BANCO CENTRAL DE COSTA RICA

CEMLA Joint Research of Central Banks
2020

Interdependence between Fiscal and Monetary Policy: the case for Costa Rica

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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.

Interdependencia entre la política monetaria y la fiscal: el caso para Costa Rica

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Las ideas expresadas en este documento son de los autores y no necesariamente representan las del Banco Central de Costa Rica.

Resumen

Este estudio analiza la interdependencia entre la política monetaria y fiscal en Costa Rica para el período 1991-2019, bajo tres enfoques metodológicos. Primero, para determinar si hay dominancia fiscal, se evalúa si el balance primario del gobierno está determinado exógenamente por los pasivos públicos mediante un modelo de vectores autorregresivos (VAR). Segundo, se estima la función de reacción del Banco Central para analizar si el déficit primario y la deuda pública tienen un efecto significativo sobre la tasa de política monetaria. Y tercero, se evalúa la relación de largo plazo entre inflación y déficit fiscal con un modelo de rezagos distribuidos autorregresivos (ARDL) con corrección de errores. En los tres casos, los resultados sugieren dominancia fiscal. De manera específica, se encuentra evidencia de una causalidad unidireccional en el sentido de Granger del balance primario sobre los pasivos públicos, también, con la función de reacción, se encuentra que el déficit primario y el crecimiento de la deuda pública tienen un impacto significativo sobre tasa de política monetaria. Mientras que para el largo plazo el déficit fiscal tiene influye sobre el resultado inflacionario.

Palabras clave: dominancia fiscal, dominancia monetaria, inflación, países en desarrollo, función de reacción.

Clasificación JEL: E31, E52, E61, H62

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Interdependence between Fiscal and Monetary Policy: the case for Costa Rica

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Abstract

We study the interdependence between monetary and fiscal policy in Costa Rica during the period 1991-2019. In order to have an integral approach, we use three different methodological approaches. First, we test for fiscal dominance by evaluating if the primary balance is exogenously determined by public liabilities (or not) using a Vector Autoregression (VAR) model. Second, we estimate the Central Bank's monetary policy reaction function and analyze if the primary deficit and public debt have a significant effect on the monetary policy interest rate. Third, in order to evaluate the long-run relationship between inflation and the fiscal deficit, we use an Autoregressive Distributed Lag (ARDL) model with error correction. The results of the three approaches revealed a fiscal dominance regime. Specifically, we find evidence that primary balances unidirectionally Granger caused public liabilities. Primary deficit and debt growth have a significant effect on the monetary policy interest rate, and in the long run, the fiscal deficit has an effect on inflation.

Key words: fiscal dominance, monetary dominance, inflation, developing countries, reaction function.

JEL codes: E31, E52, E61, H62

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Interdependence between Fiscal and Monetary Policy: the case for Costa Rica

1 Introduction

The theoretical debate about the coordination and interaction between monetary and fiscal authority was formally initiated by Sargent and Wallace (1981). In a nutshell, the effectiveness of monetary policy may depend on the economic space provided by fiscal policy.

Given the sense of a trade-off between the policies' degree of independence and their effectiveness, Aiyagari and Gertler (1985) show that certain monetarist propositions can hold only in a Ricardian regime in which the monetary policy is completely dominant and that, in fact, variables as the price level, inflation rate and nominal interest rate are higher in a fiscal dominant regime, due to the influence of government debt.

Empirically, for developing countries, this question has been reviewed broadly, and evidence suggests that, generally, the scope for monetary policy has been contingent on fiscal policy (Catão and Terrones, 2005; Zoli, 2005; De Resende, 2007; Jevović and Milenković, 2018). Therefore, understanding the degree of the fiscal authority's incidence on inflation is key for central banks when deciding their monetary policy.

This topic is especially relevant for Costa Rica given its current economic situation at least because of two reasons. First, during the last two decades, its Central Bank, BCCR, has actively pursued higher independence and has taken measures to achieve low and stable price levels under a monetary regime of inflation target. The adoption of a more flexible exchange rate regime in 2006 and the announcement of a path towards an inflation target regime have contributed to decrease inflation rates from levels higher of 10% before 2006,

to average rates of 5.5% in 2014 and 1.3% in 2020. Despite these efforts[1] for a higher level of independence, the fiscal stance remains a vulnerability.

Public finances are in a critical condition. The expansionary fiscal policy implemented as response to the financial crisis of 2008, and the lack of agreement from the Parliament to approve the correspondent fiscal reform, caused an unsustainable fiscal balance; debt grew from 28% of GDP in 2007 to almost 60% in 2019 and the fiscal balance went from a superavit in 2007 of 0.6% of GDP to a deficit of 7% in 2019. Even when a fiscal reform was approved by the end of 2018, the path towards fiscal-financial sustainability is slow paced and has been aggravated by the Covid-19 pandemic.

To our knowledge, there are only a handful of empirical studies on the interaction between fiscal and monetary policy for Costa Rica. Therefore, the main objective of this study is to contribute to the literature on the topic for emerging markets but also to provide the Central Bank of Costa Rica of information and inputs on the effectiveness of its monetary policy.

In order to approach this goal in a broad manner, we use three different but complementary methodological approaches. First, we intend to define if there is fiscal dominance by evaluating if primary balances are exogenously determined by fiscal liabilities with a Vector Autoregression (VAR) model. Second, we estimate the Central Bank's monetary policy reaction function and analyze whether or not fiscal variables have a significant effect on the short-term policy rate. Specifically, under an augmented Taylor equation form, we consider the monetary policy interest rate to be explained by inflation, output gap, exchange rate, international reserves, and primary deficit (or public debt). As a complement, we use a third approach, an Autoregressive Distribuited Lag (ARDL) model, in order to evaluate the relationship between inflation and fiscal deficit in the long-run.

For these analysis we use quarterly data from 1991 until 2019. Within this time sample, we consider some subsamples in order to differentiate between periods along the three decades of data. Still, the period of analysis does not consider data from 2020 and hence neither the changes in the economic context associated to the Covid-19 pandemic. However, it is important to keep in mind that for the near future, given the pandemic, the fiscal scenarios

[1] And other changes that followed from the recommendations of OCDE such as to disassociate the appointment of the President of the Central Bank from the political cycle, and the elimination of the voting power of the Minister of Finance in the decisions of the Board of Directors of the BCCR (see (OECD, 2018))

are expected to worsen: the latest projections of the Ministry of Finance are a fiscal deficit of 9.3% and a government debt higher than 70% to the end of the year. This increases the relevance of understanding how the fiscal policy can be limiting the margins of action of the monetary policy.

We find that, using the VAR analysis, the exogeneity test for the primary balances suggests that an episode of fiscal dominance was most probable before 2008, but not after that year. From the reaction function of the monetary policy rate, we find that the monetary policy rate have been significantly affected by the primary deficit and debt growth. And under the Error Correction model there is evidence of a long-run effect of the fiscal deficit on inflation.

This work is organized into six sections. The literature and theoretical framework are explained in Section two and three. While section four provides a contextual overview of the main fiscal and monetary variables in Costa Rica over the last four decades. Section five follows to describe the methodological approaches and section six describes and explains the main findings from the analysis. Finally, the last section, summarises the main conclusions.

2 Literature review

The interdependence between fiscal and monetary policy was first presented by Sargent and Wallace (1981). The main conclusion of their work was that the coordination scheme between monetary and fiscal authorities might influence the effectiveness of monetary policy. The authors argue that the relationship between the authorities can be seen as a game of who plays first. The monetary authority can control inflation when it plays first, because it is free to set the path of the money base. This is known as monetary dominance. While, when fiscal authority sets independently the budget, it imposes a constrain to the monetary authority. This constrain depends on the fiscal authority's own revenues and the demand for bonds of the public. The control of inflation by the monetary authority can be limited when the interest rate of the government bonds exceeds the economy's growth rate and the monetary authority has to finance the uncovered revenues with money creation. Under these circumstances, the economy is under fiscal dominance.

The literature (Aiyagari and Gertler, 1985) distinguishes fiscal and monetary regimes according to the debt-backing degree of them. In a Ricardian regime, the fiscal authority

backs all debt. While in the non-Ricardian regime, debt is all backed by seignorage. The monetary and fiscal policies accommodate each other in distinct degrees that are located in between the Ricardian and non-Ricardian cases. However, for the validity of some basic monetarist hypotheses, monetary policy requires a high fiscal policy accommodation degree (Aiyagari and Gertler, 1985). As mentioned by De Resende (2007), when fiscal policy sets its path for the primary balance, revenues from seigniorage would be needed to avoid explosive debt, and fiscal policy would be able to affect the price level.

Based on the logic of the Ricardian equivalence, the way in which government expenditure is financed does not affect household consumption decisions because they expect present changes will be cancel out by future adjustments. Under a Ricardian regime, the budget constraint of the government is satisfied at all price levels. That means, the primary surplus adjust intertemporally to maintain the present value of current and future surpluses equal to the public liabilities for any possible price level (Canzoneri et al., 2010); consequently, the price level determination is independent of the fiscal policy. However, in a non-Ricardian regime, for example, in a scenario of a lump-sum tax cut, households do not expect the tax cut to be compensated by future tax increases. As a consequence, the consumption demand rises and leads to price level increases until it eliminates the difference between the real value of the government liabilities and the expected present value of primary surpluses (Canzoneri et al., 2010). This is precisely the way how the equilibrium price level is determined under the "fiscal theory of price level" (FTPL) (Woodford, 1995).

The FTPL surged as an alternative to the quantitative theory of money, and other theories, (Woodford, 1995) from the contributions by authors like Leeper (1991); Woodford (1995); Sims (1994); Cochrane (1998). For them, the coordination problem was about finding the right combination of monetary and fiscal policies to provide a stable nominal anchor (Canzoneri et al., 2010). This theory, in words of De Resende (2007), assumes that government actions are not constrained by budget issues. Therefore, the intertemporal budget constraint remains as an equilibrium condition for equilibrium prices.

In practice, Coates and Rivera (2004) classify fiscal dominance according to the form in which fiscal deficit is financed. The common definition of fiscal dominance refers to the case in which fiscal deficit is financed in domestic capital markets in the domestic currency. In this case, the fiscal authority and the central bank may be competing for resources, which increases the interest rates (Coates and Rivera, 2004). Other types of dominance

denoted by the authors are: no dominance, exchange-rate dominance, complete dominance and monetary subordination. This last type is an extreme case of dominance of the fiscal authority in which monetary policy is dedicated to finance fiscal deficits by money creation at a cost of presence of inflation in all nominal variables.

In empirical studies, the interdependence between fiscal and monetary policy has been analysed through different approaches. Some studies have focused the attention on the link between government budget and money growth from a framework of the intertemporal government budget constraint, trough which budget deficits can be financed by debt and seignoraige. Studies in developed countries (like the USA (Bohn, 1998; Cochrane, 1998; Canzoneri et al., 2001) and developing or emerging economies (like Brazil (Tanner and Ramos, 2003); Latin American countries, Poland, South Africa and Thailand (Zoli, 2005); Colombia (Lozano and Herrera, 2008); Emerging European Economies (Jevović and Milenković, 2018)), have analysed the dynamics between debt and surplus with a VAR structure, using impulse response functions and Granger causality tests. These studies test the exogeneity of the primary surpluses, which is consistent with a case of fiscal dominance (a non-Ricardian regime).

For developing countries, most of the times the results are non-conclusive or give some evidence of fiscal dominance in concordance to a path of the primary surplus exougenously determined of public liabilities (debt and money base). The ambiguity in the results is a source of criticisms to this approach, together with a known identification problem. This problem is generated from a result in which the current primary balance affects positively the future liabilities, which could be interpreted both as a Ricardian or a non-Ricardian regime (Canzoneri et al., 2010).

Other group of studies has analyzed the relationship between monetary policy objectives and central bank responses to government through the reaction function of the Central Bank under the Taylor equation form (Taylor, 1993). The monetary policy instrument used is the short-term interest rate. This is explained by inflation deviation from target, the product gap, and other factors in which the fiscal variable is considered, and, most of the time, represented by the budget surplus/deficit or the public debt. The studies based on a panel of developed countries (European Monetary Union members (Wyplotz, 1999) and European Union countries (Afonso et al., 2019) found a null or negative response of the interest rate to the fiscal variables. These results are interpreted as if polices were

cyclical substitutes. Also, evidence of changes of the relationship in time was found.

