THE INTERDEPENDENCE OF FISCAL AND MONETARY POLICY

INTERDEPENDENCE BETWEEN FISCAL AND MONETARY POLICY: THE CASE FOR COSTA RICA

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Interdependence between Fiscal and Monetary Policy: The Case for Costa Rica*

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Abstract

We study whether fiscal policy affects monetary policy in Costa Rica during the period 1991-2019. We use three different methodological approaches. First, we test for fiscal dominance by evaluating the relationship between the primary balance and public liabilities using a Vector Autoregression model. Second, we estimate the reaction function of the Central Bank to evaluate whether the primary deficit and public debt have a significant effect on the monetary policy interest rate. This is carried out using an autoregressive distributed lag (ARDL) model with error correction. We find that the Central Bank does not accommodate its actions to fiscal policy. Third, in order to evaluate the long-run relationship between inflation and the fiscal deficit, we also use an ARDL model with error correction. There is evidence that in the long run the fiscal deficit affects inflation, mainly in the 90s.

JEL Codes: E31, E52, E61, E62.

Keywords: Fiscal Dominance, Monetary Dominance, Inflation, Reaction function.

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

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1 Introduction

The theoretical debate about the coordination and interaction between monetary and fiscal authorities was formally initiated by Sargent & 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 & 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 (Tanner & Ramos 2003, Catão & Terrones 2005, Zoli 2005, De Resende 2007, Ahmed et al. 2021). 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, the Central Bank (BCCR for its acronym in Spanish) has actively pursued higher independence and has taken measures to achieve low and stable price levels in coherence to its intentions of adopting an inflation target monetary regime.

Inflation targeting regimes generally follow the behaviour of a price index to guide the central bank actions, instead of the exchange rate or the international reserves (Delgado 2000). The Central Bank establishes and announces the target inflation rate, that must attempt to achieve by the use of tools such as the policy rate. The inflation targeting regime came into force in Costa Rica in February 2018, but the path to achieve it started earlier. The adoption of a more flexible exchange rate regime in 2006, then in 2015, and other changes[1] 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[2] for achieving a higher level of independence, the fiscal stance remains a vulnerability.

Second, 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 surplus 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 and there are fiscal explicit goals in reference

[1]See the details of the adoption path of the regime of inflation targeting followed by Costa Rica in Muñoz (2012).

[2]In addition, other changes 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).

to increasing income, contracting public spending and improving its management, 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 policies for Costa Rica. Therefore, the main objective of this study is to contribute to the literature on the topic for developing countries 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 monetary policy rate. Specifically, we estimate an augmented Taylor equation through an error correction form of an Autoregressive Distribuited Lag (ARDL) model. We consider the monetary policy interest rate to be explained by inflation, output gap, exchange rate, international reserves, and fiscal variables (like primary deficit, public debt and the domestic debt interest rate). As a complement, we also use an 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, given the pandemic, the fiscal situation worsened: the latest figures from the Ministry of Finance registered a fiscal deficit of 8.7% and a government debt 68% to the 2020. 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 test for fiscal dominance does not clearly reveal a fiscal or monetary dominance regime. This is a frequent problem in the literature that has applied this approach. From the reaction function of the monetary policy rate, we find evidence that the policy rate has been reacting positively to the growth of public debt and the domestic debt interest rate. This result suggests that, through the instrument of the policy rate, the Central Bank has not accommodated to the fiscal policy. Then, under the error correction model there is evidence of a long-run effect of the fiscal deficit on inflation mainly in the 90s.

This paper is organized into six sections. The literature and theoretical framework are explained in Sections 2 and 3. While Section 4 provides a contextual overview of the main fiscal and monetary variables in Costa Rica over the last four decades. Section 5 follows to describe the methodological approaches and Section 6 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 & 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. In contrast, when the fiscal authority independently sets the budget, it imposes a constraint to the monetary authority. This constraint 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. In these circumstances, the economy is under fiscal dominance.

The literature (Aiyagari & Gertler 1985, De Resende 2007) distinguishes fiscal and monetary regimes according to which authority backs debt. In a Ricardian regime, the fiscal authority backs all debt. While in the non-Ricardian regime, debt is all backed by seigniorage. 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 & Gertler 1985). As it was 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.

For others, the coordination problem was about finding the right combination of monetary and fiscal policies to provide a stable nominal anchor (Canzoneri et al. 2010). In that sense, the "fiscal theory of price level" (FTPL) surged as an alternative to the quantitative theory of money, and other theories (Woodford 1995), from the contributions done by authors like Leeper (1991), Woodford (1995), Sims (1994), and Cochrane (1998). 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 & Rivera (2004) classify fiscal dominance according to the form in which the 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 & 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 (Catão & Terrones 2005, De Resende 2007, Tanner & Ramos 2003, Zoli 2005). Some studies have focused the attention on the link between government budget and money growth from a framework of the intertemporal government budget constraint, through which budget deficits can be financed by debt and seignioraige. Studies in developed countries — like the USA (Bohn 1998, Cochrane 1998, Canzoneri et al. 2001) — and developing countries — like Brazil (Tanner & Ramos 2003), Colombia (Lozano-Espitia & Herrera 2008), other Latin American countries, Poland, South Africa and Thailand (Zoli 2005) — 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 inconclusive or give some evidence of fiscal dominance in concordance to a path of the primary surplus exougenously determined from public liabilities (debt and monetary base). However, a source of criticisms to this approach is that ambiguity in the results, together with a known identification problem. This problem is generated from a result in which the current primary balance affects positively future liabilities, which could be interpreted both as a Ricardian or a non-Ricardian regime (Canzoneri et al. 2010).

Other set of literature 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. Some studies based on a panel of developed countries (European Monetary Union members (Wyplosz 1999) and European Union countries (Afonso et al. 2019)) found a positive or null response of the interest rate to the government debt. These results are interpreted as if polices were cyclical substitutes, for example, when the monetary authority raises the interest rate when the deficit or the public debt increases. Also, evidence of changes on the relationship in time was found. However, in a panel data structure, Ahmed et al. (2021) found that higher ratios of public debt in advanced economies under inflation targeting (IT) regimes were associated with lower policy interest rates, which is explained mainly by a declining natural rate of interest in the countries under analysis.

In the case of developing countries, the results are mixed, with evidence of null, positive or non-linear relationships 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 were split in sub-samples to separate periods of inflation targeting (IT) regime from other regimes. On the other hand, Kuncoro & 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, suggesting a monetary dominance regime. Ahmed et al. (2021) also study the relationship in emerging countries under IT and non-IT regimes. For countries not under an IT regime, there was evidence of fiscal dominance represented as a non-linear effect of the public debt on the policy rate that depends on the ratio of foreign-currency relative to total public debt, and the ratio of hard-currency debt.

In the specific case of Costa Rica, Muñoz & Sáenz (2003) carry on the estimation of the reaction function of the Central Bank for the period 1991-2002[3] using quarterly data and an augmented Taylor rule specification through OLS method. The dependent variable was the Passive Basic interest rate[4], which is a reference interest rate[5] from six months deposits within the financial intermediaries, 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 scaled by GDP). 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.

To our knowledge, Muñoz & Sáenz (2003) work was the last effort to estimate a reaction function for the Central Bank of Costa Rica, and to include explanatory fiscal variables on it. Since that, the monetary and exchange policies suffered variations that were oriented to propitiate conditions to adopt an inflation targeting regime. Although it was adopted until 2018, related changes that occurred previously make interesting to re-estimate the central bank reaction function. For example, the explicit assignment of the monetary policy rate as the instrument to operationalize the monetary strategy since 2004 generated an official policy rate variable for modeling [6]. In addition, the changes of the exchange regime may have influenced the relationship between the policy rate and

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

[4] According to the authors, its application in modeling was similar to those obtained using the 6-month Monetary Stabilization Bonds (BEM) rate, which we use for the period 1991:Q1 to 1999:Q4.

