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 (2013) 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-output ratios based on forward simulations of the time series, and as a result, fan charts are built which summarize the confidence intervals for future debt.

In a general way, the FRF approach is extended to include uncertainty. In an application to developing countries, Burger et al. (2012) 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) proposed 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. From 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.

For the case of Costa Rica, research on this topic is limited. Among the existent studies, Espinosa-Rodríguez and Valerio-Berrocal (2014) estimated the 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% probability.

Also, 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% 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 also builds upon the solvency concept: 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 this probability could be upward biased given that government expenditure is highly inflexible as the compliance with specific spending allocations has been defined by law or constitution, which suggests the primary balance would be lower than the historically observed one.

Built upon this theoretical and empirical literature is that we outlined our investigation. Our aim is to characterize Costa Rica's fiscal balance in the short and medium term from different angles, therefore, we start by updating the estimations under de IGBC methodology, but given its weaknesses, we complement the analysis with the calculation of the FRF and an assessment under uncertainty.

4. Empirical Framework

As mentioned, 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.

4.1 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.[11] 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 et al., 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

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

form of a one-period bond. Therefore, the entire stock of inherited debt must be repaid at the end of the period along with its interests due. The period-t government budget constraint is given by:

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

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 to which interest payment 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

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

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

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

[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 by Law 7558 Art 59 the Central Bank of Costa Rica is forbidden to lend to the Treasury since 1995. Previously, since 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 80's debt crisis, where the Central Bank acquired debt from other public entities.

Where non-capital letters now represent the ratios. Hence, 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.

Finally, 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.

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]

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

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

Output gap is included in equation (5) because it controls for non-linear responses as governments want 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 which account 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

[13] Different from equation (4), the FRF uses the output gap instead of the nominal GDP growth to acknowledge tax income and expenditure needs would differ conditional on the economic cycle. To control 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.

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:

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

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

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

Which is almost the same as equation (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 run 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

[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. Second, equation (4) thus would be $d_t = \left(\frac{1+i_t}{1+\theta_t}\right) d_{t-1} - pb_t$, and after some algebra we obtain $\Delta d_t = \left(\frac{1+i_t}{1+\theta_t} - 1\right) d_{t-1} - pb_t = \left(\frac{(1+i_t)-(1+\theta_t)}{1+\theta_t}\right) d_{t-1} - pb_t$, and by the definition from nominal to real rates we have $\left(\frac{(1+i_t)-(1+\theta_t)}{1+\theta_t}\right) = \left(\frac{(1+r_t)(1+\pi)-(1+g_t)(1+\pi)}{(1+g_t)(1+\pi)}\right) = \left(\frac{r_t-g_t}{1+g_t}\right)$.

necessary adjustments in the primary balance for debt stabilization are done in the next period.[16]

Now, unit root tests are informative in two ways. First, to obtain stationarity evidence could be a first guess on the final outcome, despite Bohn´s (2007) critic. Second, the estimation of equation (8) needs to measure the statistical properties of the series. If there are unit roots among the data, Vector Error Correction Models (VECM) models would be appropriate, if not 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], meaning we extend the analysis by including estimations with VECM models, for which we use the following specification:

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

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

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

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

$$\alpha_1 = c_{11} - \alpha_{12}\beta_{13}$$

[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.

$$\alpha_2 = 1 + \alpha_{12} + \Sigma_{11} \tag{11}$$

$$\alpha_3 = -\alpha_{12}\beta_{12} + \Sigma_{12}$$

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. For the short run we compare directly the coefficient; 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 non-linearities 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 if the fiscal reaction is stronger or weaker conditional on periods of high/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 debt and primary balance are used as GDP proportion). Along with an interaction dummy between time and debt is added as control given the structural break in the expenditure series after 2008.

Finally, we included a time-varying-frame analysis to determine if the sustainability analysis changed given different temporal information (short and long run debt sustainability behavior) and to check if 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 equation (11) by varying the sample period, in order to compare the results with the estimated α^*.

Specifically, we estimated α with data from a ten-year window, from 1975 until 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 αs are named as "expanding", given that the sample is increasing by one 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 the sample from 2018 until 2009, and added a year per estimation; the first year to be added was 2008, then 2007 and so on. The resulting α's estimated series is called "contracting".

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

4.3 Risk assessment

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

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 its the 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 debt's non-fiscal determinants, and a bootstrapping process which simulates multiple shocks

[19] The fiscal determinants considered are primary balance, expenditure, tax income, and interest payments, (all) for the Central Government and expressed as share 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).

on the VAR's outcome. The latter, displays the variables' behavior by means of the fan charts[21]. Specifically, the debt path is calculated recursively with a FRF and the conventional stock-flow identity.[22]

For the uncertainty assessment we start with the following specification

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

where $\Psi_t = (g_t, r_t^{US}, r_t, z_t)$.