In the case of developing countries, there is evidence of a null or positive relationship between the short-term interest rate and the fiscal variables. For example, for Argentina, Brazil, Chile, Colombia, Mexico, Poland, South Africa and Thailand, using quarterly data on individual countries and carrying a time series analysis by Ordinary Least Squared (OLS) method, Zoli (2005) did not find evidence of a reaction of the monetary policy interest rate to primary balances. The results hold even when the analyses was split in subsamples to separate inflation target (IT) regime adoption from other regimes. By the other hand, Kuncoro and Sebayang (2013) studied the reaction of the domestic rate (relative to the US interest rate) to the primary balance and debt. They found a positive reaction of Indonesian Central Bank to both variables between period 1999-2010. Then, Ahmed et al. (2019) study the relationship in both, advanced and emerging economies. For the latter, in countries non under an inflation target regime, there was a non-linear effect of public debt on the policy rate. The effect depended on the ratio of foreign-currency relative to total public debt, and the ratio of hard-currency debt. While in advanced economies higher ratios of public debt were found to be associated with lower policy interest rates.

In the specific case of Costa Rica, Muñoz and Sáenz (2003) carry on the estimation[2] of the reaction function of the Central Bank for the period 1991-2002 using quarterly data and an augmented Taylor rule specification. The dependent variable was the Passive Basic interest rate, which is a reference rate from six months deposits within the financial intermediaries ("tasa de interés básica pasiva" in Spanish) explained by inflation deviation from target, output gap, deviation from international reserves, external real interest rate, devaluation of nominal exchange rate, and fiscal variables (fiscal deficit or domestic debt). The results indicated that domestic debt had a significant and positive effect on the interest rate. This was interpreted as a response to the pressure for the government finance needs and the necessity of money absorption from the Central Bank.

Another line of study rises from the question of whether fiscal deficits are inflationary in the long-run (Walsh, 2010). This question was analysed on a sample of developed and developing countries by Catão and Terrones (2005) from 1960-2001 with an ARLD structure and an error correction (EC) model. They concluded that fiscal deficits are inflationary in developing countries and high inflation economies. However, there was no evidence

[2] Corbo (2000) and Pizarro et al. (2000) estimated previously the reaction function for the Central Bank of Costa Rica, but do not considered fiscal variables in their models.

of inflationary effects on developed countries with low inflation rates. According to the authors, previous empirical studies on this question weakly found evidence of a relationship due to short periods of data and inadequate econometric techniques. A similar analysis, but for the Pakistan case concluded that, besides other variables, fiscal deficit was found to be major determinant of the price level (Jalil et al., 2014).

The study of the effect of fiscal policy on inflation has also been reviewed through the analysis of public debt. For example, Barquero and Loaiza (2017) analysed the relationship between inflation and public debt for a panel of net debtors countries, including Costa Rica, for the period 1965-2014. They applied GMM and an VEC model to estimate the long-run effects. The results suggested that increases in public debt are inflationary for net debtors countries with high levels of debt. They conclude that fiscal policy is a determinant factor of inflation in highly indebted developing countries.

Then, a study from the Finance Ministry of Costa Rica (Obando, 2017) analysed the relationship between the interest rate, inflation rate and the fiscal deficit using restricted VAR and VEC models with annual data from 1991 to 2016. The study concluded that there is a positive long-run effect of the fiscal deficit on the interest rate that is explained by the use of the last one as a tool for attracting resources to cover debt. No evidence of an effect of the fiscal deficit on inflation was found. However, due to the short sample size under analyses the results have to be read with caution.

3 Theoretical framework

A simple form to present the interdependence between fiscal and monetary policies is through the consolidated government's budget identity. This will allow us to examine if government revenues and expenditures affect inflation. We follow the budget accounting framework presented by Walsh (2010). This framework contains two budget identities. The budget identity of the fiscal side of the government is given by:

$$G_t + i_{t-1}B_{t-1}^T = \tau_t + (B_t^T - B_{t-1}^T) + RCB_t \tag{3.1}$$

where the left hand side includes government expenditures, G_t and interest payments on pending debt, which includes the nominal interest rate, i_{t-1}, and the total debt B_{t-1}^T of the the period $t-1$ (where the superscript T denotes total debt). The right hand side

includes government revenues from: tax revenue, τ_t, new issues of interest-bearing debt, $(B_t^T - B_{t-1}^T)$, and the direct receipts from the central bank, RCB_t.

The Central Bank budget identity, which relates the changes in its assets and liabilities, can be expressed as:

$$(B_t^M - B_{t-1}^M) + RCB_t = i_{t-1}B_{t-1}^M + (H_t - H_{t-1}) \tag{3.2}$$

where the left hand side includes the Central Bank purchases of government debt, $(B_t^M - B_{t-1}^M)$, and the RCB_t. The right hand side includes the interest payments from the fiscal authority, $i_{t-1}B_{t-1}^M$, and the change in central banks liabilities (the monetary base), $(H_t - H_{t-1})$.

Then, if $B = B^T - B^M$ represents the government interest-bearing debt in hands of the public, the consolidated government budget identity can be obtained by combining Equations 3.1 and 3.2, and expressed in terms of the price level as follows:

$$\frac{G_t}{P_t} + i_{t-1}\frac{B_{t-1}^T}{P_t} = \frac{\tau_t}{P_t} + \frac{(B_t - B_{t-1})}{P_t} + \frac{(H_t - H_{t-1})}{P_t}. \tag{3.3}$$

Equation 3.3 indicates that government expenditures can be payed using taxes, funds from the private sector or seignoriage. A representation in lowercase letters indicate that variables are deflated by the price level:

$$g_t + r_{t-1}b_{t-1} = t_t + (b_t - b_{t-1}) + s_t, \tag{3.4}$$

where the terms r_{t-1} and s_t represent the real interest factor and revenues from seignorage, respectively.

However, Equation 3.4 does not impose a restriction on government borrowing. To do that, we need the government intertemporal budget constraint. Under the assumption that r is a positive constant, the intertemporal budget constrain can be written as:

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+i}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{t_{t+i}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} + \lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^i}. \tag{3.5}$$

This indicates that all current and future government revenues have to be equal to current

and future expenditures plus current outstanding debt. Then, the primary deficit can be defined as $pd = g - t - s$, equation 3.5 implies that

$$(1+r)b_{t-1} = -\sum_{i=0}^{\infty} \frac{pd_{t+i}}{(1+r)^i}. \tag{3.6}$$

When the government has outstanding debt ($b_{t-1} > 0$), it must generate a primary surplus in present value. Equation 3.6 is considered a government constrained for which the combined monetary and fiscal authorities make budget decisions to ensure the equation holds for all possible values of the initial price level and interest rates. However, as previously mentioned, the FTPL proponents argue that this is an equilibrium condition. As that condition allows to create money as a source of revenues, fiscal deficits can generate inflation. Regrouping terms of Equation 3.6 and taken $R = 1 + r$, current liabilities can be financed in terms of the primary surplus or seignoriage, and take the form of:

$$b_{t-1} = R^{-1} \sum_{i=0}^{\infty} R^{-i}(t_{t+i} - g_{t+i}) + \sum_{i=0}^{\infty} R^{-i} s_{t+i} \tag{3.7}$$

A reduction of the fiscal primary surplus requires an increase of the present value of seigniorage to maintain the equality in Equation 3.7. In words of Walsh (2010), given the present value of surplus, an attempt by the central bank to reduce inflation and seigniorage today must lead to higher values in the future because the present discounted value of seigniorage cannot be altered. Therefore, in that scenario, a rigid position of the fiscal authority, implies that the monetary authority will be forced eventually to produce higher inflation.

4 Short overview of the monetary and fiscal policy in Costa Rica

The previous sections suggest that the effectiveness of the monetary policy can be affected by the fiscal policy according to the discipline that fiscal authorities have in their budget management and how active the monetary policy is. In the next section, we present some fiscal and monetary episodes of Costa Rican history that might have influenced the scope of action of the monetary authority. We also discuss some measures that have been implemented in order to give higher independence levels to the Central Bank in several

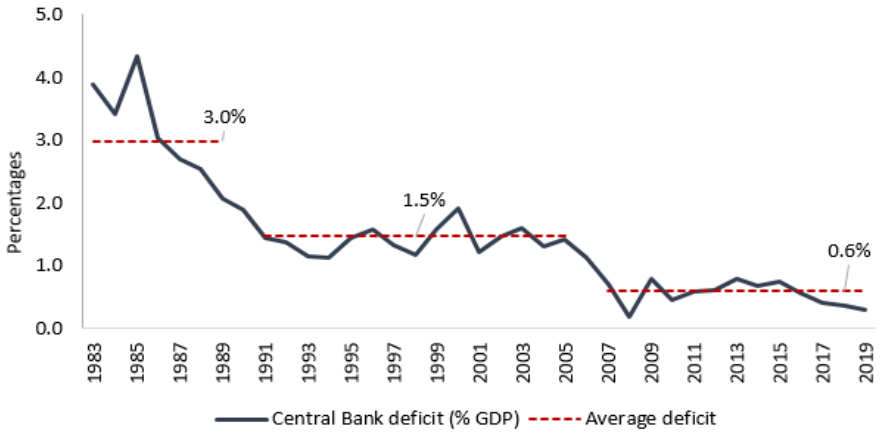
areas. These details are going to be relevant for our empirical analysis.

The first event occurred after the oil shock of the late 1970s that affected public finances through a reduction in revenues (due to higher prices of imports, and decreases of exports) and a complicated external debt situation (acquisition of very short-term loans to accumulate reserves of foreign currency and the increases in the international interest rates) (Lizano, 1999; Gonzáles-Vega, 1990). The intern macroeconomic conditions contributed to worsen the situation. The country had a fixed exchange rate that was over-valuated and a shortage of international reserves that led to a currency crisis that caused the suspension of debt service in 1981. The fiscal deficit began to be financed with domestic debt. Then, the instability of the exchange rate and inflationary pressures brought inflation to 82% in 1982. In that year, the Central Bank adopted the crawling peg exchange rate regime.

The external debt had been centralized in the Central Bank in order to control its expansion and facilitate renegotiation (Gonzáles-Vega, 1990). On one hand, external indebtedness exceeded the institution's assets and, on the other hand, the losses of state-owned companies assumed by the BCCR in its role of economic development promoter, generated its own debt. Open market operations to control domestic debt affected monetary policy significantly such that, in words of Delgado and Vargas (1990), its function was equivalent to financing the fiscal deficit entirely with the issue of money through stabilization bonds. According to Gonzáles-Vega (1990), these generated about a quarter of the total losses in 1981, which limited the use of policy instruments as open market operations and legal reserves.

From 1990 to 2005, the BCCR began canceling liabilities without generating inflation pressures due to a series of capitalizations made by the Ministry of Finance and the Government (Muñoz, 2012). During that period, the Central Bank deficit represented around 1.5% of GDP (see Figure 1). Another factor that limited the monetary control was the liberalization of the capital account in 1992, due to the presence of a fixed exchange rate regime. Moreover, the bankruptcy of the "Banco Anglo" in 1994, a state bank, generated losses that represented 1.8% of GDP, Mesalles and Céspedes (2007) to the central government. However, with the new Central Bank Law of 1995 (Ley Orgánica del Banco Central), the possibilities of financing the Government by the BCCR were reduced. This law gave the BCCR more independence and allow focusing on internal and external stability of the currency.