[5] "tasa de interés básica pasiva" in Spanish.

[6] The policy rate variable is described in the Section 5.

some explanatory variables, and its is important to consider it in the analysis. We also make a contribution to the literature by using an ARDL model in the error correction (EC) form to explore for a long-run relationship between the policy rate and the fiscal variables.

Another line of study rises from the question of whether fiscal deficits are inflationary in the long run (Walsh 2010). This question was analysed by Catão & Terrones (2005) on a sample of 107 countries (including Costa Rica) for period 1960-2001. They used two strategies of dynamic panels: a mean group estimate and a pooled mean group estimate, each one of an ARDL specification with error correction term. Due to evidence of sample heterogeneity, the countries were grouped by level of financial development and inflation performance. Costa Rican data were included in the groups of developing countries or with mid-level inflation. The authors concluded that budget deficits are inflationary in most groups, except for low-inflation economies and advanced countries. The relationship is stronger among high-inflation and developing country groups and kept even after considering into the long-run equation variables like oil prices, openness to foreign trade and an exchange rate regime indicator. Also, Catão & Terrones (2005) mention that previous empirical studies on this question weakly found evidence of a relationship due to short periods of data and the use of inadequate econometric techniques.

Individual studies for developing countries, like Pakistan (Jalil et al. 2014) and Nigeria (Abubakar et al. 2014), have also addressed this topic under ARDL models and have found that fiscal deficit is an important determinant of inflation. Other works have found similar results by applying Vector Error Correction Models (VECM) in countries like Indonesia and Uganda (see references in Bulawayo et al. 2018) and Colombia (Lozano-Espitia 2008). For Costa Rica, Obando (2017) analysed the relationship between the interest rate[7], the inflation rate and the fiscal deficit using restricted VAR and VEC models with annual data from 1991 to 2016. The study found a positive long-run effect of the fiscal deficit on the interest rate that is explained by the use of the latter as a tool for attracting resources to cover debt. Then, no evidence of an effect of the fiscal deficit on inflation was found, however, this might have been related to low statistical power due to the small sample size. We contribute to the topic in Costa Rica using a greater sample size based on quarterly data and reviewing the existence of a long-run relationship between inflation and fiscal deficit through a ARDL model with EC term.

The study of the effect of fiscal policy on inflation has also been reviewed through the analysis of public debt. For example, Barquero & 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

[7]She uses the passive basic interest rate.

determinant factor of inflation in highly indebted developing countries.

Finally, De Resende (2007) developed an econometric strategy to estimate the degree of interdependence between fiscal and monetary policies. The procedure was empirically applied to a set of OECD and developing countries, including Costa Rica. It specifically consisted on estimating the country-specific parameter of the debt-backing (δ), proposed by Aiyagari & Gertler (1985), through a dynamic ordinary least squares method using data of money, debt, and private consumption. According Aiyagari & Gertler (1985), when δ=1 the government backs all debt, while when δ=0 the monetary authority backs fully all government debt. The findings suggest that fiscal dominance is more frequent among developing countries and these have a higher degree of fiscal dominance than OECD countries. For the specific case of Costa Rica, in a sample from 1951-2002, the estimated δ was 0.238, but this figure was not statistically different from 0. This result classified the country under a regime in which the monetary authority backs all government debt. An episode of this type certainly occurred in the 1980s, however, important changes in the management of monetary policy were made in the following decades (see Section 4).

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:

$$G_t + i_{t-1}B^T_{t-1} = \tau_t + (B^T_t - B^T_{t-1}) + RCB_t, \tag{1}$$

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_{t-1} of 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, $(B^T_t - B^T_{t-1})$, 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:

$$(B^M_t - B^M_{t-1}) + RCB_t = i_{t-1}B^M_{t-1} + (H_t - H_{t-1}), \tag{2}$$

where the left hand side includes the central bank purchases of government debt, $(B^M_t - B^M_{t-1})$, and the RCB_t. The right hand side includes the interest payments from the fiscal authority, $i_{t-1}B^M_{t-1}$, and the change in central bank´s 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 (1) and (2), and expressed in terms of the price level as follows:

$$\frac{G_t}{P_t} + i_{t-1}\frac{B^T_{t-1}}{P_t} = \frac{\tau_t}{P_t} + \frac{(B_t - B_{t-1})}{P_t} + \frac{(H_t - H_{t-1})}{P_t}. \tag{3}$$

Equation (3) indicates that government expenditures can be payed using taxes, funds from the private sector or seigniorage. A representation in lowercase letters indicates that variables are deflated by the price level:

$$g_t + r_{t-1}b_{t-1} = t_t + (b_t - b_{t-1}) + s_t, \tag{4}$$

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

However, equation (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:

$$(1+r)b_{t-1} + \sum_{i=0}^{\infty}\frac{g_{t+i}}{(1+r)^i} = \sum_{i=0}^{\infty}\frac{t_{t+i}}{(1+r)^i} + \sum_{i=0}^{\infty}\frac{s_{t+i}}{(1+r)^i} + \lim_{i\to\infty}\frac{b_{t+i}}{(1+r)^i}. \tag{5}$$

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 (5) implies that

$$(1+r)b_{t-1} = -\sum_{i=0}^{\infty}\frac{pd_{t+i}}{(1+r)^i}. \tag{6}$$

When the government has outstanding debt $(b_{t-1} > 0)$, it must generate a primary surplus in present value. Equation (6) is considered a government constrain 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 (6) and taken $R = 1 + r$, current liabilities can be financed in terms of the primary surplus or seignoriage, and take the form of:

$$b_{t-1} = R^{-1}\sum_{i=0}^{\infty}R^{-i}(t_{t+i} - g_{t+i}) + \sum_{i=0}^{\infty}R^{-i}s_{t+i}. \tag{7}$$

A reduction of the fiscal primary surplus requires an increase of the present value of seigniorage to maintain the equality in equation (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 to have eventually a higher inflation.

4 Short Overview of the Monetary and Fiscal Policy in Costa Rica

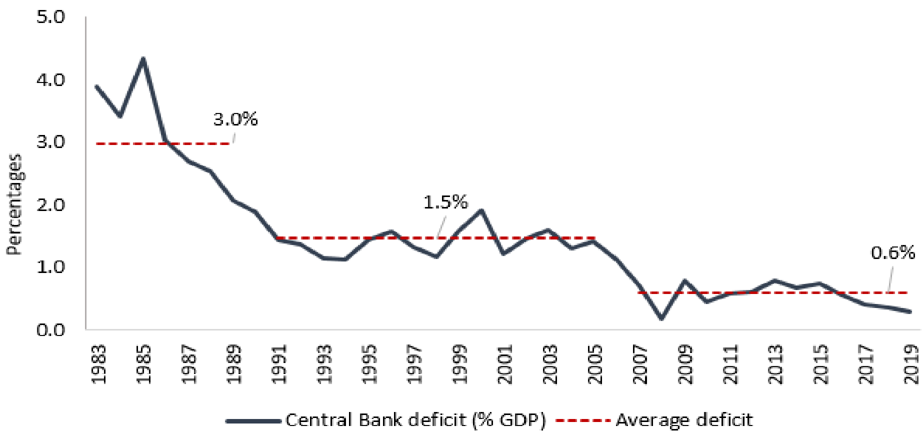
The previous sections suggest that the effectiveness of the monetary policy can be affected by the fiscal policy according to the discipline that fiscal authorities have in their budget management and how active the monetary policy is. In this section, we present some fiscal and monetary episodes of 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 that affected public finances occurred after the oil shock of the late 1970s 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 internal macroeconomic conditions contributed to worsening 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 the expansion and facilitate its 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 & 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 Costarricense" in 1994, a state bank, generated losses that represented 1.8% of GDP to the Central Government.