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

From the VAR model, 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 the non-fiscal debt determinants, allows us to obtain the 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, which are not sensitive to the variables' ordering as we are not looking for causal relationships but for the overall year-on-year dynamics.

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

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

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

[23] As we do not separate 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 of Costa Rica in its Macroeconomic Program 2019-2020, use the nominal exchange rate, and we rather be aligned to this official source. Finally, we think the nominal exchange rate use is appropriate as we are using the 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.

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

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

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

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

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, Ministerio de Hacienda, while the effective interest rate was calculated by dividing interest

[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.

rate payments by total debt, and the series of GDP, inflation and real exchange rate, were gathered from the Central Bank, BCCR.[26]

The one year US Treasury rate was retrieved from FRED, 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 as 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, and has maintained a constant behavior during the last two decades. This is because the BCCR is constantly redeeming its debt and the other public entities (non-financial) 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 base line equation described by (8), therefore, we begin our empirical review testing for the presence of unit roots in the variables of the model.

Table 1 summarizes the results of three different unit root tests (Augmented Dickey Fuller, Phillips-Perron, and Structural Break test) using four different specifications (without intercept nor trend; with intercept without trend; with intercept and trend; 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 approach as the Kalman Filter, for example. We use the HP filter with a lambda parameter value of 26. This estimation comes from Álvarez-Corrales (2017) who based on the work of Marcet and Ravn (2003) adjust 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.

Table 1: Unit root tests' results

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
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

Note: *1: Without intercept nor trend; 2: With intercept 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 with Central Bank of Costa Rica, Costa Rica's Treasury, and United States Treasury data.

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]

[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

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 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 rates' 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.

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 allows this entity to intervene in a discretionary manner to avoid excess volatility, and the exchange rate is 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 figures 2 and 3).

Whereas the unit root presence for debt-to-GDP ratio would be an indicative for no-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, based on Rojas and Sáenz (2003), and considering the economic context of 2018. The discussion of the fiscal reform, during this year, was profound and generated social tensions which at some moment were visible with

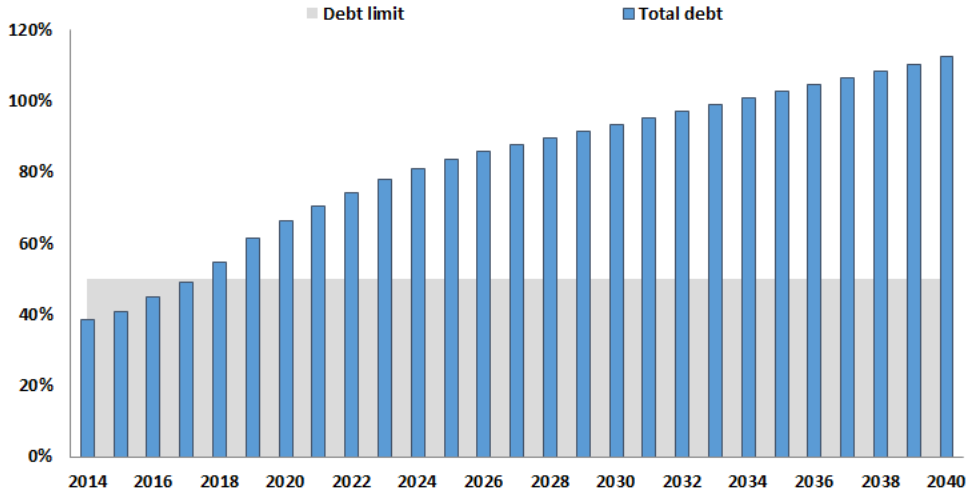
signals the aftermath of the bankruptcy of the public bank, Banco Anglo. Also, 2008 and 2009, intend to capture the fiscal decisions on wages and public employment as response to the financial crisis.

strikes. The largest movement came from the education and health sectors; their strikes had a large social and economic impact; students lost three months of classes, there were important delays in programmed surgeries and main road blockages which affected exports by land.

By mid-2018, it was highly uncertain if it was going to pass in the Parliament and also, there was 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 there was no fiscal reform, and the results showed an exponential growth of the debt ratio, as seen in figure 9, where the debt limit was (already) surpassed in 2018.