Figure 1: Central Bank Deficit, 1983-2019

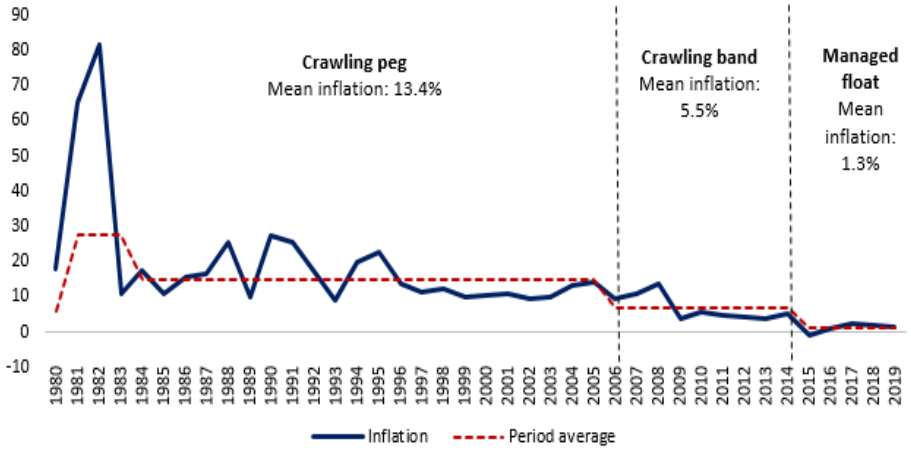


Source: Central Bank of Costa Rica

Even so, under a fixed nominal exchange rate and an open capital account, the autonomous management of monetary policy was not feasible. The country faced the problem known as the "Impossible Trinity". The crawling peg regime was in force until 2006 and the macroeconomic management relied on monetary aggregates as an intermediate variable of the monetary policy Lizano (2007). From October 2006, the crawling band regime was adopted to take steps towards the application of the called "Possible Trinity" Lizano (2007), characterized by the combination of a flexible exchange rate, inflation target regime, and independent monetary policy. Inflation rate decreased from an average of around 13% before 2007 to an average of 5.5% under the adoption of the crawling band regime (see Figure 2). From 2014, the Central Bank adopted a managed float regime that gave more flexibility in the determination of the exchange rate regime, in order to have higher levels of independence and reinforce the use of the interest rate in the transmission of the monetary policy (Muñoz, 2018).

To guarantee a successful transition, in addition to other factors, the ability to use the short-term interest rate as an instrument of monetary policy was required (Muñoz, 2012). The Central Bank introduced the concept of Monetary Policy Rate (MPR) in 2004. It was defined as an instrument that would allow effective intervention in the liquidity market by establishing the marginal cost of funds for commercial banks (Muñoz, 2012). The reference of the MPR was modified several times until June 2011, when the Central Bank redefined

Figure 2: Inflation and exchange rate regimes, 1980-2019



Source: Central Bank of Costa Rica

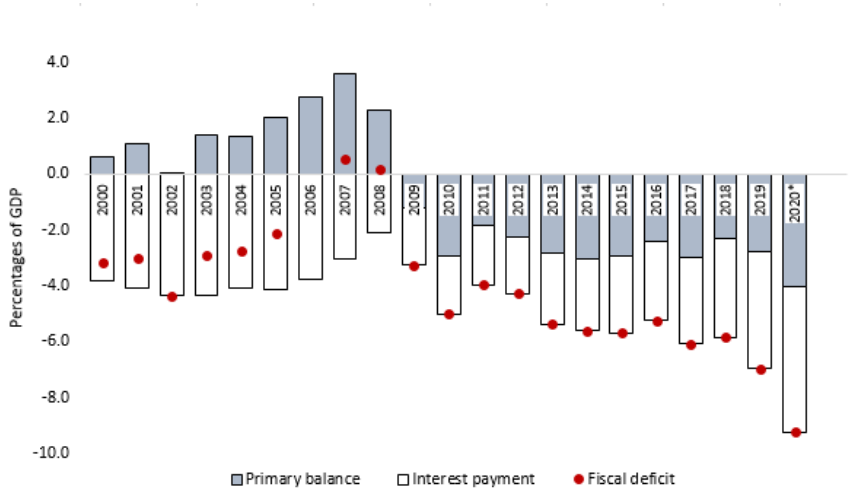
the concept that is applied to date.

During the 2000s, before the international financial crisis, the public finances registered significant improvements reflected in primary surpluses and low fiscal deficits. This was attributable, on the one hand, to a restrictive spending policy and higher tax revenues as result of the economic growth of those years (Esquivel and Lankester, 2019). The situation changed in 2008, with lower economic growth, plus an expansionary fiscal policy in response to the effects of the financial crisis. However, the increases in expenditures were in highly rigid sectors such as salaries and current transfers that continued even after the crisis. Since then, the situation of public finances continued to deteriorate. Between 2009 and 2019, the fiscal deficit as a percentage of GDP reached 7% and the Central Government debt as a percentage of GDP grew steadily, more than doubling and standing at 58.5% in 2019 (see Figure 3). As a consequence, the country received a negative risk rating by the end of 2018. Therefore, the cost of borrowing to attract funds from abroad significantly increased.

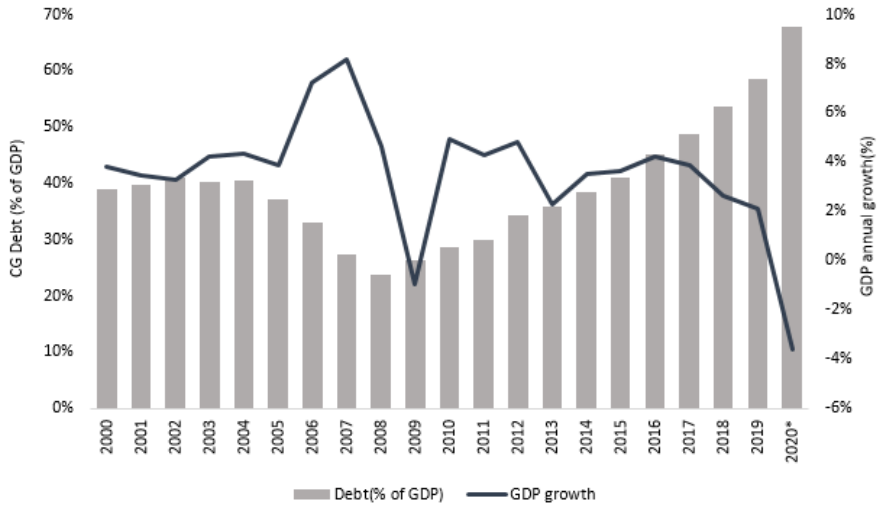
In this context, in July 2019 the Law 9635, "Ley de Fortalecimiento de las Finanzas Públicas", in spanish, came into force, which would imply higher tax collection and improvements in spending of the public sector. In terms of collection, the main modification was the change from the sales tax to a value-added tax that broadened the tax base by taxing services. In addition, it included a capital gains tax and new tax on high wages. In

Figure 3: Public Finances, 2000-2019

(a) Primary surplus, interest payment and fiscal balance of the Central Government



(b) Debt of the Central Government and GDP growth



Note: *Projection from IMF
Source: Central Bank of Costa Rica

terms of expenditures, public sector compensation schemes were modified and it was established a fiscal rule that limits the growth of spending[3] for certain levels of indebtedness

[3]These limits applied on salaries, payment of services and transfers to institutions.

and economic growth.

On the other hand, in order to achieve greater independence in the monetary policy, the BCCR implemented two reforms based on OECD recommendations. They consisted in disassociating the appointment of the President of the Central Bank from the political cycle and making clear the reasons for a possible dismissal (OECD, 2018). The other reform was the elimination of the vote by the Minister of Finance in the decisions of the Board of Directors of the BCCR (OECD, 2018).

The expectations of an improvement in the government finances lasted until March 2020, due to the COVID-19 pandemic. The macroeconomic projections for 2020, announced in July of that year by the Central Bank and the Ministry of Finance, estimated a decrease of 5% of real GDP, the fiscal deficit is expected to reach 9.3%, while the Central Government's indebtedness will reach around 70% relative to the GDP. This will be the result of lower income generation, in addition to the measures taken to face the pandemic such as the moratorium on the payment of taxes, more flexible payment of fees to the Social Security Fund (Caja Costarricense de Seguro Social, CCSS), and transfers to households and firms affected by the pandemic (BCCR, 2020). Some compensatory measures announced to reduce the fiscal impact are reduction of expenses, temporary measures to increase income and contraction of multilateral credits (BCCR, 2020).

5 Methodology and data

To evaluate empirically the interdependence between monetary and fiscal policy in Costa Rica, this study considers three common approaches used in the empirical literature. As a starting point, a test for fiscal dominance is applied by assessing if the primary balance is exogenously determined by public sector liabilities through a VAR model. The next step is to estimate, in a regression analysis, the response of the monetary policy rate to fiscal variables using a Taylor equation form. Finally, we estimate if there is a relationship between fiscal deficit and inflation using an ARDL model. The three methodologies are presented below.

5.1 Testing for fiscal dominance

As mentioned in the literature review, this approach is based on the idea that the government and the central bank are linked through the consolidated government budget constraint. The fiscal authority could consider liabilities when making decisions about its revenues and expenditures. This can be tested by estimating the relationship between the primary balance and public liabilities, that include public debt and the monetary base (the two sources to finance the deficit). The relationship between the variables can be expressed using a VAR structure of a two-equation system given by:

$$\begin{aligned} PB_t &= \alpha_0 + \sum_{j=1} \alpha_j PB_{t-j} + \sum_{j=1} \beta_j liab_{t-j} + \alpha_x X_t + \epsilon_t \\ liab_t &= \gamma_0 + \sum_{j=1} \delta_j PB_{t-j} + \sum_{j=1} \gamma_j liab_{t-j} + \gamma_x X_t + \mu_t, \end{aligned} \tag{1}$$

where $liab$ and PB denote public liabilities and primary balance, respectively, both scaled by the GDP. These variables are expressed in first differences as the unit root tests shown later, suggests the variables are non-stationary in levels. We also include dummy variables to control for seasonal patterns and fiscal events. Specifically we include dummy variables that indicates the Banco Anglo's bankruptcy in 1994, the financial crisis impact on the economy in 2008, the change in fiscal variables from 2009, and the entry into force of the Law 9635. These are exogenous variables denoted in the equations by the vector X_t. Then, the VAR results can be interpreted by the Impulse-Response functions (IRFs) and complemented with Granger causality tests.

According to Jevović and Milenković (2018), an unidirectional Granger causality from the lagged primary balance to the current public liabilities indicates fiscal dominance, but the causality of the lagged public liabilities to the current primary balances indicates monetary dominance. Looking at the temporal relationships in the IRFs, the results can be classified under FD or MD (Lozano and Herrera, 2008; Zoli, 2005; Tanner and Ramos, 2003). In the first regression of the system of equations (1), negative β_j indicate fiscal dominance because the increase in current liabilities is seen like more resources for tomorrow expenditures. Positive β_j can be interpreted as both, monetary dominance or fiscal dominance cases. In the case of FD, higher primary balances are created to compensate the increases in

liabilities in order to limit debt accumulation. However, in the case of MD, the real value of liabilities might have increased (due to a price level drop) because primary balances are expected to be higher. A null effect of $liab$ on PB, that is $\beta_j = 0$, indicates that primary balance is exogenous which is consistent with a fiscal dominance case.

In the second regression of the system of equations (1), negative or positive δ_j indicate monetary dominance. A negative effect on future liabilities of a positive shock to the current primary balance means that increases in government revenues (or a reduction in expenditure) are used to pay down the debt. Positive effects on future liabilities of the current primary balance can be the result of the government anticipation of future obligations. Finally, a null effect ($\delta_j = 0$) suggest an exogenous primary balance that is consistent with fiscal dominance.

This approach, however, has been criticized because it does not consider that a primary balance respond to the economic cycle. This could cause erroneous conclusions if the period of analysis is short (Zoli, 2005; Canzoneri et al., 2010). There is also an identification problem as the same result (e.g. with β_j positive) could be consisted with a fiscal or a monetary dominance regime. To address this challenge, according to Canzoneri et al. (2010), some authors associate the results with the most plausible story for the case. For these reasons, we applied this methodology but we complement it with a further analysis of other empirical applications.

5.2 Central Bank Reaction Function

We also study the Central Bank response to the fiscal policy through the estimation of a reaction function, which includes fiscal variables. The model basis is the Taylor equation, proposed by Taylor (1993), who argued that good monetary rules call for a reaction of the interest rate to changes in the price levels and real income. In our model, the dependent variable is the short-term interest rate (monetary policy rate), which is explained by the inflation deviation from the target and the product gap. Intuitively, values of the observed inflation rate above target, or the real GDP above the potential output, would call for an increase of the short-term rate of the Central Bank. In addition, the empirical literature suggests to include a lag of the policy rate to consider the inertial component of the interest rate (Goodhart, 2006).

For emerging countries, other factors like the exchange rate have been found to have an

important role on the monetary policy (Zoli, 2005; Caporale et al., 2018; Afonso et al., 2019). This is the so called augmented Taylor rule. For several emerging economies, exchange rate movements affect central bank behaviour, even when the exchange regime is flexible (Caporale et al., 2018). An increase in the exchange rate, a depreciation, would be associated with an increase in the policy rate to compensate a lower premium for investing in the country.