Figure 1: Deficit of the Central Bank of Costa Rica, 1983-2019

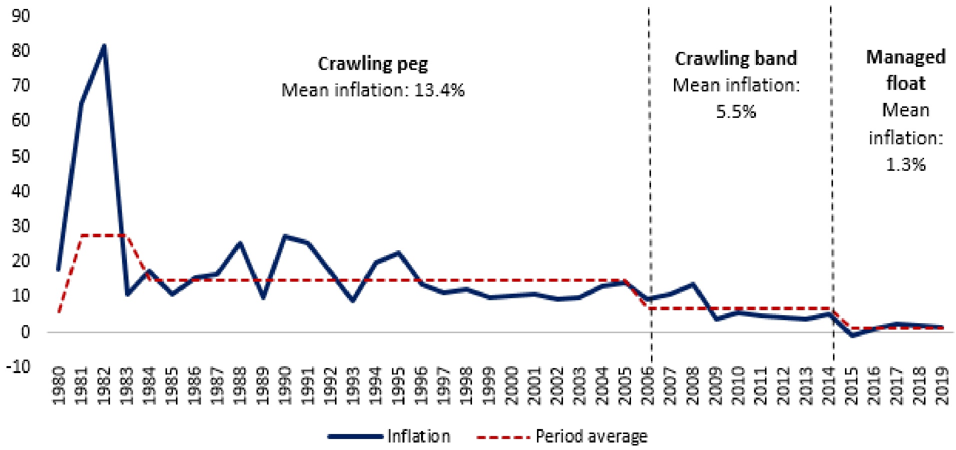


Notes: Deficit of the Central Bank of Costa Rica as percentage of the GDP. Source: authors' elaboration with data from the Central Bank of Costa Rica.

From November 1995, the new Law of the Central Bank (Ley Orgánica del Banco Central, N°7558) reduced the possibilities of the BCCR to finance the Government (Mesalles & Céspedes 2007). This law was intended to increase the autonomy and independence of the Central Bank. Central Bank attributions were clearly delimited by law, and its function acquired more independence from the political scope (Delgado 2000).

This would allow the Central Bank to focus on internal and external stability of the currency. Even though, 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 place 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. The annual 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).

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



Notes: Annual inflation rate and average inflation rate (in percentages) by current exchange rate regime. Source: authors' elaboration with data from Central Bank of Costa Rica.

In order to guarantee a successful transition to an inflation targeting regime 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 the concept that is applied to date[8].

In January 2018, the BCCR concluded the gradual transition towards a monetary inflation targeting regime, and announced the "de jure" adoption of the regime from February of 2018. The goal for the long-term inflation was defined at 3%, allowing for deviations within a margin of 1 percentage point. The Central Bank uses a prospective approach to make the adjustments required in the instruments of monetary policy. For that, it bases on the analysis of the economic outlook, inflation forecast and inflation expectations towards that goal, and how transitory the deviation may be with respect to the target (BCCR 2018).

More actions taken by the Central Bank in order to achieve greater monetary policy independence were to implement 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

[8]See Tenorio (2008) for details on the changes of the qualitative definitions of the monetary policy rate.

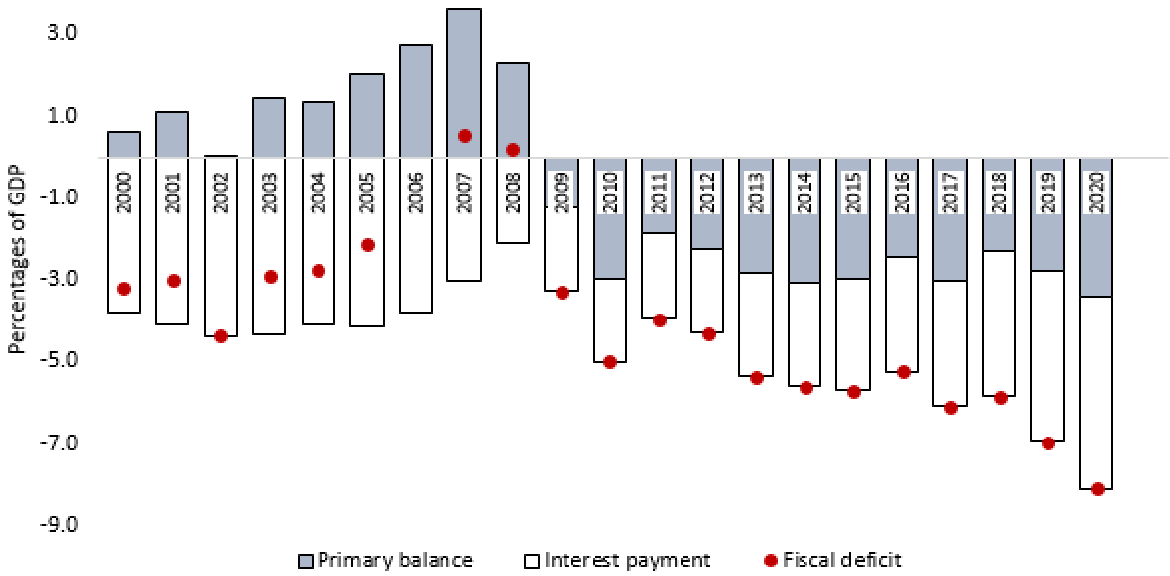
other reform was the elimination of the vote by the Minister of Finance in the decisions of the Board of Directors of the BCCR (OECD 2018).

Since 1982, the fiscal policy made little use of financing from the Central Bank. However, according to Delgado (2000), the political inability to achieve balanced public finances exerted negative influence and pressure on monetary policy reflected in an interest conflict. Then, 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 to a restrictive spending policy and higher tax revenues as result of the economic growth of those years (Esquivel & Lankester 2019).

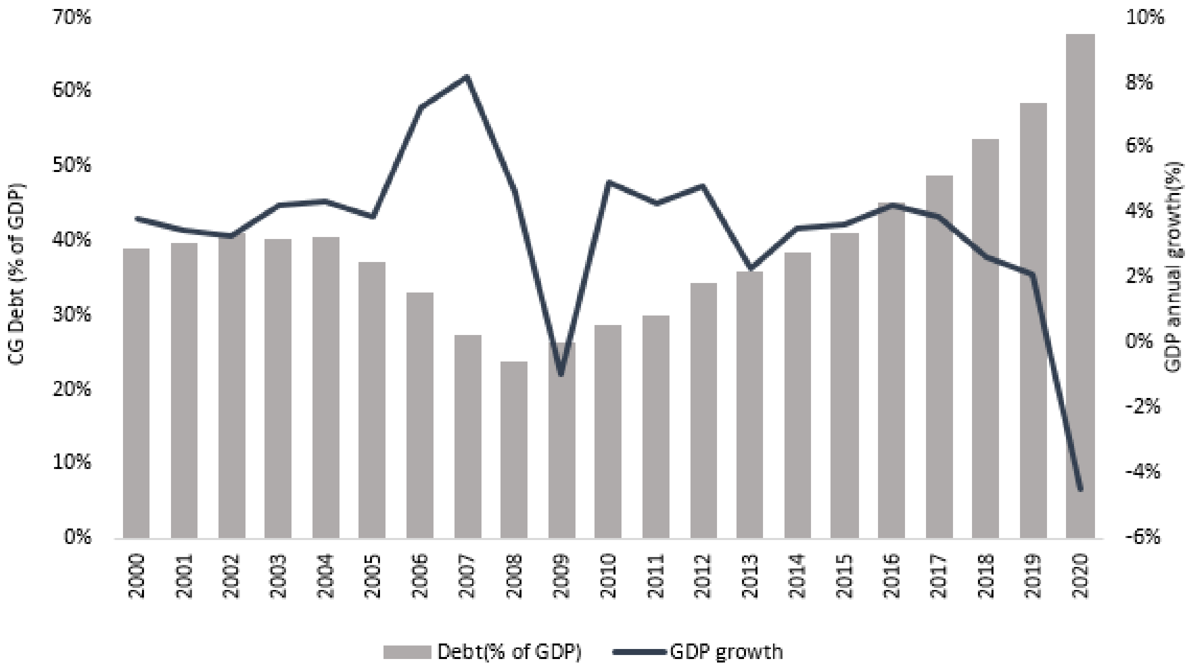
However, the situation changed in 2008, with lower economic growth, plus an expansionary fiscal policy in response to the effects of the financial crisis. However, the increases in expenditures were in highly rigid sectors such as salaries and current transfers that continued even after the crisis. Since then, public finance results 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.