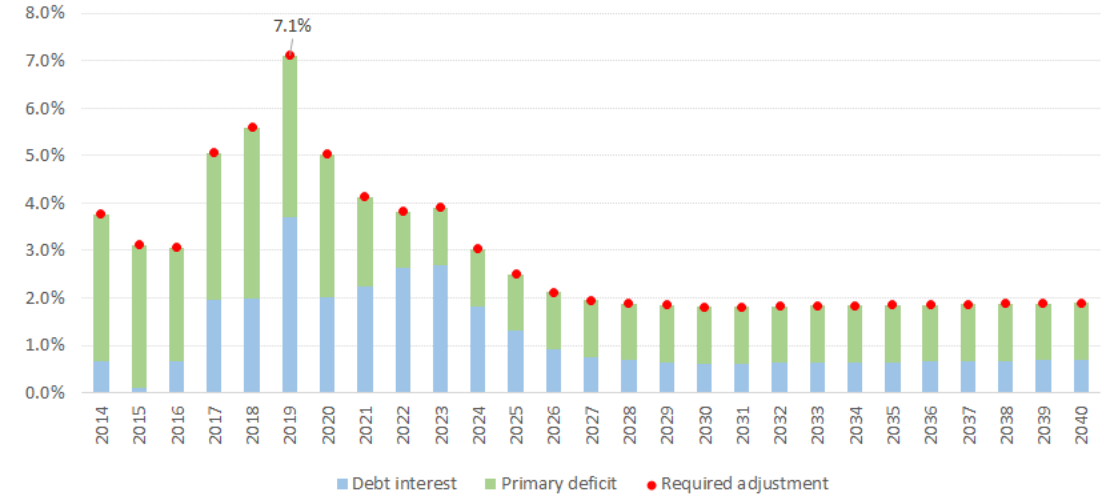
Figure 9: Intertemporal Budget Constraint, Total debt projection July 2018



Source: authors.

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

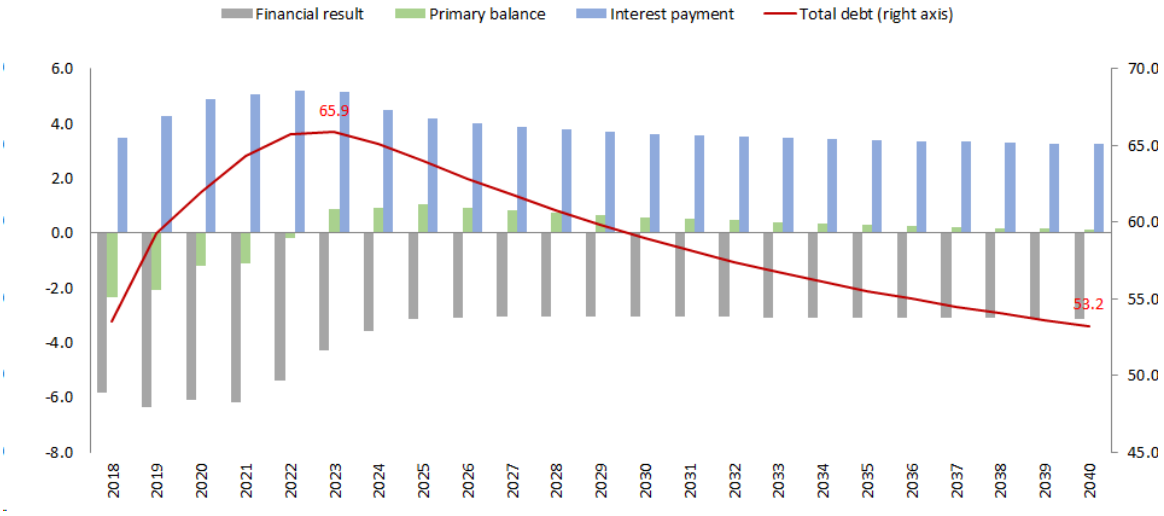
Figure 10: Intertemporal Budget Constraint, required adjustment, July 2018



Source: authors.

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% (figure 11). By that year, the required primary balance adjustment was be 0.2% of GDP (figure 12).

Figure 11: Financial balance, primary balance and total debt, with fiscal reform



Source: authors.

Figure 12: Primary balance required adjustment, with fiscal reform

Source: authors.

Table 2 shows the main assumptions and results for this model.[29] What we observe 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 re-arrangement by the Treasury, where short term debt is exchanged for longer maturities and also, some external debt is 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 lower their risk premium for Costa Rican debt contributing to the decrease of the interest rate.

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.

[29] This table intends to summarize the results obtained from the IGBC model and the main assumptions employed in order to define the required primay 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.

The estimates of the IGBC approach rely significantly on the assumptions of future behavior. In this case, the Treasury assumes a proficient portfolio management and a strict enforcement of the fiscal rule on expenditure.

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

The estimates under this approach considered different econometric models and specifications, in order to account for comparability of results and robustness checks. And also to ensure that the results are not being driven by any one particular choice in the specification of the model or of 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 annex B1.

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

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.

The results from the debt sustainability coefficient using the VECM estimation , 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.