Some public finance variables such as the fiscal deficit or public debt have also been considered as factors that might affect monetary policy rate. In developing countries, the evidence shows positive or null effects of these variables. A common explanation for these positive effects is that after an increase in the fiscal deficit or public debt, the Central Bank increases the policy rate in response to the pressure of attracting resources from the private sector. We include primary deficit and public debt variables to study the interaction between monetary and fiscal policies in our model.

We also include other variables that can reflect the context of the monetary policy in the country in the period of analysis. This is the case of the international reserves, which were specially important before 2006 under the crawling peg exchange rate regime when the Central Bank had to defend the fix exchange rate. Following Muñoz and Sáenz (2003), we also consider the deviation of international reserves from its trend. An increase in foreign reserves above the trend would be negatively related to the MPR to avoid a strong entrance of capitals. In addition, changes in the monetary regime, in the exchange regime, and fiscal events are control for. Specifically, we include dummy variables that indicates the Banco Anglo's bankruptcy in 1994, structural change of inflation in 1999 (Torres, 2012), crawling band regime from 2006 to 2013, managed float exchange regime from 2014, and the financial crisis impact on economy to the end of 2008 and 2009. Additionally, we also control for seasonal patterns in data.

The equation can be written as

$$i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2(\pi - \pi^*)_{t-1} + \beta_3(y - y^*)_{t-1} + \beta_4 e_{t-1} + \beta_5 fiscal_{t-1} + \beta_6 ir_{t-1} + \mu_t \quad (2)$$

where i_t and i_{t-1} denotes the policy rate in the current and the previous period, respectively. The expressions $(\pi - \pi^*)_{t-1}$ and $(y - y^*)_{t-1}$ represent the deviation of inflation from target

and deviation of real GDP growth from the trend. Also, e_{t-1} denotes the quarterly growth of the exchange rate and $fiscal_{t-1}$ represent fiscal variables, like the primary deficit or the public debt. Finally, ir_{t-1} is the deviation of international reserves from trend, and μ_t is the error term. The coefficients from β_0 to β_6 are the unknown parameters to be estimated. The equation can be estimated through Ordinary Least Square (OLS) method; for that, one requirement is to have stationary series. When this is not the case and the series are weakly dependent of their time trends, the inclusion of a time trend in the model can solve the problem (Wooldridge, 2009). However, in a multiple variable regression, if the dependent variable is integrated of order one, I(1), and at least some of the independent variables are I(1), the results may be spurious. A common solution is to include variables I(1) in first differences, this however can limits the scope of the research question. According to Engle and Granger (1987) work, the results of a regression including variables I(1) in levels can still be useful if a lineal combination of the variables is an I(0) process. The Engle-Granger cointegration test can be applied for testing the null hypothesis of unit root in the residuals (Wooldridge, 2009).

5.3 Inflation and fiscal deficit

According to Walsh (2010), fiscal deficits might be financed by seigniorage. Therefore, there has been an interest in reviewing empirically if fiscal deficits can cause inflation. A common question in the studies that address this topic is whether fiscal deficits are inflationary in the long-run. Based on Catão and Terrones (2005), we proposed an auto-regressive distributed lag (ARDL) model to explore this question for Costa Rica. This structure allows modelling the dynamics in which inflation adjusts to fiscal deficit, as well as the inclusion of other determinants of inflation. The model can be written as

$$\pi_t = \alpha + \sum_{j=1}^{p} \lambda_j \pi_{t-j} + \sum_{i=0}^{q} \boldsymbol{\beta_i'} \boldsymbol{x_{t-i}} + \mu_t \tag{3}$$

where π_t is the observed inflation, α is the drift component, π_{t-j} are the p lags of the dependent variable, $\boldsymbol{x_{t-i}}$ is the vector of explanatory variables that includes q lags on every variable. The terms λ_j and $\boldsymbol{\beta_i}$ represent scalars and a vector of coefficients, respectively, while μ_t is the error term. As explanatory variables we included the fiscal deficit, monetary base, oil prices growth and openness index. We also included the exchange rate which is

important for developing economies as (Jalil et al., 2014) argue. Catão and Terrones (2005) also mentioned that a broad measure of deficit is desirable, therefore we also considered the deficit of the Central Bank as an explanatory variable.

We additionally control for events that might have affected inflation and fiscal deficit by including a dummy variable that indicates the Banco Anglo's bankruptcy in October 1994. We consider dummies that indicate the changes of the exchange regime, the 2008 financial crisis, the structural change on fiscal variables, and the implementation of the Law 9635. Additionally, we control for seasonal effects.

Three advantages of the ARDL procedure are: first, the the possibility of including stationary and non-stationary variables (Kripfganz and Schneider, 2018), second, the elimination of endogeneity problems with the inclusion of lagged variables, and third, the provision of consistent results for analysis based on small samples (Jalil et al., 2014). A re parametrization of Equation 3 to represent the ARDL in terms of an error correction (EC) model[4] allows us to study the short-run dynamics and can be written as:

$$\Delta\pi_t = \alpha + \phi[\pi_{t-1} - \boldsymbol{\theta'} \boldsymbol{x_t}] + \sum_{j=1}^{p-1} \lambda_j \Delta\pi_{t-j} + \sum_{i=0}^{q-1} \boldsymbol{\beta_i'} \boldsymbol{\Delta x_{t-i}} + \mu_t. \tag{4}$$

When no cointegrating relationships are found, (Kripfganz and Schneider, 2018) suggest running an ARDL in first differences.

5.4 Data

In order to carry out the proposed analysis, we use quarterly time series data for Costa Rica for the period 1991:Q1 to 2019:Q4. The data sources are the Central Bank of Costa Rica (Banco Central de Costa Rica, BCCR), Finance Ministry (Ministerio de Hacienda, MH), National Institute of Statistics and Census (Instituto Nacional de Estadística y Censos, INEC), Bloomberg and risk rating agencies (Fitch Ratings, Moody's, and Standard & Poor's). The definitions of the variables are described below.

As we applied three different estimation approaches the specific set of variables used in every case will be detailed separately.

[4] Also called equilibrium correction model

For the initial test of fiscal dominance through the VAR model, data of Central Government primary balance from the Finance Ministry, and public liabilities, generated by the sum of the Central Government debt and the monetary base (MB) from the Central Bank, are used. The two variables are scaled as GDP percentages.

For the estimation of the Central Bank's reaction function, the monetary policy interest rate (MPR) is the dependent variable. The BCCR officially announced a the MPR in June 2011, for the previous period it is used an indicator of the MPR built by Castro and Chaverri (2013) for which different interest rates were used according to the respective Central Bank definition of the short-term policy rate. The reaction function based on Taylor equation proposes that the Central Bank reacts to inflation deviation from inflation target and product gap. The inflation rate variable was generated as the annual variation of the quarterly average of the Consumer Price Index (CPI) from INEC. Inflation rate is also measured as the annual variation of the quarterly average of the Core Index or Truncated Media Index (TMI) provided by BCCR. We compute the deviation of everyone of that measures to the inflation target. The BCCR prescribed an official target of inflation from 2008, the data of previous quarters was collected as inflation projections from the Central Bank's Monetary Programs or Macroeconomic Programs.The product gap is calculated for the Central Bank as real GDP minus trend estimated with a Hodrick-Prescott filter.

The response to the MPR to fiscal variables is assessed by the inclusion of the fiscal deficit from MH and the Central Government debt from the BCCR; debt was also separated in the domestic and external components, all of them were scaled by the GDP. We also generated real debt growth as the annual change of log real debt. Nominal exchange rate growth is generated as the growth of the average of buying and selling exchange rate of colon with the United States dollar (a positive change corresponds to a nominal depreciation) with data from BCCR. International reserves are included as deviations from trend, this one is calculated with a Hodrick-Prescott filter. The current account variable is scaled by GDP, and an openness variable is measured by the sum of imports and exports from the BCCR scaled by the GDP. Also, we included the deficit of the Central Bank relative to the GDP.

On the third empirical approach, inflation rate is the dependent variable, it was generated as previously mentioned, but in quarterly variations. The independent variable of interest, the fiscal deficit, was scaled by the GDP or the monetary base. Some other determinants of inflation suggested by the literature are included, that is the case of the annual oil price

growth, generated with WTI oil prices data from Bloomberg; openness, nominal exchange rate growth and central bank deficit were measured as mentioned previously, and the money base is expressed as GDP percentage.

Table 1: Descriptive statistics, 1991:Q1-2019:Q4

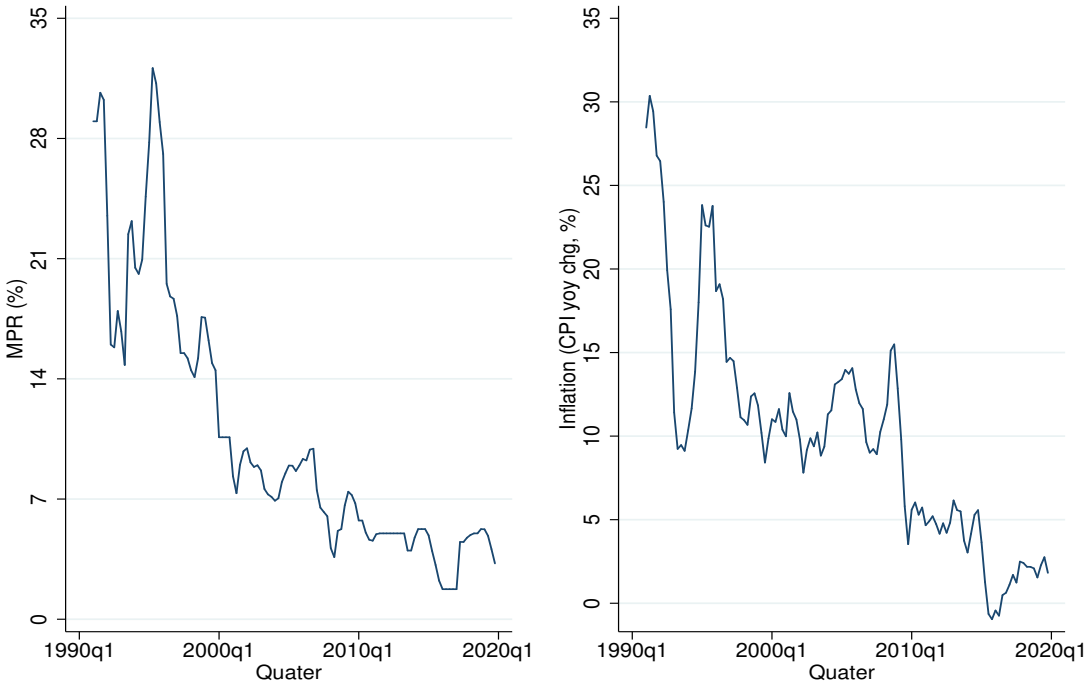
Variables	Mean	Std.dev	Min.	Max.	Obs.
Monetary policy rate, MPR (%)	10.7	7.8	1.8	32.1	116
Inflation (CPI YoY chg, %)	10.0	6.9	-1.0	30.4	116
Core Inflation (CI YoY chg, %)	7.3	4.2	0.3	17.5	96
Truncated Media inflation (TM YoY chg, %)	7.4	4.0	1.3	17.5	96
Inflation target	8.4	3.9	3.0	18.0	116
Inflation deviation (CPI)	1.6	4.2	-5.0	18.4	116
Inflation deviation (Core)	-0.1	2.1	-4.7	8.5	96
Inflation deviation (TM)	0.0	1.8	-2.1	8.5	96
Inflation (CPI QoQ chg, %)	2.3	1.8	-0.4	8.2	116
Fiscal deficit, FD (% of GDP)	3.6	2.3	-2.5	12.6	116
Fiscal deficit, FD (% of MB)	14.7	8.7	-10.7	41.5	116
Primary deficit, PD (% of GDP)	0.3	2.4	-4.9	9.3	116
Total Debt (% of GDP)	37.2	7.8	22.5	58.4	116
Domestic Debt, DDebt (% of GDP)	27.3	7.1	15.6	45.7	116
External Debt, EDebt (% of GDP)	9.9	3.4	3.6	28.4	116
Debt QoQ chg (%)	1.4	8.0	-56.8	27.5	115
Debt YoY chg (%)	6.0	10.3	-39.6	21.8	112
Monetary base, MB (% of GDP)	6.1	1.0	4.0	8.1	116
Liabilities, Liab (% of GDP)	43.4	7.9	28.6	65.6	116
Output Gap	0.0	1.1	-2.3	3.3	116
Nominal exchange rate growth, NER (%)	1.5	2.2	-4.6	9.3	115
International Reserves Gap, IR gap	0.0	1.2	-4.0	2.7	116
Oil Price YoY chg (%)	7.83	32.25	-53.53	112.45	116
Openness (% of GDP)	77.5	10.1	61.4	96.5	116
Current account balance, CC (% of GDP)	-4.3	2.6	-10.7	1.4	84
Deficit of Central Bank, DefBC (% of GDP)	0.9	0.5	-0.1	2.2	112

Note: Std.Dev indicates Standard Deviation. Variables in changes (or differences) are expressed in quarterly variations (differences), unless otherwise stated.
Source: authors with Central Bank of Costa Rica, Finance Ministry, INEC, Bloomberg.