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



Notes: Graph (a) shows the primary surplus, the interest payment, and fiscal balance of the Central Government, all data are scaled by GDP. Graph (b) shows the debt of the Central Government scaled by GDP (right axis), and the annual growth rate of GDP (left axis). Source: authors' elaboration with data from Central Bank of Costa Rica and Finance Ministry.

In this context, in July 2019, the Fiscal Reform ("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 terms of expenditures, public sector compensation schemes were modified and it was established a fiscal rule that limits the growth of spending[9] for certain levels of indebtedness and economic growth.

The expectations of an improvement in the government finances lasted until March 2020, due to the COVID-19 pandemic. The macroeconomic program for 2020-2021 (BCCR 2021) estimated a decrease of 4.5% of real GDP in 2020, the fiscal deficit was around 8.7%, while the Central Government's indebtedness reached 68% relative to the GDP. This was 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).

5 Methodology and Data

To evaluate empirically the interdependence between monetary and fiscal policies in Costa Rica, this study considers three approaches used in the 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 the response of the monetary policy rate to fiscal variables using a Taylor equation form, in a regression analysis and under ARDL models with errors correction. Finally, we estimate if there is a relationship between fiscal deficit and inflation using an ARDL model with error correction. 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 includes 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:

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

$$PB_t = \alpha_0 + \sum_{j=1} \alpha_j PB_{t-j} + \sum_{j=1} \beta_j Liab_{t-j} + \alpha_x X_t + \epsilon_t,$$
$$Liab_t = \gamma_0 + \sum_{j=1} \delta_j PB_{t-j} + \sum_{j=1} \gamma_j Liab_{t-j} + \gamma_x X_t + \mu_t, \tag{8}$$

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 account for seasonal patterns and fiscal events. Specifically, we include dummy variables that indicate 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.

Looking at the temporal relationships in the IRFs, the results can be classified under FD or MD (Lozano-Espitia & Herrera 2008, Zoli 2005, Tanner & Ramos 2003). In the first regression of the system of equations (8), 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 MD, higher primary balances are created to compensate the increases in liabilities in order to limit debt accumulation. However, according to the FTPL, this could be classified as a case of FD, where 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. Lozano-Espitia & Herrera (2008) mentioned that another condition of a MD regime is that the PB_t response to a previous increase in PB_{t-1} has to be positive ($\alpha_j > 0$).

In the second regression of the system of equations (8), 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. A positive effect on future liabilities of the current primary balance can be the result of the government anticipation of future obligations. Finally, a null effect ($\delta_j = 0$) suggests an exogenous primary balance that is consistent with fiscal dominance.

This approach, however, has been criticized because it does not consider that the primary balance responds 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 consistent 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 (also called monetary policy rate or policy rate), which is explained by the observed values of inflation deviation from target and the output gap. Intuitively, values of the observed inflation rate above target, or the real GDP above the potential output, would call for an increase of policy rate of the central bank. Some studies consider also a forward looking component. 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 developing 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, Ahmed et al. 2021). This is the so called augmented Taylor rule. For several developing countries, 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 (Ahmed et al. 2021, Kuncoro & Sebayang 2013, Zoli 2005). We include the primary deficit, public debt variables and the debt interest rate to study the interaction between monetary and fiscal policies in our model. The type of interaction between monetary and fiscal policies can be determined in the model according to the coefficient sign. A negative relationship indicates complementarity between the policy instruments (Wyplosz 1999), this is a fiscal dominance regime where monetary authorities follows accommodative monetary policy, with low interest rates in order to alleviate the public debt burden. By contrast, a positive sign would indicate that the instruments are used as cyclical substitutes (Wyplosz 1999), this is a case of monetary dominance because the monetary authorities raise the policy rate in reaction to inflation pressures generated by higher deficits or indebtedness. A null impact is more consistent with a monetary regime, that would indicate that monetary policy does not accommodate fiscal policy (Zoli 2005).

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 & Sáenz (2003), we consider the deviation of international reserves from its trend. An increase in foreign reserves above the trend would be negatively related to the policy rate to avoid a strong entrance of capitals. In addition, fiscal events, changes in the monetary regime or monetary factors are controlled. Specifically, we include dummy variables that indicate the Banco Anglo's bankruptcy in 1994, structural change of inflation from 1999 to 2002 (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. Additionally, we also control for seasonal patterns in data.

The equation can be written as

$$i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2(\pi - \pi^*)_{t-1} + \beta_3(y - y^*)_{t-1} + \beta_4 e_{t-1} + \beta_5 fiscal_{t-1} + \beta_6 ir_{t-1} + \mu_t, \quad (9)$$

where i_t and i_{t-1} denote 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 its trend. Also, e_{t-1} denotes the quarterly growth of the exchange rate and $fiscal_{t-1}$ represents fiscal variables, like the primary deficit, public debt or interest rate of the 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 parameters to be estimated.

The equation (9) can be estimated through Ordinary Least Square (OLS) method; for that, one requirement is to have stationary series. Otherwise, in a multiple variable regression where 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 Wooldridge (2009). A common solution is to include variables I(1) in first differences, this however can limit the scope of the research question. To avoid that problem, we apply an Auto Regressive Distributive Lag (ARDL) model with errors correction.

This approach allows us to test for levels relationships between the dependent variable and the regressors, irrespective of its order of integration, I(0) or I(1) (Kripfganz & Schneider 2018). It was proposed by Pesaran et al. (2001) and uses a bounding testing approach by applying "*standard F- and t-statistics to test the significance of the lagged levels of the variables in a univariate equilibrium correction mechanism*". Two other advantages of the ARDL procedure are the consideration of endogeneity problems with the inclusion of lagged variables, and the provision of consistent results for analysis based on small samples[10]. When no cointegrating relationships are found, Kripfganz & Schneider

[10]In words of Pesaran & Shin (1999), the use of the ARDL estimation procedure is directly com-

(2018) suggest running an ARDL in first differences.

A reparametrization of equation (9) to represent the ARDL model with errors correction (EC)[11] can be written as:

$$\Delta i_t = c_0 + c_1 T + \phi[i_{t-1} - \boldsymbol{\theta' z_t}] + \sum_{j=1}^{p-1} \lambda_j \Delta i_{t-j} + \sum_{l=0}^{q-1} \boldsymbol{\beta'_l \Delta z_{t-l}} + \mu_t, \tag{10}$$

where i_t is the policy rate, c_0 is the intercept, T is a linear trend, i_{t-j} are the p lags of the dependent variable, $\boldsymbol{z_{t-l}}$ is the vector of k explanatory variables included in equation (9) that covers q lags of every variable. The term $\boldsymbol{\theta}$ defines the long-run equilibrium relationship between the policy rate and the independent variables, and ϕ is the error correction term that indicates the speed of adjustment to the equilibrium. The terms λ_j and $\boldsymbol{\beta_l}$ represent scalars and a vector of coefficients, respectively, while μ_t is the error term.