Table 4: Vector Error Correction Model estimation

Dependent variable: Primary Balance (Pb)			
Variable	**VECM 1**	**VECM 2**	**VECM 3**
Debt $_{t\text{-}1}$	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 Rica's Treasury, and United States Treasury data

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 by a particular reason, for example, the 80's debt crisis, the financial crisis, and the closure of Banco Anglo; all statistically significant and signaling a decline in the primary balance as share of the GDP.

The result seems intuitive as the fiscal reaction statistical significance is lost, and the primary balance is more persistent given its lagged value has a higher estimate. The omission of the dummy variables would rather state a huge impact on primary balance and debt as something normal, not related with extreme situations as effectively was the case, which could mislead to conclude there is 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 on 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, and when the opposite, 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 in $t - 1$ is associated with a short-run increase between 0.05% and 0.08% in the ratio of primary balance-to-GDP.

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 of debt sustainability: even if the debt is on an explosive future path, its growth rate might not be fast enough, though the IGBC condition for sustainability holds.

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

The coefficient that controls for inertia, the lagged primary deficit as a percentage of output, 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 historical public financial needs. The results show that every time the deficit increases in 1%, it will cause an increment between 0.31% and 0.59% in the deficit of the next year.

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, and hence, there is weak evidence of fiscal policy being used as a stabilization tool. At the same time, this unresponsiveness may be explained by the high degree of inflexibility on expenditure.

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 a highly significant and 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 is going to 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 has the expected (negative) sign.

In the appendix table B3, as a robustness check we perform three additional estimations as presented in Bohn (1998) and D'Erasmo et al. (2016), including other variables that can shed some light about the fiscal reaction dynamics.

Namely we measure possible asymmetric response of primary balance conditional on debt-to-GDP 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 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 means there is not a clear evidence for non-linear effects on the FRF, despite 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; 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. 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 autorregresive process for the primary balance. Therefore, as the primary balance decreases corresponds to debt increases especially for the last years of the sample, the debt coefficient becomes negative given the now 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 exogenous variable, for robustness only.

We acknowledge the importance of finding evidence of non-linear primary balance reaction, so we included the Threshold Autoregressive Model (TAR), using debt gap as 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 table B4 from the appendix section. The results turned robust and 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 lagged debt gap observations, for the former, and to the negative lagged debt gap observations for the latter.

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 responsive. The opposite occurs for the negative gap observations, the reaction functions is more responsive. Overall, this

accounts for evidence on non-linearities 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 the FRF when the debt is below its long-run path, a serious problem for Costa Rica's fiscal policy.

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

From all these econometric specifications it seems that the results are robust and are not being driven by a particular choice of the 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 where fiscal policy has been sustainable according to the standard DSA framework as in Burger et al. (2012).

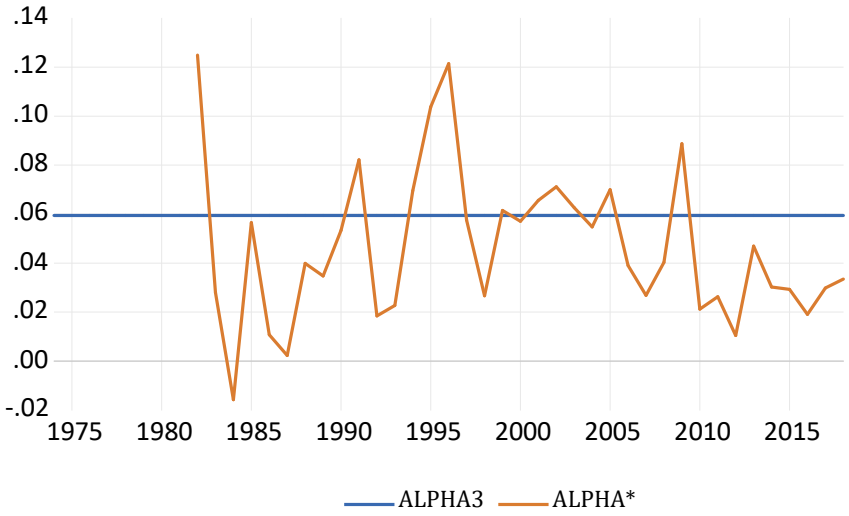
We begin with the short-run parameter by taking the OLS baseline specification with controls. The resulting estimate for $\alpha_3 = 0.07$ is compared with $\alpha^* = \frac{r-g}{1+g}$ presented in equation 7; if α^* is greater than α_3, it implies debt as share of GDP is not sustainable in the short-term.

Figure 9, shows the historical dates for short-term no sustainability are in the 1980s corresponding to the debt crisis, 1994-95 the moment of Anglo Bank's closure, and in 2009 with the international financial crisis with the structural break in the debt path.

[30] 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.

[31] Its results can be found in table B1 from the Annex section.

Figure 13: Short term debt sustainability analysis with time varying α, 1975-2018



Source: authors.