The descriptive statistics of the variables are shown in Table 1. It includes the mean, the standard deviation, and the minimum and maximum value for each variable. The evolution of the series are shown in Figures 4, 5, and A1. There is a negative trend of the monetary policy rate and inflation rate (see Figure 4). The bankruptcy of Banco Anglo in October 1994, and the financial crisis in 2008 are episodes of high inflation. The international financial crisis of 2008 also generated changes in the economy, and caused

a structural break on Costa Rica's fiscal stance given the response of the Government specifically with its current expenditure (see Figure 5). The series of control variables like output gap, inflation deviation from target, exchange rate, international reserves, monetary base, openness, current account and oil prices can be seen in appendix A (Figure A1).

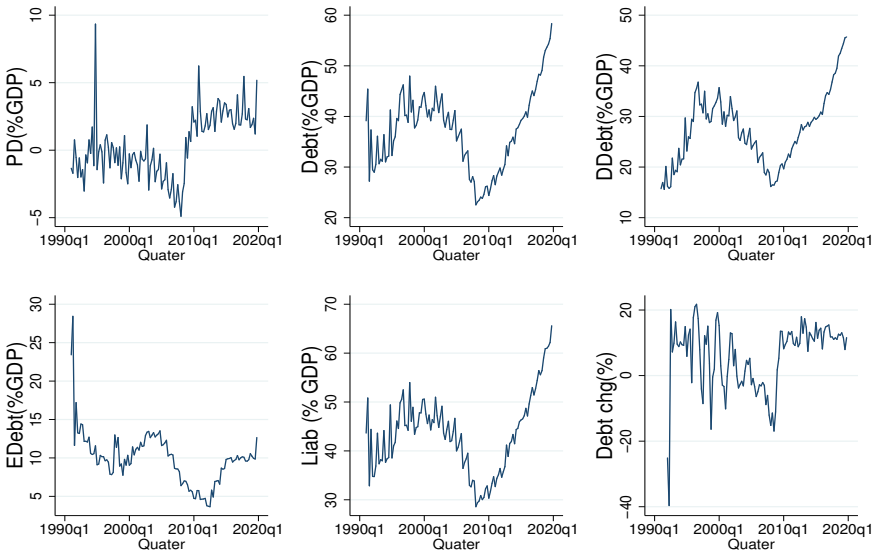
Figure 4: Monetary policy rate and inflation



Source: Central Bank of Costa Rica

The graphical analysis also allows us to observe some important relationships between the variables. There is a concentration of the MPR at values above 14% before 2000, which is consistent with higher inflation rates in that period. For the same period, the primary deficit was between -3% (surplus) and 2%, except for the forth quarter of 1994 when a higher deficit resulted due to the bankruptcy of the Banco Anglo (see Figure 6). Two different patterns can be seen after 2000. First, primary surpluses are positively associated with policy rates, most of them above 5%, between 2000 and 2008. Second, primary deficits are negatively associated to policy rates, most of them around 5% or lower, since 2009.

Figure 5: Graphs of fiscal variables



Source: Central Bank of Costa Rica

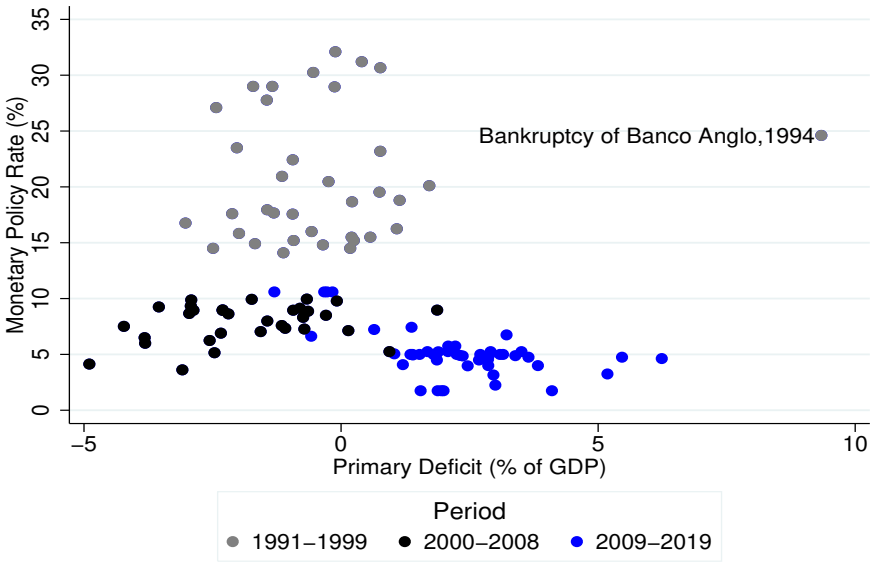
This might be showing a change in the relationship of the variables, or reflecting a non-linear association, between the MPR and the fiscal deficit. We will review this with greater detail in the Results Section.

We also analyse the association between inflation an fiscal deficit. Both series follow a common trend before 2008, when episodes of high fiscal deficits seem to be followed by higher inflation rates (see Figure 7). From the financial crisis, public finances deteriorate showing an upward trend with higher fiscal deficits, while inflation levels kept on decreasing. We will test if the relationship between this variables changed from 2008, controlling for other variables and issues of time series data to avoid spurious relationships.

As it is common in practice when dealing with time series data, we test for the stationarity of the series using unit root tests such as Augmented Dickey Fuller (ADF) and Phillips-Perron (PP). The number of lags is chosen using the information criteria of Akaike (AIC), Schwartz Bayesian (SBIC), and Hannan and Quinn (HQIC). When there was an ambiguity about the optimal number of lags, the SBIC criterios prevailed.

Most of the variables are stationary in levels, but we cannot reject the null hypothesis of a

Figure 6: Monetary Policy Rate and Primary Deficit, 1991:Q1-2019:Q4



Source: Central Bank of Costa Rica

unit root in levels for total debt and public liabilities. However, these are stationary in first differences. There are also some variables for which the order of integration is ambiguous between tests and specifications, that is the case of the MPR, inflation variables, primary deficit, fiscal deficit, and current account. All of them were stationary in first differences[5].

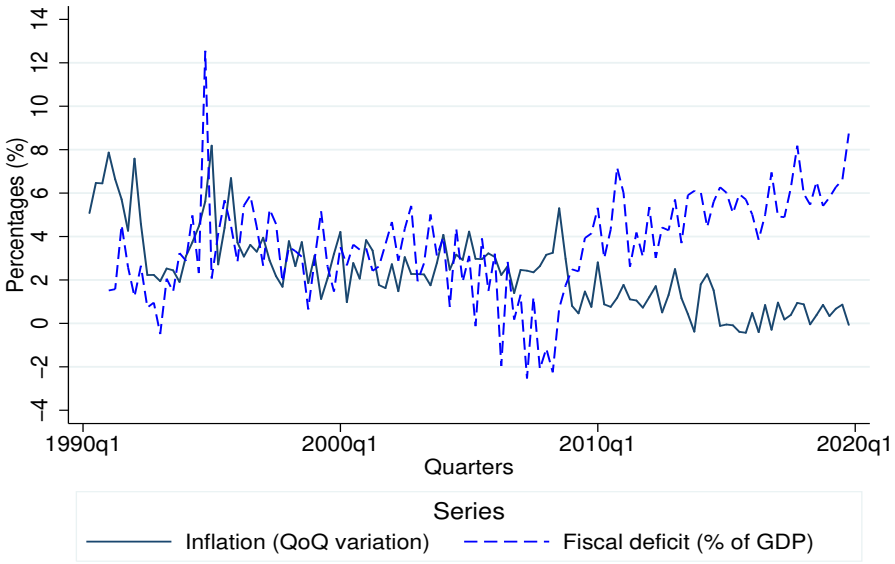
6 Results

Testing for fiscal dominance

We test the relationship between the primary balance and the public liabilities using a VAR model. First, the test of ADF and PP for unit root suggested that the variables were not stationary in levels. Therefore, we use the variables in first differences and the series become stationary (see Table A1 in appendix A). That suggested that these variables may be considered integrated of order one I(1) in the full sample. Second, we choose the lag order of the VAR model based on information criterion of Schwartz Bayesian (SBIC),

[5]Table A1 in the appendix shows the results of ADF (top panel) and PP (bottom panel) for every variable, under different specifications

Figure 7: Inflation and Fiscal Deficit, 1991:Q1-2019:Q4



Source: Central Bank of Costa Rica

which indicated an optimal number of four lags. We also included binary variables in the VAR model indicating specific financial events and seasonal patterns.

The results of the Granger test of exclusion for every variable can be seen in Table 2. In both cases, the null hypothesis were not rejected. There was no evidence of causality in the Granger sence in any direction for the full sample. Looking at the IRFs of Figure 8, in general, current innovations of both variables do not have a significant effect on the future path of the another variable. This result is consistent with a FD regime, in which the primary balances are exogenously determined. We test the VAR for stationarity; because all the eigenvalues lie inside the unit circle we conclude that the VAR satisfies the stability condition. We also check the VAR specification for no residual autocorrelation using the Lagrange Multiplier test, which indicates no residual autocorrelation at the 5% level.

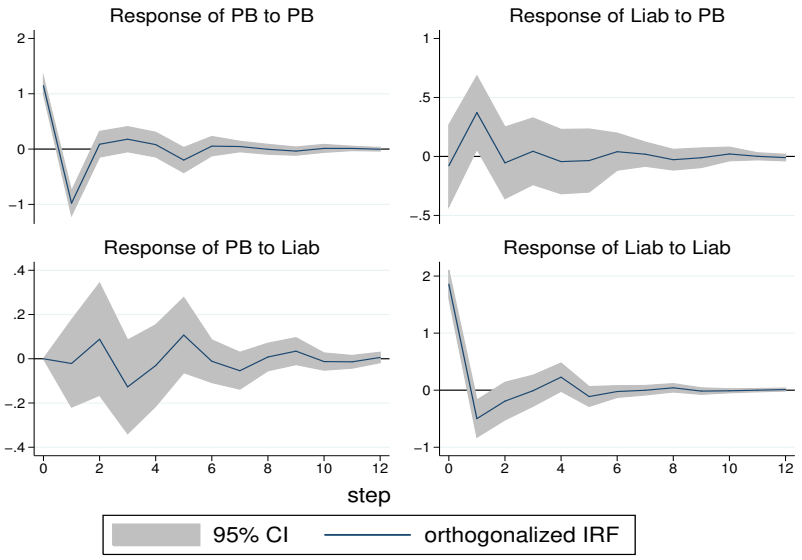
Then, we review if the results vary according to the period of analysis. We split the sample from 1991:Q1 to 2007:Q4, and from 2008:Q1 to 2019:Q4, considering the structural break of the public finances. For the first subsample, there is evidence that the primary balance Granger causes liabilities, but we do not rejected the null hypothesis that liabilities does not

Table 2: Granger causality tests

Period	Null hypothesis	Chi-square	DoF	P-value	Conclusion
1991-2019	Liab does not Granger cause PB	2.21	4	0.70	Ambiguous
	PB does not Granger cause Liab	6.47	4	0.17	
1991-2007	Liab does not Granger cause PB	5.32	4	0.26	FD
	PB does not Granger cause Liab	10.32	4	0.04	
2008-2019	Liab does not Granger cause PB	3.73	4	0.44	Ambiguous
	PB does not Granger cause Liab	3.29	4	0.51	

Note: DoF indicates degrees of freedom. FD: fiscal dominance
Source: authors with data from Central Bank of Costa Rica and Finance Ministry

Figure 8: Impulse Response Functions



Source: Central Bank of Costa Rica

cause the primary balance. This indicates an unidirectional causality of primary balances to public liabilities, which suggests a FD regime from 1991 to 2007. The IRFs stayed very similar to the full sample case (see Figure B2 in appendix B). For the second subsample, the results support the full sample findings, there is not evidence of Granger causality in any direction. The IRFs graphs shows that current innovations of none of the variables

have a significant effect on the future path of the another (see Figure B3 in appendix B), which supports the full sample results.