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 whether fiscal deficits can cause inflation (see references in Bulawayo et al. 2018). A common question in the studies that address this topic is whether fiscal deficits are inflationary in the long run. Based on Catão & Terrones (2005), we use an ARDL model to explore this question for Costa Rica. This structure allows modelling the dynamics in which inflation adjusts to the fiscal deficit, as well as the inclusion of other determinants of inflation. The model can be written as

$$\pi_t = \alpha + \sum_{j=1}^{p} \lambda_j \pi_{t-j} + \sum_{i=0}^{q} \boldsymbol{\beta'_i x_{t-i}} + \mu_t, \tag{11}$$

where π_t is the observed inflation, α is the intercept, π_{t-j} are the p lags of the inflation rate, $\boldsymbol{x_{t-i}}$ is the vector of (k x 1) explanatory variables that includes q lags of 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, the monetary base, oil prices growth, and the trade openness index. We also included the exchange rate which is important for developing economies as Jalil et al. (2014) argue. Catão & 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

parable to the semi-parametric fully-modified OLS approach estimation of cointegrating relations. The choice between them has to be made on the basis of their small sample properties and computational convenience.

[11] It is also called equilibrium correction model.

by including a dummy variable for the Banco Anglo's bankruptcy in October 1994. We consider dummies for the changes of the exchange regime, the 2008 financial crisis and the structural change on fiscal variables. Additionally, we control for seasonal effects.

A reparametrization of equation (11) to represent the ARDL in terms of an error correction (EC) model can be written as:

$$\Delta\pi_t = \alpha + \phi[\pi_{t-1} - \boldsymbol{\theta}'\boldsymbol{x_t}] + \sum_{j=1}^{p-1} \lambda_j \Delta\pi_{t-j} + \sum_{i=0}^{q-1} \boldsymbol{\beta_i'\Delta x_{t-i}} + \mu_t. \tag{12}$$

The term $\boldsymbol{\theta}$ defines the long-run equilibrium relationship between the policy rate and the independent variables, and ϕ is the error correction term an indicates the speed of adjustment to the equilibrium.

5.4 Data and Period of Study

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.

For the initial test of fiscal dominance through the VAR model, data of the 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. We analyze the full period, but also two sub-periods according to the structural breaks in the fiscal variables, that is, period one from 1991-2007 and period two from 2008-2019.

For the estimation of the Central Bank's reaction function, the monetary policy interest rate (MPR) is the dependent variable. Since BCCR officially announced the monetary policy rate until June 2011, we use data of different interest rates for the previous quarters. According to Castro & Chaverri (2013) the alternative rate has to be consistent over time and able to capture the stances of monetary policy. Therefore, from 1991 to 1999, we use the Monetary Stabilization Bonds (BEM) rate at six months which at that time was used for the Central Bank to control monetary aggregates[12]. Then, from 2000 to May 2011, we use the indicator of the monetary policy rate (IMPR) of the BCCR built by Castro & Chaverri (2013). The authors selected an interest rate coherent to the definition of the short-term policy rate each one of the five times that the Central Bank

[12] These bonds are now used for debt management.

changed the policy rate definition[13].

The reaction function based on Taylor equation proposes that the Central Bank reacts to inflation deviation from inflation target and output gap. The inflation rate variable was generated as the annual variation of the quarterly average of the Consumer Price Index (CPI) from INEC. Data on inflation expectations at 12 months were available from 2009 from BCCR estimations. We compute the deviation of the both measures to the inflation target. The Central Bank prescribed an official target of inflation from 2008, the data of previous quarters were collected as inflation projections from the Central Bank's Monetary Programs or Macroeconomic Programs. The output gap is calculated for the Central Bank as real GDP minus its trend estimated with a Hodrick-Prescott filter.

The reaction of the policy rate to fiscal variables is assessed by the inclusion of the primary 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. In addition, we include data of the debt interest rate from MH measured as the weighted average rate of Central Government domestic 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. The real exchange growth rate variable was calculated as the quarterly variation of the Multilateral Real Exchange Rate Index with moving weights (ITCERM-PM) from the BCCR. International reserves are included as deviations from its 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. We analyze the full period, and also two sub-periods based on data availability. We analyse the sub-period from 2000-2019 to consider only the time in which data of the policy rate or its indicator was available. The second sub-period goes from 2009 to 2019 and it is limited for the availability of data on inflation expectations and the debt interest rate.

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. 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; trade openness, nominal exchange rate growth and central bank deficit were measured as mentioned previously, and the money base is expressed as GDP percentage. In this case, in addition to the full sample, we study the period previous the break in fiscal variables, 1991-2008. Then, because the period from the structural break was shorter than necessary to implement the proposed

[13] See Tenorio (2008) for details on the changes of the qualitative definitions of the policy rate.

methodology, we include data from 2000-2019 in order to analyse the last two decades and excluding the 90s.

Dummy variables to control for specific financial and fiscal events, structural breaks and exchange regimes changes are defined as follows: bankruptcy of the Banco Anglo Costarricense (D94 = 1, over 1994:Q4, 0 otherwise), structural change on inflation identified by Torres (2012) between April 1999 and April 2004 (D9902 = 1, over period 1999:Q2 - 2002:Q2, 0 otherwise), adoption of crawling band regime from October 2006 to December 2013 (D0613 = 1, over period 2013:Q4 - 2013:Q4, 0 otherwise), adoption of managed float exchange regime from 2014 (D1419 = 1, over 2014:Q1 -2019:Q4, 0 otherwise), the financial crisis impact on economy to the end of 2008 (D08 = 1, over 2008:Q4, 0 otherwise) and 2009 (D09 = 1, over 2009, 0 otherwise), and the entry into force of the Law 9635 in June 2019 (D19 = 1, over 2019:Q3 and 2019:Q4, 0 otherwise).

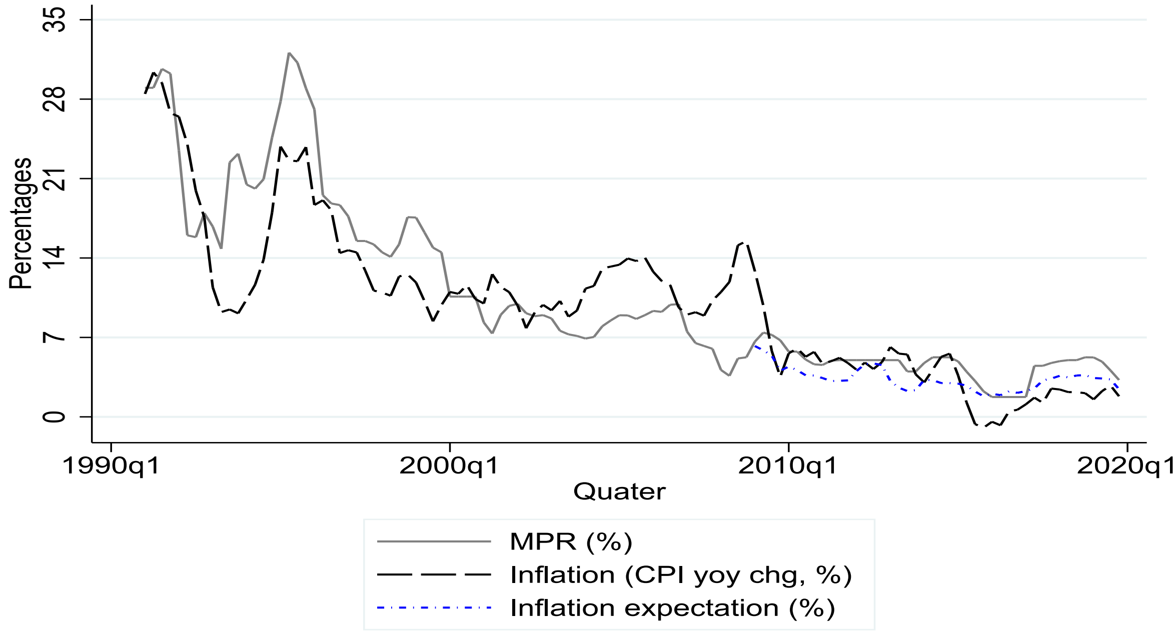
The descriptive statistics of the variables are shown in Table (1). It includes the mean, the standard deviation, and the minimum and maximum value for each variable. The evolution of the series are shown in Figures (4), (5), and Figure (9) in Appendix A. There is a negative trend of the monetary policy 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 9).