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

The sustainability conclusions are completely different with both specifications. The OLS says 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.

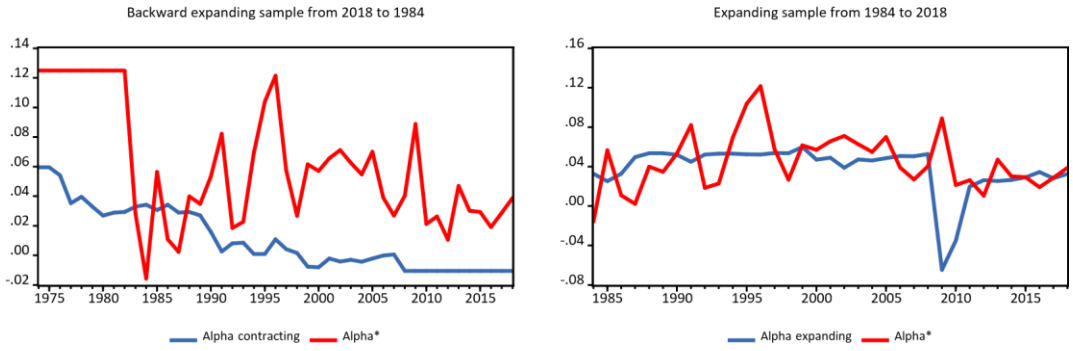
To account for these caveats and in order to give more relevance to recent history we compute a short and long run DSA while steadily enlarging the sample. We start estimating with a ten year sample, from 1975 to 1984. For a second estimation, we expand the sample by a year and recover the correspondent debt's coefficient. This estimation is done recursively and we report it as "Alpha expanding" (right panel of figure 14).

We performed the same exercise but backwards. Namely, the first estimation used the time sample from 2009 until 2018, and added a year at a time. Now the respective coefficient is

reported for the first year of the sample (e.g. 2009) under the name "Alpha contracting" (left panel of figure 14).

Figure 14 shows the results for the short-run[32]. On the left the backward expanding window (Alpha contracting estimate) performs well to see the sustainability of the 80s debt crisis. Despite that, it seems as if the forward expanding window (Alpha expanding estimate) compiles in a better manner the recent fiscal events. With it, is possible to see the 2018 uncertainty about fiscal sustainability when the fiscal reform was still on 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).

Figure 14: Short term debt sustainability analysis with time varying α and varying sample, 1975-2018



Source: authors.

6. Risk Assessment

The last part of our debt sustainability analysis is to build upon the results of the FRF an assessment under uncertainty as there exist multiple sources that may affect the projected

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

path of fiscal policy such as the domestic and foreign economic activity evolution, and private agents' expectations.

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

It is difficult to determine which effect would dominate in the end. Moreover, the increase of the 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 put additional uncertainty in the Costa Rica's outcomes from its fiscal policy. Therefore, a risk assessment is necessary. To do this, we follow the fan chart methodology proposed by Celasun et al. (2007).

This exercise will evaluate the estimated forecast made by the Treasury which considers the returns from the fiscal reform on the main fiscal variables fiscal reform. 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 this projections, our aim is to obtain different debt paths, with different probabilities, by measuring the uncertainty of the debt forecast given 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) their impact on public debt.

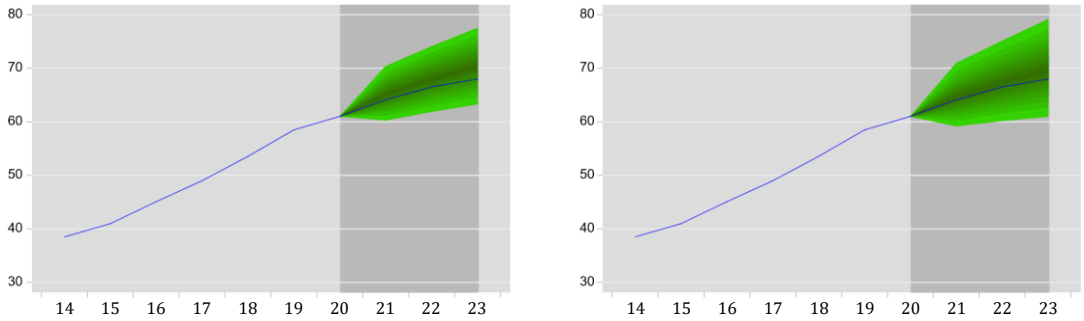
Figure 15 shows the debt's forecast under uncertainty. The blue line is our baseline for comparison; it represents the path forecasted by the Treasury with the expected the returns of the fiscal reform on income (tax raise) and expenditure (fiscal rule). The green colored

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

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 if there is economic activity feedback or not. If there is, we use a VAR model to complement the FRF results (Figure 15.b).