Central Bank Reaction Function

Although the previous results preliminarly suggest some degree of fiscal dominance, they do not reveal clearly the reaction of the monetary authority, if any, to the fiscal policy. Therefore, we estimate the augmented Taylor rule for the Central Bank using quarterly data from 1991 to 2019. The results are presented in Table 3, columns from (1) to (5) show regression results of different specifications, for every of them the dependent variable is the MPR. Column (1) has the baseline model: the augmented Taylor equation plus the primary deficit; Column (2) additionally includes a linear trend to avoid spurious correlations; Column (3) adds the gap in international reserves; Column (4) includes a variable to consider the deficit of the Central Bank, and Column (5) check if results keep after the inclusion of a variable representing a negative outlook by the risk rating agencies.

The results are very similar through the five specifications. The coefficient of the lagged dependent variable shows a positive and significant inertial component of the MPR. The inflation deviation from target is not significant. Consistent with the literature, the output gap has a positive and significant coefficient, as well as the nominal exchange rate change. The coefficient of deviation from international reserves is negative and significant as expected.

The primary deficit, PD, has a positive and significant coefficient of 0.26 on the MPR (see Column 1 Table 3). However, the inclusion of the linear trend raised the coefficient magnitude to 0.37 (40% above), and also decreased the magnitude of the lagged dependent variable coefficient (see Column 2 Table 3). This might be due to a possible estimation bias of the first model, so we keep the linear trend for next regressions. Then, the magnitude of the PD decreased after the inclusion of the IR, which might suggests a specification error (see Column 3 Table 3). The $CBdef$ did not has a significant coefficient and it did not change the previous results (see Column 4 Table 3). The results also kept similar after controlling for a negative outlook by the risk rating agencies (see Column 5 Table 3). We choose the model in Column 3 Table 3 as our core regression, which indicates that an increase of one percent in the PD generates an increase of 29 basis points on the MPR.

The estimation method was OLS and the standard errors were obtained using Newey-West

HAC estimator. A source of concern, however, is that the results from the unit root tests for the MPR and PD series do not rejected the presence of unit roots in all the cases (see Table A1 in appendix A). To address this issue, besides of the inclusion of the linear trend, we check if the linear combination of the variables cointegrates. We test the null hypothesis of unit root of the error term and it was rejected.

Table 3: Reaction Function of the Central Bank

Variables	(1)	(2)	(3)	(4)	(5)
MPR_{t-1}	0.908***	0.798***	0.774***	0.786***	0.785***
	[0.042]	[0.049]	[0.043]	[0.042]	[0.042]
Inflation deviation $(\text{CPI})_{t-1}$	0.002	0.001	0.013	0.013	0.015
	[0.101]	[0.103]	[0.086]	[0.128]	[0.129]
Output gap_{t-1}	0.373**	0.389**	0.445***	0.417**	0.419**
	[0.175]	[0.167]	[0.158]	[0.167]	[0.167]
NER_{t-1}	0.196**	0.206**	0.147**	0.134**	0.120*
	[0.079]	[0.087]	[0.068]	[0.063]	[0.066]
PD_{t-1}	0.258***	0.367***	0.292***	0.284***	0.291***
	[0.086]	[0.077]	[0.073]	[0.075]	[0.076]
IR gap_{t-1}			-0.578***	-0.476***	-0.472***
			[0.179]	[0.162]	[0.163]
DefCB_{t-1}				-0.170	-0.170
				[0.438]	[0.435]
Negative outlook_{t-1}					0.902*
					[0.527]
Trend		-0.062**	-0.077***	-0.074***	-0.077***
		[0.024]	[0.023]	[0.022]	[0.023]
Constant	-0.071	3.736**	5.062***	5.099***	5.258***
	[0.562]	[1.560]	[1.439]	[1.461]	[1.476]
Observations	114	114	114	111	111
R-squared	0.958	0.962	0.968	0.964	0.965

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH, INEC, Fitch Ratings, Moody's and S&P

Until now, we assume linear relationship between the primary deficit and the policy rate, something that can be questioned. For example, in Figure 6 there is not a clear linear form, however other factors need to be consider in the analysis to conclude that. We tested for nonlinear relationship between the PD and the MPR including a quadratic term of the PD in the core regression. The results can be seen in Table 4. The coefficient for the quadratic term is not significant, rather the primary deficit supported the findings of a

positive linear relationship of the PD with the MPR (Column 1 Table 4). Then, looking at Figure 6, a quadratic shape seems to be more clear for period 2000-2019, hence we tested the nonlinear relationship hypothesis in that subsample. We did not find evidence of a nonlinear relationship, but neither of a linear one for that subsample (Column 2 Table 4). This result indicates that the PD had a significant effect on the MPR that was particularily higher in the 90s.

Additionally, we evaluated if the relationship between PD and the MPR changed from 2008, when public finances indicators deteriorate after the financial crisis. Thus, we included a time dummy variable that assumes value one in quarters from 2008 onwards and zero otherwise, and an interaction term of this one with the PD. The coefficients of the PD before and after 2008 are positive and significant for the full sample, but the magnitudes seem to be different (see Column 3 Table 4). However, the Wald test did not rejected the null hypothesis that coefficients are equal. Then, for the sample 2000-2019, there is evidence of a positive and significant effect of PD after 2008, but not before that year (Column 4 4). Again, the Wald test did not rejected the hypothesis of equality between the coefficients. We confirm the findings of a positive effect of the primary deficit on the monetary policy rate.However, the evidence suggest that a change of the effect seems to be happen from 2000.

Another fact to note in the estimations based on the subsample from 2000-2019 is that inflation deviation has a significant coefficient (Column 2 and 4 4). This might be reflecting a higher commitment of the Central Bank to the control of the price level. The output gap have a negative but no significant coefficient and the coefficient of international reserves is lower.

Then, we evaluated if the $Debt$ has a significant effect on the MPR. The results are shown in Table 5. We tried different measures and forms of the debt variable as: total debt in Column (1), a quadratic term of $Debt$ in Column (2), the interaction between $Debt$ and the dummy variable from 2008 in Column (3), the external debt, $EDebt$, and the domestic debt, $EDebt$, in Column (4), debt growth $Debtchg$ in Column (5), and the interaction of $Debtchg$ and the time dummy variable in Column (6). We find a significant positive coefficient only for the $Debtchg$. This can be interpreted as an increase of 4.9 basic points on the MPR due to an increase of one perceptual point in debt annual growth rate.

Then, we estimated the models with some variations to check the robustness of our results.

Table 4: Reaction Function of the Central Bank to Primary Deficit

Variables	(1) 1991-2019	(2) 2000-2019	(3) 1991-2019	(4) 2000-2019
MPR_{t-1}	0.776***	0.701***	0.783***	0.657***
	[0.044]	[0.074]	[0.044]	[0.070]
Inflation deviation $(CPI)_{t-1}$	0.011	0.221***	0.020	0.235***
	[0.086]	[0.047]	[0.093]	[0.044]
Output gap_{t-1}	0.422**	-0.096	0.451***	-0.048
	[0.174]	[0.093]	[0.171]	[0.078]
NER_{t-1}	0.145**	0.117**	0.114*	0.094**
	[0.068]	[0.048]	[0.066]	[0.042]
PD_{t-1}	0.271***	0.054		
	[0.096]	[0.064]		
PD*PD $_{t-1}$	0.008	-0.003		
	[0.016]	[0.014]		
PD $_{t-1}(after2008)$			0.249**	0.115**
			[0.101]	[0.054]
$PD_{t-1}(before2008)$			0.409***	0.103
			[0.091]	[0.137]
IR gap_{t-1}	-0.582***	-0.207***	-0.566***	-0.182***
	[0.180]	[0.056]	[0.180]	[0.053]
Trend	-0.075***	-0.020*	-0.066**	-0.006
	[0.024]	[0.011]	[0.027]	[0.012]
Constant	4.943***	2.888***	4.647***	2.687***
	[1.576]	[1.072]	[1.600]	[0.956]
Observations	114	80	114	80
R-squared	0.968	0.939	0.968	0.944

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

First, we use the passive interest rate (PIR) as a substitute for the MPR. This one has a close relation to the MPR (Castro and Chaverri, 2013) and it was used as the interest rate of the monetary policy in the reaction function estimated by Muñoz and Sáenz (2003)[6]. The results support the sign and statistical significance of our findings on the effects of PD or $Debtchg$ on the interest rate (see Table B1 in appendix B). However, the magnitude of the PD coefficient is around a 40% lower. We did not find evidence of nonlinear relation-

[6]Previous works (Pizarro et al., 2000; Corbo, 2000) had use the six months interest rate of the Monetary Stabilization Bonds (BEM) as the interest rate intervention variable given that it used to be an instrument of intensive use for the control of monetary aggregates (Castro and Chaverri, 2013)

Table 5: Reaction Function of the Central Bank to Public Debt

Variables	(1)	(2)	(3)	(4)	(5)	(6)
MPR_{t-1}	0.824***	0.822***	0.800***	0.808***	0.777***	0.769***
	[0.048]	[0.053]	[0.067]	[0.047]	[0.040]	[0.042]
Inflation deviation $(CPI)_{t-1}$	-0.006	-0.011	-0.014	0.005	0.065	0.086
	[0.084]	[0.092]	[0.089]	[0.085]	[0.110]	[0.125]
Output gap_{t-1}	0.343**	0.329*	0.315*	0.350**	0.449**	0.519**
	[0.161]	[0.196]	[0.185]	[0.166]	[0.175]	[0.224]
NER_{t-1}	0.068	0.077	0.098	0.083	0.033	0.026
	[0.063]	[0.075]	[0.071]	[0.066]	[0.065]	[0.076]
IR gap_{t-1}	-0.689***	-0.688***	-0.687***	-0.689***	-0.589***	-0.586***
	[0.203]	[0.206]	[0.199]	[0.205]	[0.178]	[0.175]
$Debt_{t-1}$	-0.001	-0.057				
	[0.025]	[0.243]				
Debt*$Debt_{t-1}$		0.001				
		[0.003]				
$Debt_{t-1}(before2008)$			-0.001			
			[0.054]			
$Debt_{t-1}(after2008)$			0.038			
			[0.052]			
$DDebt_{t-1}$				0.013		
				[0.031]		
$EDebt_{t-1}$				-0.040		
				[0.054]		
Debt chg_{t-1}					0.049**	
					[0.023]	
Debt $chg_{t-1}(before2008)$						0.048
						[0.030]
Debt $chg_{t-1}(after2008)$						0.076*
						[0.030]
Trend	-0.058**	-0.059**	-0.074**	-0.067***	-0.070***	-0.069***
	[0.023]	[0.025]	[0.032]	[0.024]	[0.022]	[0.025]
Constant	4.081**	5.207	4.934	4.673**	4.996***	5.088***
	[1.881]	[6.050]	[3.512]	[1.869]	[1.429]	[1.553]
Observations	114	114	114	114	111	111
R-squared	0.964	0.964	0.963	0.964	0.962	0.963

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

ships between the interest rate and the PD or the $Debt$. The results for the rest of the explanatory variables in the models are similar to the previous findings, but the coefficient of the output gap was significant only for the model that included $Debtchg$ variable.

Second, we run two models using the inflation rate measured by an average Core Index and the Truncated Media Index as deviation of the target (see Table B2). In both cases, the coefficient of inflation deviation from target was no significant, and the PD coefficient kept positive and significant.The magnitude was lower, but this was a result of a different sample period since core inflation data was available from 1996. We check this when we estimated the core regression on a sample limited by the available data of core inflation measure. We also test if there was a better assessment of monetary policy dynamics when considering other external variables like CA and *openness* (Afonso et al. (2019); Karagiannides and Liambas (2019)). The core regression results hold after the inclusion of *openness* and the coefficients of this variables was no significant. Data for CA was available from 1999, with its inclusion the PD was not significant due to a different sample period and not to the inclusion of the variable.