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

Variables	Statistics				
	Mean	Std. Dev	Min.	Max.	Obs.
Monetary Policy Rate (%)	10.7	7.8	1.8	32.1	116
Inflation (CPI YoY chg, %)	10.0	6.9	-1.0	30.4	116
Inflation expectation (12 months, %)	3.4	1.0	1.8	6.2	44
Inflation target	8.4	3.9	3.0	18.0	116
Inflation deviation (CPI)	1.6	4.2	-5.0	18.4	116
Inflation expectation deviation	-0.9	1.0	-2.8	0.7	44
Inflation (CPI QoQ chg, %)	2.3	1.8	-0.4	8.2	116
Fiscal deficit (% of GDP)	3.6	2.3	-2.5	12.6	116
Primary deficit (% 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 (% of GDP)	27.3	7.1	15.6	45.7	116
External Debt (% of GDP)	9.9	3.4	3.6	28.4	116
Debt YoY chg (%)	1.4	8.0	-56.8	27.5	115
Domestic Debt interest rate (%)	8.5	2.0	6.7	14.6	44
External Debt interest rate (%)	5.5	1.0	4.1	8.2	44
Monetary base, MB (% of GDP)	6.1	1.0	4.0	8.1	116
Liabilities (% of GDP)	43.4	7.9	28.6	65.6	116
Output Gap	0.0	1.1	-2.3	3.3	116
Real exchange rate growth	-0.2	2.2	-7.5	5.2	115
Nominal exchange rate growth	1.5	2.2	-4.6	9.3	115
International Reserves Gap	0.0	1.2	-4.0	2.7	116
WTI Oil Price growth (%)	7.8	32.3	-53.5	112.4	116
Trade openness (% of GDP)	77.5	10.1	61.4	96.5	116
Current account balance (% of GDP)	-4.3	2.6	-10.7	1.4	84
Deficit of Central Bank (% of GDP)	0.9	0.5	-0.1	2.2	112

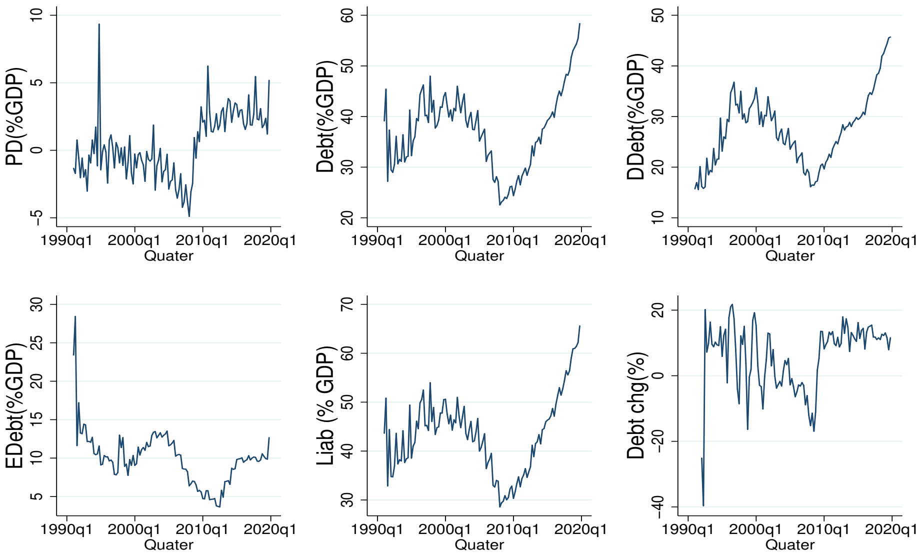
Notes: Std.Dev: standard deviation. Min: minimun. Max: maximun. Obs: number of observations. Variables in changes (or differences) are expressed in quarterly variations (differences), unless otherwise stated. CPI: consumer price index. Source: authors with data from Central Bank of Costa Rica, Finance Ministry, INEC, and Bloomberg.

Figure 4: Monetary policy rate, inflation and inflation expectations



Notes: MPR refers to the monetary stabilization bonds rate from 1991 to 1999, the indicator of the monetary policy rate from 2000 to 2011:Q1, and the official monetary policy rate from 2011:Q2 to 2019. Annual inflation rate is the annual variation of the quarterly average of the Consumer Price Index. Inflation expectations at 12 months data was available from 2009. Source: authors with data from Central Bank of Costa Rica.

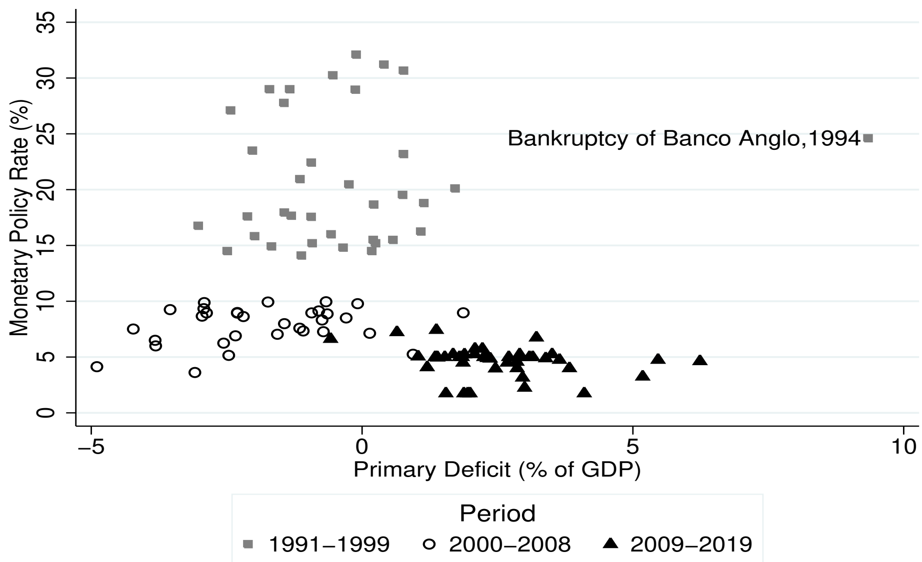
Figure 5: Graphs of fiscal variables



Notes: PD: primary deficit.Debt: total public debt. DDebt: domestic debt. EDebt: external debt. Liab: public liabilities. Debt chg: yoy variation of total debt. Source: authors' elaboration with data from Central Bank of Costa Rica and Finance Ministry.

The graphical analysis also allows us to observe some important relationships between the variables. There is a concentration of the policy rate 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. This might be showing a change in the relationship of the variables, or reflecting a non-linear association, between the policy rate and the fiscal deficit.