Figure 15: Forecasted public debt's path under uncertainty



(a) Only FRF (b) FRF and VAR

Note: in blue treasury forecast, in dark green this study mean forecast.
Source: authors with information from the BCCR and Ministerio de Hacienda.

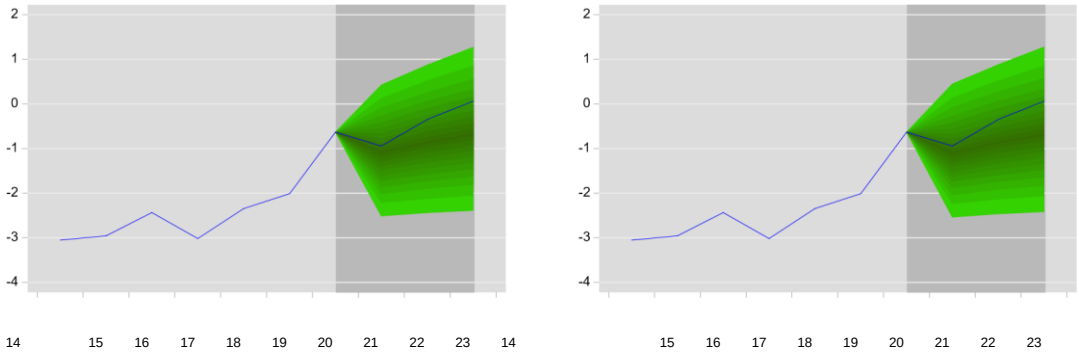
For both cases depicted in Figure 15 the mean forecast (in dark green) is above the projected path of the Ministerio de Hacienda. Nevertheless, when we include the economic activity feedback, in figure 15b, the fan chart's confidence interval widens.

The Treasury's forecast is near the 45th percentile of the fan chart's average of 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. Figure 16 shows the primary balance's forecast under uncertainty, with and without economic feedback.

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

Figure 16: Primary balance's uncertain forecast



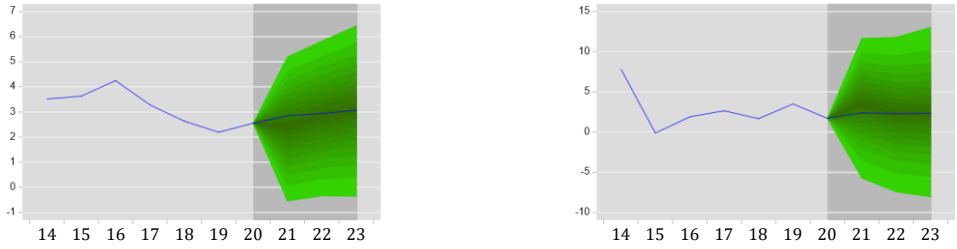
(a) Only FRF (b) FRF and VAR

Note: in blue treasury forecast, in dark green this study mean forecast.

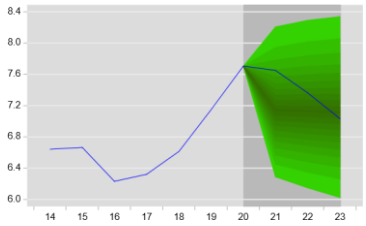
Source: authors with BCCR and Treasury data.

It does not seem as if the primary balance is leading the differences between the debt paths observed in Figure 15. When looking at other determinants like the economy's growth rate and the change in the nominal exchange rate (figure 17), there are no important differences between the Treasury's forecast and the fan charts estimated. Except in the long-run as the potential GDP growth forecast is 3.2% instead of 3.5% used by Treasury.

Figure 17: Non fiscal determinant's forecast under uncertain



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



(c) Debt's effective interest rate

Note: in blue treasury forecast, in dark green this study mean forecast.
Source: authors with BCCR and Treasury data.

What happens with the debt effective interest rate in 2023? As figure 17c shows its future path presents a different story. The Treasury's forecast shows debt will pay a real interest about 7.03%, which is near the 41th percentile from our forecast, while our average debt's 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% of debt-to-GDP, while this model predicts 66%.

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

Given the results of this model, we conclude that it is necessary to include the economic feedback in the estimations given that the inclusion of other determinants such as the interest rate, helps forecast the debt path more accurately. Recall that including the VAR model to the fan chart estimation implies adding the exchange rate and the foreign interest rate, hence,

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

jointly they could provide a reasonable forecast for the debt interest rate due to the uncovered parity of interest rates, despite its empirical limitations.

7. Final Remarks

The main goal of this research was to determine if Costa Rica's debt path is sustainable or not. Therefore, it empirically assesses 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 was evident that the IGBC provided valuable information on the topic but the approach was somewhat limited, mainly because its conclusion on sustainability holds even under weak results of the unit root tests, and the methodology demands assumptions which can be unrealistic on the future trajectories of the main variables, and that the solvency condition does not necessarily imply that debt is sustainable in the long run.