Finally, we previously mentioned that there was ambiguity in the results of the unit root tests for the MPR and the PD series, and there was evidence of nonstationarity of *debt* series. One alternative to address the issue of having spurious regressions is to estimate the model in first differences. We show the results of the core regression in first differences for PD and $Debt$ in Table B3 in the appendix. In general, the coefficients changed in sign, magnitude and none of them was significant. However, the quadratic term of PD and $Debt$ become positive and significant. This specification explains the difference in the MPR in terms of the difference in PD, or $Debt$, and it differs to the relationship in levels.

We conclude that the primary deficit and the debt annual growth have had a positive effect on the MPR. This conclusion seems to be particularly clear in the 90s.Since 2000, the evidence suggests a lower reaction of the MPR to fiscal variables. This happens even from 2009, where public finances showed an important deterioration. A possible explanation is that the changes done by the Central Bank for having higher independence levels might have contributed to it.

Inflation and fiscal deficit

The previous finding provides evidence of a positive reaction of the MPR to primary deficits. One hypothesis is that the Central Bank reaction is positive with it faces the pressure of competing with the Finance Ministry for resources to finance the deficit. This would discourage consumption and investment, and eventually it would be reflected in lower

inflation rates. However, the literature has highlighted that fiscal deficit can be inflationary when the Central Bank have to use seignorage to finance government expenditure. We study this topic for Costa Rica following Catão and Terrones (2005) work. They applied an ARDL model to evaluate the long-run relationship between fiscal deficit and inflation, controlling for other variables.

First, we test for the order of integration of the inflation rate and the fiscal deficit (see Table A1) using the augmented Dickey Fuller test, and Phillips-Perron test for unit roots. Most of the variables are stationary, however, there is some ambiguity in the cases of inflation rate and fiscal deficit between the two types of tests. Therefore, an ARDL could be a well approach. Then, we test for the long-run relationship between the variables. Johansen method can be used for this purpose, it performs a tests of the number of cointegrating equations in a group of variables. The null hypothesis of two or less cointegration relationships between inflation and the fiscal deficit was not rejected. This allows us to estimate the model presented in Equation 4 in the form of an EC model.

The number of lags were chosen using BIC information criterion. We also used AIC to check if changes in the number of lags affected the results. Table 6 shows the results of the EC model. We present six different models, all of them controlled for short-run effects and dummy variables indicating some financial crisis episodes, other financial events, and seasonal patterns. The long run effect of the fiscal deficit on inflation is positive, significant at 5% or 1% and with a magnitude close to 0.3 in all regressions. This implies that an increase of 1% of the fiscal deficit increases inflation by 0.3 percentage points on average, holding other factors constant. From Column (2) Table 6, we included the monetary base, which also has a positive effect on long-run inflation, with a magnitude of around 0.37, but with a lower significance of 10% of most cases.

The oil prices coefficient has not a significant impact on the long-run (Column 3 Table 6), but then entered positive and significantly as a short-run effect. The NER coefficient is positive and significant (Column 4 Table 6), indicating the increase in inflation when the colon depreciates respect to the US dollar. We also included openness (Column 5 Table 6) and the deficit of the Central Bank (Column 6 Table 6), but none of them had a significant long-run impact on inflation. The estimated error correction coefficient, ϕ in Equation 4, is negative and above 0.7, which indicates a deviation from equilibrium will converge toward long run levels.

Table 6: Long-run effect of fiscal deficit on inflation

Variables	(1)	(2)	(3)	(4)	(5)	(6)
FD_{t-1}	0.291**	0.295**	0.287**	0.290**	0.282**	0.306***
	[0.117]	[0.122]	[0.132]	[0.124]	[0.119]	[0.111]
MB_{t-1}		0.371*	0.383*	0.366*	0.335	0.375*
		[0.210]	[0.225]	[0.213]	[0.208]	[0.190]
Oil price chg $_{t-1}$			0.006			
			[0.004]			
NER $_{t-1}$				0.251**	0.268***	0.162**
				[0.097]	[0.096]	[0.068]
Openness $_{t-1}$					-0.038	
					[0.029]	
DefCB $_{t-1}$						-0.339
						[0.330]
Constant	0.394	1.200	0.475	1.025	2.789	-1.436
	[2.280]	[2.262]	[2.246]	[2.278]	[2.373]	[2.208]
EC	-0.768***	-0.762***	-0.721***	-0.754***	-0.763***	-0.831***
	[0.083]	[0.083]	[0.082]	[0.084]	[0.083]	[0.094]
Observations	111	111	111	111	111	108
R-squared	0.631	0.622	0.612	0.625	0.631	0.627

Note: Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

Pesaran et al. (2001) bounds test was applied post estimation to check the suitability of the estimation of the EC form. According to Kripfganz and Schneider (2018), this test requires error terms to be normally distributed, homoskedastic and serially uncorrelated. After checking the validity of the error distribution assumptions, the bounds test confirmed the relationship of cointegration of the core model (Column 4 Table 6).

Previously, we observed in Figure 5 that the relationship between inflation and fiscal deficit seems to have changed from the financial crisis. However, from the above analysis, we found that inflation is also determined by other variables.We test if the relationship between inflation and fiscal deficit changed in time using two sub-samples under the framework of the EC model (see Table 7). The first sample considers years from 1991 to 2008. We find a positive and significant effect of the fiscal deficit on inflation, with a magnitude of 0.4 percent points (Column 1 Table 7). Then, we included other variables found determinants of inflation previously, the long-run coefficients of the fiscal deficit and the monetary base were higher and significant, but the nominal exchange rate did not had an effect (Column 2

Table 7).Then, we test the relationship for the period 2000-2019 [7]. In this case, the evidence suggests that fiscal deficits did not affected inflation (Column 3 Table 7). Even more, only the nominal exchange rate seems to have a significant long-run effect on inflation (Column 4 Table 7). This result is in line with the conclusion of Catão and Terrones (2005), who find that fiscal deficits are inflationary in high inflation countries.That was the case of Costa Rica in the 90s. Then, the EC coefficient was negative and significant in all the regressions, but this doubled the magnitude in the second and fourth model, which indicates a faster adjustment to the equilibrium when considering other long-run inflation determinants.

Table 7: Long-run effect of fiscal deficit on inflation

Variables	(1)	(2)	(3)	(4)
Sample	1992-2007	1992-2007	2000-2019	2000-2019
FD_{t-1}	0.403**	0.693***	0.045	0.022
	[0.156]	[0.144]	[0.094]	[0.072]
MB_{t-1}		0.702***		-0.210
		[0.136]		[0.226]
NER_{t-1}		-0.043		0.101**
		[0.159]		[0.045]
Constant	6.875**	-0.126	2.393	0.677
	[3.053]	[2.997]	[2.527]	[2.569]
EC	-0.770***	-1.417***	-0.897***	-1.128***
	[0.131]	[0.207]	[0.132]	[0.178]
Observations	61	61	80	80
R-squared	0.661	0.816	0.648	0.696

Note: Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

As robustness checks, we use the primary deficit instead of the fiscal deficit (see Table B4 in appendix B). The results supported the positive effect of fiscal deficit on inflation. We also used the annual variation of inflation as dependent variable instead the quarterly variation. The coefficient of the fiscal deficit was not significant for the whole sample, but it was for the period previous 2008. The results confirmed the finding of a positive long-run effect of the fiscal deficit on inflation for the 90s.

[7] We included the period previous to 2008 to not limit the degree of freedom for the analysis

7 Final Remarks

As stated at the beginning of this research, its main objective is to contribute to the literature on the interdependence between fiscal and monetary policy for emerging markets but also to provide the Central Bank of Costa Rica of information and inputs on the effectiveness of its monetary policy.

This goal was pursued in a broad manner, by implementing three different but complementary methodological approaches with Costa Rican data for the period 1991-2019.

First, by evaluating if primary balances were exogenously determined by public liabilities in a VAR model, we found that the primary balance Granger causes public liabilities for the period from 1991 to 2007. However, this approach does not reveal clearly the reaction of the monetary authority to the fiscal policy. Therefore, the second methodology intended to evidence the relationship between the Central Bank's reaction function and the fiscal variables by estimating the augmented Taylor rule with the inclusion of determinants such as the primary deficit and debt growth. The results show that these fiscal variables have a significant impact on the monetary policy interest rate.

Finally, the third approach, an ARDL model with EC, was implemented to provide evidence on the long run effects of fiscal deficits on inflation. Its analysis revealed a long-run effect of the fiscal deficit on inflation. For the Costa Rican case, our findings seem to be in line with the conclusion of Catão and Terrones (2005), who argue that fiscal deficits are inflationary in developing countries with already high inflation rates.

In general, the results from these three methodological approaches indicate that there is fiscal dominance in Costa Rica. When considering the time subsamples, the evidence seems to be clearer for the decade of the 90's.

Our analysis did not consider data from 2020 and hence neither the changes in the economic context associated to the Covid-19 pandemic. However, it is important to keep in mind that the Ministry of Finance has projected that the fiscal deficit will increase to 9.3% of GDP and the government debt will reach levels higher than 70% of GDP by the end of 2020.

In accordance to our findings, it would be expected that monetary policy has a reduced space to react contraciclically to the negative shock of the pandemic. Still, it seems as if

the fiscal imbalance is such that it does not have much space either.

However, due to the recent economic situation, different actors on the economic and political fields have call for the monetary policy to support the fiscal authority. This pressures are probably going to increase and push for a higher coordination degree between the authorities.

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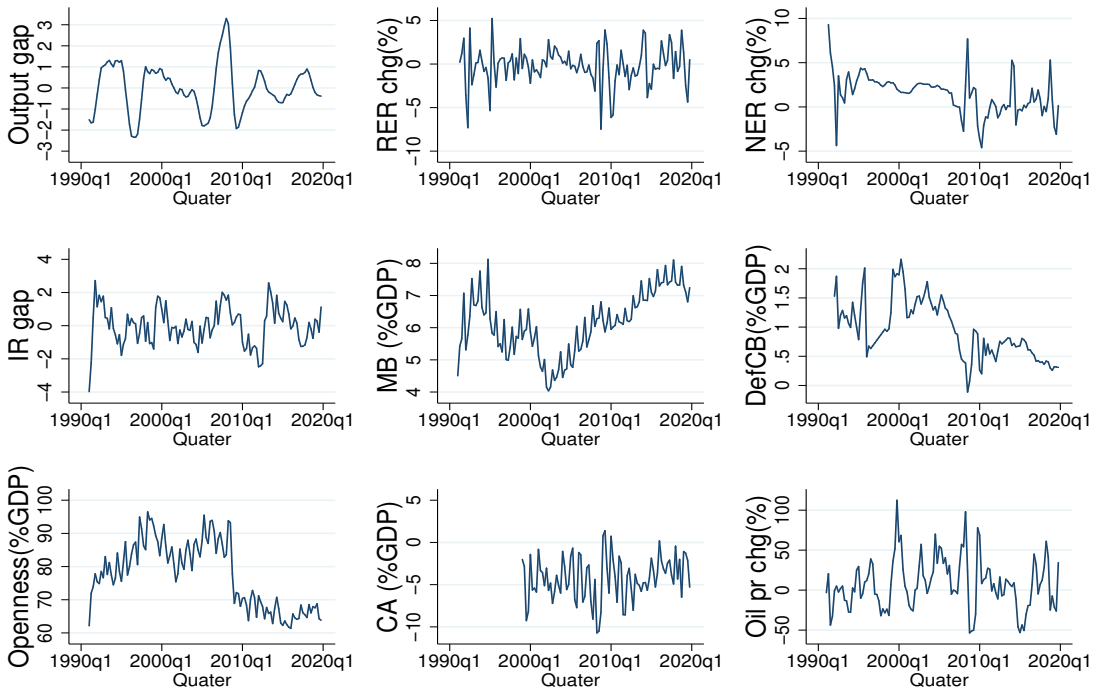
Appendices