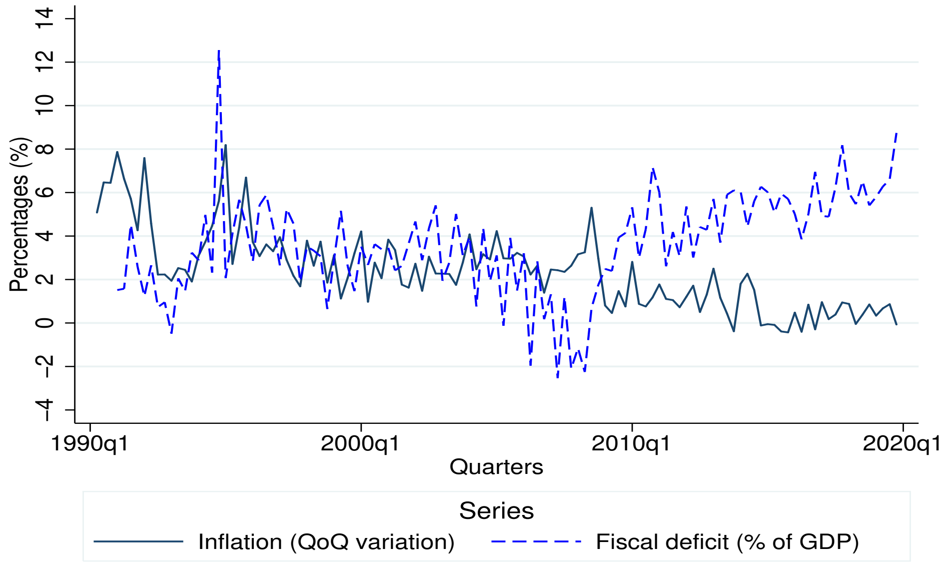
Figure 6: Monetary Policy Rate and Primary Deficit, 1991:Q1-2019:Q4



Notes: Monetary policy rate refers to the monetary stabilization bonds rate from 1991 to 1999, the indicator of the monetary policy rate from 2000 to 2011:Q1, and the official monetary policy rate from 2011:Q2 to 2019. Source: authors' elaboration with data from Central Bank of Costa Rica and Finance Ministry.

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 these variables changed in time, controlling for other variables and issues of time series data to avoid spurious relationships.

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



Notes: Inflation rate is the quarterly variation of the Consumer Price Index. Source: authors' elaboration with data from Central Bank of Costa Rica and Finance Ministry.

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 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[14].

6 Results

6.1 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 10 in Appendix A). That suggested that these variables

[14]Table (10) in the Appendix shows the results of ADF (top panel) and PP (bottom panel) for every variable, under different specifications.

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), which indicated an optimal number of four lags. We also include dummy variables in the VAR model indicating specific financial or fiscal events, and seasonal patterns.

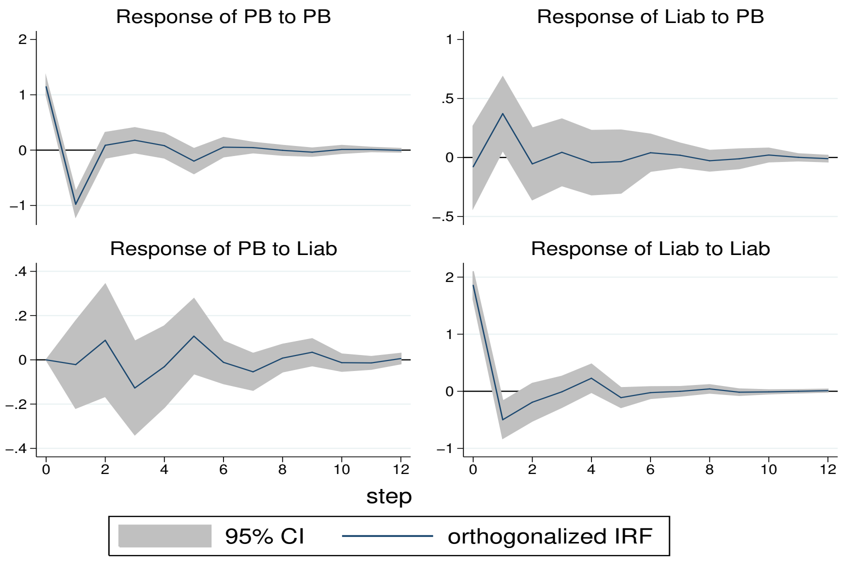
The results of the Granger test of exclusion for every variable and three periods can be seen in Table (2). For the full sample (1991:Q1-2019:Q4), in both cases, the null hypothesis is not rejected, there is no evidence of causality in the Granger sense in any direction. Looking at the IRFs of Figure (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 (see Figure 10 in Appendix). We also check the VAR specification for no residual autocorrelation using the Lagrange Multiplier test for four lags ($\chi^2(4)$= 5.24), which indicates no residual autocorrelation at the 5% level.

Table 2: Granger causality tests of primary balance and public liabilities

Period	Null hypothesis	Chi-square	DoF	P-value
1991:Q1-2019:Q4	Liab does not Granger cause PB	2.21	4	0.70
	PB does not Granger cause Liab	6.47	4	0.17
1991:Q1-2007:Q4	Liab does not Granger cause PB	5.32	4	0.26
	PB does not Granger cause Liab	10.32**	4	0.04
2008:Q1-2019:Q4	Liab does not Granger cause PB	3.73	4	0.44
	PB does not Granger cause Liab	3.29	4	0.51

Notes: Granger causality test for public liabilities and the primary balance. DoF: degrees of freedom. Liab: public liabilities. PB: primary balance. ** indicates significance at 5%. Source: authors' calculations.

Figure 8: Impulse Response Functions between primary balance and public liabilities 1991:Q1-2019:Q4



Notes: Impulse Response Functions are estimated from the results of the VAR model represented in equation (8). Sample period: 1991:Q1-2019:Q4. Liab: liabilities. PB: primary balance. CI: confidence intervals. Source: authors' calculations.

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 sub-sample, there is evidence that the primary balance Granger causes liabilities, this result is in line with a MD regime from 1991 to 2007, but, at the same time, we can not reject the null hypothesis that liabilities do not cause the primary balance, that is consistent with a FD regime. The IRFs stayed very similar to the full sample case, the response of the primary balance to increases of the primary balance in the previous quarter is negative, contrary to the required positive sign for a MD regime (see Figure 11 in Appendix B). For the second sub-sample, the results support the full sample findings, there is not evidence of Granger causality in any direction and the IRFs graphs show that current innovations of none of the variables have a significant effect on the future path of each other (see Figure 12 in Appendix B).

As robustness checks, we run a VAR model for every component of public liabilities variable: public debt and the monetary base. The VAR between the primary balance and public debt can be taken as the reaction function of the fiscal authority to the public debt. In this case, as it was expected, the results for debt are very similar to those previously found for the analysis of the liabilities in the whole period, (see Figure 13 and Table 11 in Appendix B), this similarity was expected due to debt variable represents around an 85% of the public liabilities. However, it contrasts with a previous estimation of the reaction function presented by Lankester-Campos et al. (2020), who found a positive response of the primary balance to debt for period 1970-2018, so, according to the authors, debt was considered to be sustainable in that period.

In the case of the VAR estimation between the primary balance and the monetary base, we reject the null hypothesis that primary balance does not cause the monetary base with a significance of 10% (see Table 11), this might suggest a case of monetary dominance. Then, the IRFs in Figure (14) shows a negative response of the monetary base to a previous increase on its innovations, that may reflect a commitment of the Central Bank to reduce the money supply the periods after the increase, which also give evidence against the hypothesis of fiscal dominance. However, current innovations of the primary balance do not provoke a response on the monetary base neither a positive response on the primary balance in the future, two requirements for a monetary dominant regime. Therefore, we can not conclude either about fiscal or monetary dominance. For this reason, in the next subsections, we use other methodologies to study the interdependence between fiscal and monetary policies.