Ergo, we decided to complement, those results with the estimation of the FRF, which, to the best of our knowledge, has not been done before for Costa Rica, probably because of data limitations. Following Bohn's research,[36] 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.[37] For the short-run, the fiscal reaction estimated states for each 1% increase in debt-to-GDP ratio, the primary balance increases near 0.05%, which accumulates to the 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 past history of small responses to fiscal unbalances influences this result. Also, the

[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.

permanent increase in fiscal stimulus since 2008, and the lack of political consensus on previous fiscal reforms shaped upwards the debt-to-GDP path.

For this reason, we studied the short run sustainability 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 and added observations at the beginning of the sample. By analyzing the α coefficient estimated, in terms of sign and significance, we were able to define that recent data signals that Costa Rica was heading to unsustainability, meaning it had run unsustainable policies in the past. This is why the implementation of the new fiscal rule is key, and it was an important first step towards sustainability, approved on December 5th, 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 the Treasury has estimated from 2019 until 2023. This means, our projected series include the policy changes, both in terms of taxation increase 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. Whereas the latter expected 0.1% for the ratio of primary balance-to-GDP in 2023 relative to our average of near -0.7%, it is not the optimism in the primary balance but in the effective interest rate which accounted for the difference in timing. This interest rate expected by the Treasury to be 6.8% at 2030, whereas for us would be 8.3%, 1.5 percentage points above. Thus, our estimates for the debt-to-GDP ratio state its peak would be reached near 2026-27, almost four years later relative to Treasury's expectations.

In sum, this paper finds that debt has been unsustainable for specific episodes in the long and short run. For the most recent observations, the conclusion is that 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, year from which its upward trend is reverted.

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.

Now, there are other important aspects to discuss building up from 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% is defined by law or constitution, and most of it goes to current expenditure. And also, there are automatic expansion factors on public sector wages which may signal that the (possible) sustainability attained with this reform can be reversed in the long run.

Also, there must be a discussion to determine if the cuts in current expenditure will strengthen public investment, turning into a virtuous path for future growth. In terms of policy making, it is necessary to include along the sustainability analysis, a cost-benefit analysis and a return over investment, in order to determine if the constricting fiscal policy may be compensated 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 much-needed upgrade in public infrastructure.

However, larger fiscal deficits do 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.

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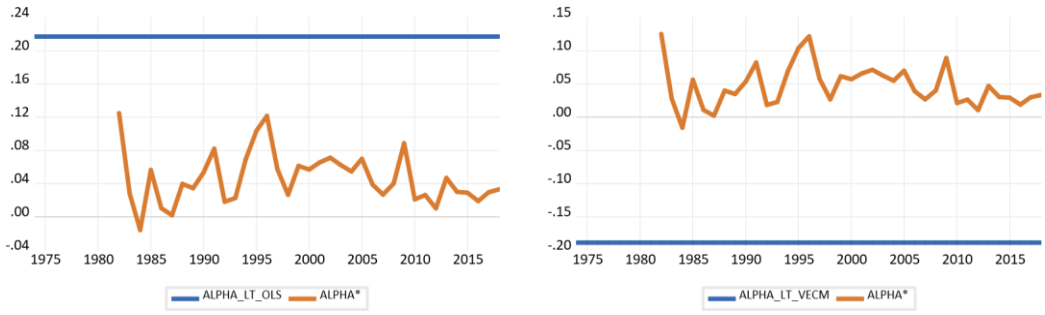
Appendices

A Standard log-run sustainability analysis

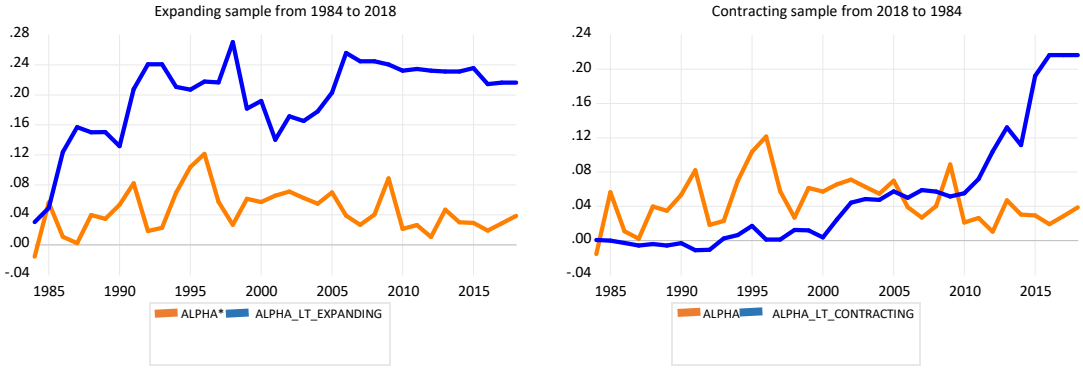
Figure A1: Long-term debt sustainability

OLS estimate in left panel, VECM estimate in right panel



Source: Authors.