A Data

Figure A1: Graphs of control variables, 1991Q1-2019Q4



Source: Central Bank of Costa Rica

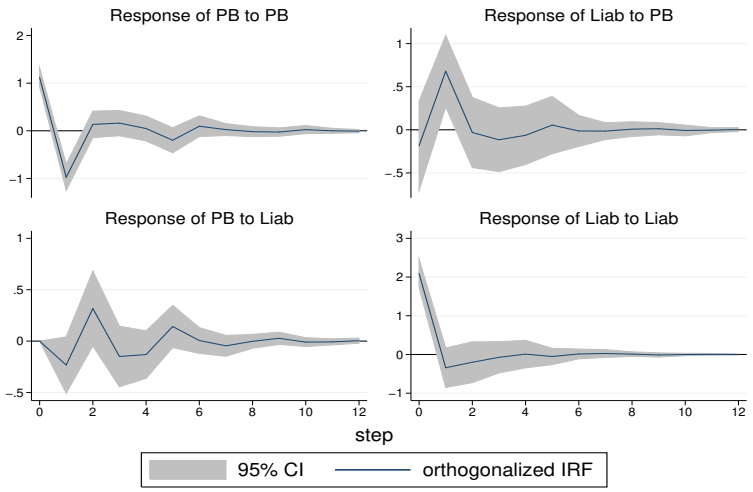
Table A1: Unit root test's

Variables	(1) NCNT	(2)CNT	(3) CT	(4)Diff.	Lags
			Augmented Dicky-Fuller test		
MPR	-2.47 **	-2.64 *	-3.85 ***	-5.35 ***	3
Inflation (CPI)	-2.55 **	-3.09 ***	-4.94 ***	-4.30 ***	2
Inflation (CPI QoQ chg)	-2.21 **	-2.79 *	-4.56 ***	-9.93 ***	2
Core Inflation	-1.83 *	-2.16	-4.01 ***	-5.56 ***	2
TM inflation	-1.97 **	-1.95	-3.26 *	-5.44 ***	2
Inflation deviation (CPI)	-4.90 ***	-4.89 ***	-5.11 ***	-8.73 ***	1
Inflation deviation (Core)	-5.33 ***	-5.41 ***	-5.25 ***	-6.50 ***	1
PD (% of GDP)	-1.43	-1.52	-2.12	-5.39 ***	4
FD (% of GDP)	-0.15	-1.65	-2.10	-4.86 ***	4
Total Debt (% of GDP)	1.20	0.01	-0.14	-8.90 ***	2
Debt YoY chg (%)	-4.24 ***	-5.96 ***	-5.83 ***	-10.50 ***	1
Liabilities	1.42	0.08	-0.02	-5.31 ***	4
RER	-9.62 ***	-9.66 ***	-9.62 ***	-14.82 ***	0
NER	-5.26 ***	-6.27 ***	-7.11 ***	-12.38 ***	0
CC (% of GDP)	-1.19	-3.50 ***	-3.79 ***	-4.56 ***	4
Openness (% of GDP)	-0.60	-0.94 **	-2.14	-4.78 ***	4
Output Gap	-4.39 ***	-4.37 ***	-4.36 ***	-4.25 ***	4
IR Gap	-5.04 ***	-5.03 ***	-5.04 ***	-8.61 ***	1
DefCB (% of GDP)	-1.81 *	-2.91 ***	-3.65 ***	-8.92 ***	1
			Phillips-Perron test		
MPR	-2.29 **	-2.26	-3.03	-7.55 ***	3
Inflation (CPI)	-2.44 **	-2.55	-3.44 ***	-7.35 ***	2
Inflation (CPI QoQ chg)	-2.30 **	-3.75 ***	-6.95 ***	-17.26 ***	2
Core Inflation	-2.17 **	-2.19	-3.13 *	-5.98 ***	2
TM inflation	-2.45 **	-2.23	-2.91	-6.06 ***	2
Inflation deviation (CPI)	-4.06 ***	-4.03 ***	-4.18 ***	-9.90 ***	1
Inflation deviation (Core)	-4.40 ***	-4.42 ***	-4.23 ***	-8.19 ***	1
PD (% of GDP)	-5.27 **	-5.35 ***	-6.76 ***	-24.68 ***	4
FD (% of GDP)	-1.95 **	-6.52 ***	-7.35 ***	-26.10 ***	4
Total Debt (% of GDP)	0.58	-0.98	-1.16	-18.36 ***	2
Debt YoY chg (%)	-4.22 ***	-5.41 ***	-5.42 ***	-13.67 ***	1
Liabilities	0.79	-1.21	-1.47	-19.72 ***	4
RER	-9.62 ***	-9.66 ***	-9.62 ***	-14.82 ***	0
NER	-5.26 ***	-6.27 ***	-7.11 ***	-12.38 ***	0
CC (% of GDP)	-2.60 **	-7.10 ***	-7.26 ***	-14.08 ***	4
Openness (% of GDP)	-0.17	-2.24	-3.92 ***	-13.83 ***	4
Output Gap	-3.52 ***	-3.52 ***	-3.50 ***	-4.09 ***	4
IR Gap	-5.71 ***	-5.69 ***	-5.68 ***	-12.21 ***	1
DefCB (% of GDP)	-1.65 *	-2.85 **	-3.79 ***	-11.53 ***	1

Note: NCNT: Without intercept nor trend; CNT:With intercept without trend; CT: With intercept and trend; Diff: First differences. Source: Central Bank of Costa Rica

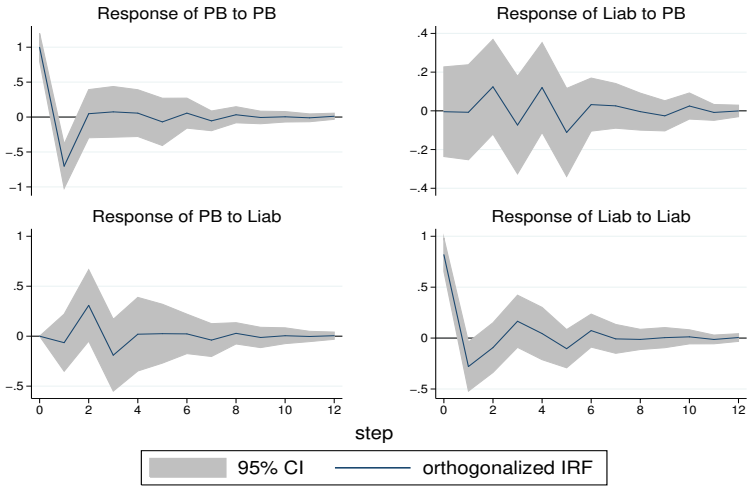
B Results

Figure B2: Impulse Response Functions, 1991:Q1-2007:Q4



Source: Central Bank of Costa Rica

Figure B3: Impulse Response Functions, 2008:Q1-2019:Q4



Source: Central Bank of Costa Rica

Table B1: Estimate of the Reaction Function of the Central Bank

Dependent variable: Passive Interest Rate (PIR))

Variables	(1)	(2)	(3)	(4)	(5)
PIR_{t-1}	0.727***	0.727***	0.738***	0.737***	0.704***
	[0.052]	[0.053]	[0.056]	[0.053]	[0.046]
Inflation deviation $(CPI)_{t-1}$	-0.009	-0.008	-0.006	-0.004	0.069
	[0.080]	[0.080]	[0.078]	[0.086]	[0.101]
Output gap_{t-1}	0.289	0.301	0.258	0.262	0.338**
	[0.177]	[0.190]	[0.177]	[0.201]	[0.167]
NER_{t-1}	0.245***	0.246***	0.185**	0.182**	0.215***
	[0.085]	[0.086]	[0.076]	[0.082]	[0.064]
PD_{t-1}	0.177***	0.188**			
	[0.061]	[0.079]			
PD*PD $_{t-1}$		-0.005			
		[0.013]			
$Debt_{t-1}$			0.017	0.035	
			[0.031]	[0.225]	
Debt*$Debt_{t-1}$				-0.000	
				[0.003]	
Debt chg_{t-1}					0.053**
					[0.022]
IR gap_{t-1}	-0.636***	-0.633***	-0.708***	-0.709***	-0.737***
	[0.176]	[0.177]	[0.188]	[0.193]	[0.170]
Trend	-0.058***	-0.059***	-0.055***	-0.055***	-0.059***
	[0.019]	[0.019]	[0.020]	[0.021]	[0.017]
Constant	6.715***	6.753***	5.948***	5.624	7.041***
	[1.584]	[1.601]	[1.836]	[5.188]	[1.346]
Observations	114	114	114	114	111
R-squared	0.967	0.967	0.966	0.966	0.968

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

Table B2: Estimate of the Reaction Function of the Central Bank: changing control variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Sample	1996-19	1996-19	1996-19	1991-19	1999-19	1999-19
MPR_{t-1}	0.730***	0.749***	0.717***	0.776***	0.776***	0.776***
	[0.082]	[0.080]	[0.087]	[0.044]	[0.047]	[0.046]
Output gap_{t-1}	0.134	0.115	0.141	0.444***	-0.030	-0.030
	[0.102]	[0.094]	[0.107]	[0.158]	[0.071]	[0.068]
NER_{t-1}	0.120**	0.118**	0.117**	0.134**	0.120**	0.120**
	[0.051]	[0.051]	[0.052]	[0.063]	[0.051]	[0.046]
PD_{t-1}	0.171**	0.169**	0.170**	0.315***	0.093*	0.093*
	[0.072]	[0.068]	[0.067]	[0.074]	[0.051]	[0.052]
IR gap_{t-1}	-0.279***	-0.272***	-0.286***	-0.574***	-0.182***	-0.182***
	[0.092]	[0.089]	[0.095]	[0.180]	[0.051]	[0.054]
Inflation deviation $(CI)_{t-1}$	-0.013					
	[0.080]					
Inflation deviation $(TM)_{t-1}$		-0.076				
		[0.121]				
Inflation deviation $(CPI)_{t-1}$			0.033	0.017	0.186***	0.186***
			[0.064]	[0.086]	[0.049]	[0.045]
$Openness_{t-1}$				0.012		
				[0.027]		
CA_{t-1}					0.000	
					[0.050]	
Trend	-0.063***	-0.064***	-0.061***	-0.076***	-0.022**	-0.022**
	[0.021]	[0.021]	[0.022]	[0.024]	[0.010]	[0.010]
Constant	5.047***	4.828***	5.132***	4.014	2.343**	2.342***
	[1.768]	[1.691]	[1.910]	[3.206]	[0.916]	[0.838]
Observations	95	95	95	114	83	83
R-squared	0.960	0.961	0.965	0.963	0.955	0.957

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

Table B3: Estimate of the Reaction Function of the Central Bank (First Differences)

Variables	(1)	(2)	(3)	(4)
Inflation deviation $(CPI)_{t-1}$	0.206	-0.438	0.189	0.033
	[0.468]	[0.365]	[0.469]	[0.398]
Output gap_{t-1}	-1.511	-2.104	-1.585	-2.336
	[1.835]	[1.843]	[1.822]	[1.865]
NER_{t-1}	-0.061	-0.132	-0.006	0.054
	[0.164]	[0.148]	[0.146]	[0.138]
IR gap_{t-1}	0.997	0.687	1.065	-0.101
	[0.709]	[0.720]	[0.679]	[0.510]
PD_{t-1}	-0.050	-0.107		
	[0.337]	[0.199]		
PD*PD $_{t-1}$		0.156***		
		[0.038]		
$Debt_{t-1}$			-0.172	0.243
			[0.193]	[0.161]
Debt*$Debt_{t-1}$				0.072***
				[0.016]
Constant	15.893***	14.180***	16.221***	13.859***
	[1.589]	[1.421]	[1.563]	[1.501]
Observations	113	113	113	113
R-squared	0.604	0.676	0.608	0.679

Note: Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC

Table B4: Estimates of the long-run effect of fiscal deficit on inflation: Robustness Check

	(1)	(2)	(3)
Sample	1992-2019	1992-2009	1992-2008
DV	Inflation (QoQ chg)	Inflation (YoY chg)	Inflation (YoY chg)
FD_{t-1}		-0.137	1.603***
		[0.331]	[0.353]
PD_{t-1}	0.381***		
	[0.139]		
MB_{t-1}	0.229	1.622**	2.550***
	[0.181]	[0.691]	[0.427]
NER $_{t-1}$	0.166**	1.228**	0.316
	[0.071]	[0.473]	[0.244]
Constant	0.308	2.863	4.256
	[2.192]	[3.761]	[3.561]
EC	-0.786***	-0.316***	-0.501***
	[0.087]	[0.046]	[0.055]
Observations	110	109	65
R-squared	0.672	0.667	0.838

Note: Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively.All the regressions include dummy for seasonal patterns, fiscal events and change in monetary regimes.
Source: authors with data from BCCR, MH and INEC