Figure 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

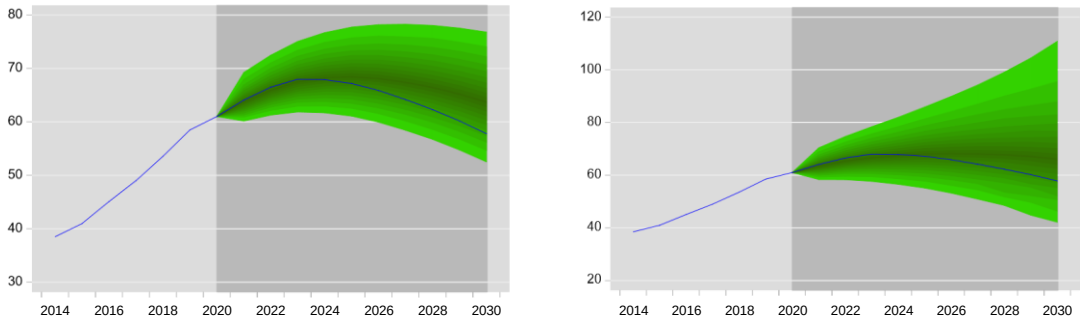
Dependent variable: Primary Balance (Pb)			
Variable	**TAR 1**	**TAR 2**	**TAR 3**
Constant	-1.23*	-1.01	-0.56
	(0.67)	(0.80)	(1.04)
Pb_{t-1}	0.55***	0.47***	0.43***
	(0.10)	(0.12)	(0.14)
$Debt_{t-1}$	0.06**	0.05**	0.05*
	(0.02)	(0.02)	(0.02)
Debt Gap_{t-1}^{+}	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(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

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.

C Risk assessment until 2030

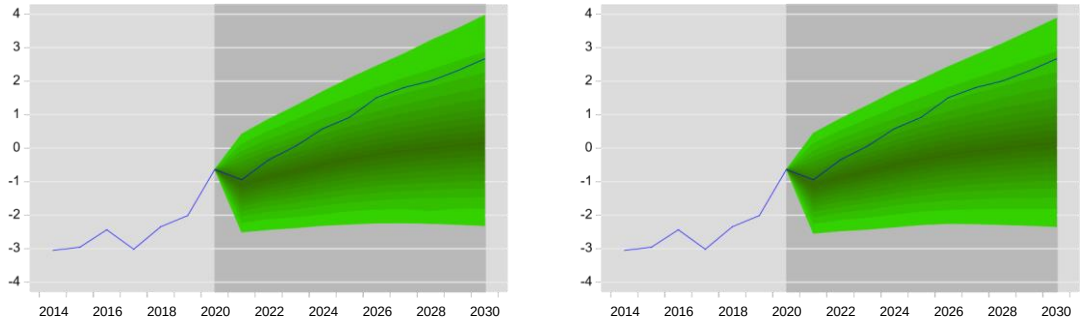
Figure C1: Debt's uncertain forecast until 2030



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

Source: authors.

Figure C2: Primary balance's uncertain forecast until 2030

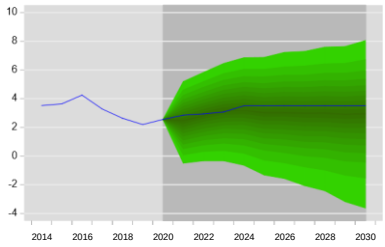


(a) Only FRF **(b)** FRF and VAR

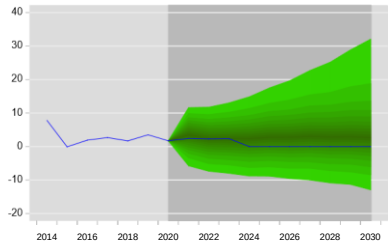
Note: in blue treasury forecast, in dark this study mean forecast.

Source: authors with BCCR and Treasury data.

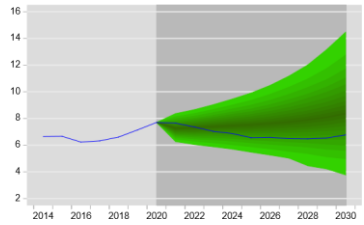
Figure C3: Non fiscal determinant's uncertain forecast until 2030



(a) Real GDP growth



(b) Change in nominal exchange rate



(c) Debt's effective interest rate

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	0.094-0.121	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.
Atish R. Ghosh and Quresh (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).