6.2 Central Bank Reaction Function

The previous results do not allow us to clearly identify a fiscal or monetary dominance regime for Costa Rica in the period of analysis. Additionally, they do not reveal a clear 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:Q1 to 2019:Q4. The results are presented in Table (3), columns from (1) to (5) show regression results of different specifications; for every of them, the estimation method is OLS and the dependent variable is the policy rate, MPR.

The results are very similar in all the specifications. The coefficient of the lagged dependent variable shows a positive and significant inertial component of the policy rate. 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 0.4 on the policy rate (see column 1 Table 3). The inclusion of the linear trend does not change the coefficient so we excluded for the next regressions (see column 2 Table 3). Then, the magnitude of the primary deficit decreases after the inclusion of the international reserves, which might suggest a specification error of the previous model (see column 3 Table 3). The Central Bank deficit, $CBdef$, does not have a significant coefficient, but its inclusion changes the significance of the international reserves variable (see column 4 Table 3). The results keep similar after controlling for a negative outlook of the country by the risk rating agencies (see column 5 Table 3).

Table 3: Estimate of the Reaction Function of the Central Bank to Primary Deficit using OLS

Variables	(1)	(2)	(3)	(4)	(5)
MPR_{t-1}	0.788***	0.758***	0.799***	0.806***	0.807***
	[0.034]	[0.054]	[0.033]	[0.038]	[0.038]
$Inflation\ deviation(CPI)_{t-1}$	0.050	0.052	0.050	0.027	0.030
	[0.095]	[0.096]	[0.086]	[0.120]	[0.120]
$Output\ gap_{t-1}$	0.597***	0.564**	0.583***	0.593***	0.594***
	[0.205]	[0.217]	[0.194]	[0.202]	[0.203]
NER_{t-1}	0.189**	0.193**	0.170***	0.121**	0.111*
	[0.081]	[0.085]	[0.063]	[0.054]	[0.056]
PD_{t-1}	0.404***	0.402***	0.362***	0.351***	0.353***
	[0.082]	[0.085]	[0.071]	[0.072]	[0.072]
$IR\ gap_{t-1}$			-0.364**	-0.227	-0.220
			[0.174]	[0.162]	[0.163]
$DefCB_{t-1}$				-0.242	-0.243
				[0.641]	[0.642]
$Negativeoutlook_{t-1}$					0.588
					[0.469]
$Trend$		-0.015			
		[0.024]			
$Observations$	114	114	114	111	111
$R-squared$	0.965	0.966	0.968	0.968	0.965

Notes: Estimates of the reaction function of the Central Bank using equation (9). Dependent variable: monetary policy rate. Fiscal variable: primary deficit. Estimation method: Ordinary Least Squares. Sample period: 1991:Q1-2019:Q4. Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummies for seasonal patterns, fiscal events, and change of the exchange rate regime. Source: authors' calculations.

The estimation method is OLS and the standard errors are obtained using Newey-West HAC estimator. However, a source of concern is that the results from the unit root tests for the *policy rate* and the $primary\ deficit$ series do not reject the presence of unit roots in all the cases (see Table 10 in Appendix A). To address this issue, we check if the linear combination of the variables cointegrates using an ARLD model with error correction component similar to Shrestha & Semmler (2015) and following the procedure proposed in Pesaran et al. (2001).

The first step is to determine the appropriate lag length, p, and if there is needed to include a linear trend, using the AIC and BIC information criteria, as also the Breusch-Godfrey Lagrange Multiplier(LM) statistic for testing the hypothesis of no serial correlation. Table (12) in Appendix B shows the results. The AIC indicates a larger lag order (p=4) than BIC (p=1), irrespective of whether the linear trend was included or not. However, the LM test for order 1 and 4 ($\chi^2(1)$ and $\chi^2(4)$, respectively) indicates that it is preferable to select a lower lag order of p=1.

Then, the bounds test for testing the existence of a level relationship between the policy rate and the independent variables are presented in Table (13) in Appendix B. We evaluate the results with and without a linear trend, according to Pesaran et al. (2001) the model specifications correspond to Case III of unrestricted constant and no trend, and Case V of unrestricted constant and unrestricted trend. Using five independent variables (k = 5), the values of $F-$ and $t-$statistics are compared with the critical value bounds at 5% (shown in Pesaran et al. 2001). The null hypothesis that there exists no level equation is rejected when using 1 lag[15] for Case III (F=7.9 and t=-4.1) and Case V (F=8.6 and t=-4.6).

These results support the existence of levels equation in the form of the EC model. Therefore, we estimate the levels equation with deterministic trend for an ARDL($p, q_1, ..., q_5$) = ARDL$(1, 1, 1, 1, 1, 1)$. The results are shown in column 1 Table (4), there is no evidence of a relationship between the policy rate and the primary deficit in the long run. Consistently with the previous OLS estimations, the relationship between the policy rate and inflation deviation is not significant, while there is a positive relationship with the output gap and the exchange rate devaluation. The international reserves are negatively related to the primary deficit, as expected, and the magnitude is high. The error correction term of -0.24 indicates that the adjustment to the long-run equilibrium takes around one year.

[15]Due to the test result depend on the selection of the lag order, we tested for p to be equal to either 1 to 4. However, based on the relevance of no serial correlation we decide to use only 1 lag.

Table 4: Estimate of the Reaction Function of the Central Bank to Primary Deficit using ARDL model with EC

Equation Sample	(1) 1991-2019	(2) 1991-2019	(3) 2000-2019
Long-run effects:			
Inflation deviation (CPI)	0.042	0.223	0.720**
	[0.244]	[0.230]	[0.292]
Output gap	1.534*	1.398*	-0.360
	[0.793]	[0.776]	[0.482]
NER chg	1.402**		0.727**
	[0.535]		[0.279]
IR gap	-2.206***	-2.166***	-1.017**
	[0.813]	[0.805]	[0.417]
PD	0.565	0.496	0.552
	[0.666]	[0.651]	[0.411]
RER chg		1.007**	
		[0.412]	
Error Correction	-0.236***	-0.237***	-0.264***
	[0.051]	[0.051]	[0.060]
Observations	114	114	80
R-squared	0.532	0.531	0.616

Notes: Estimates of the levels equation for the reaction function of the Central Bank from the ARDL model with error correction like in equation (10). Dependent variable: monetary policy rate. Fiscal variable: primary deficit. Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

We also estimate a model including the depreciation of the real exchange rate instead of the nominal depreciation, this variable also have a positive and significant effect, and the results of the other variables remained similar (see column 2 Table 4).

Based on Figure (6), there seems to be differences in the relationship between the policy rate and the primary deficit in time. We test through the model if there are changes from 2000, this period only considers data about the indicator of the monetary policy rate (IMPR) and the official policy rate, it means, excluding the part of the series that is made up of BEM's rate. The results are robust, there is no significant long-run effect of the primary deficit on the policy rate. On the other hand, the Central Bank seems to react positively to inflation deviation from target, but not to the output gap in this period (see Column 3 Table 4). This might be reflecting a change in the Central

Bank's stance and its commitment to the control of the price level. Testing the same hypothesis of a possible change over time in the relationship between the variables, we tried to analyse a sub-sample from 2008, but according to the bounds tests, the null hypothesis of no levels equation was not rejected.

In general, the evidence suggests that the Central Bank does not react to the primary deficit in the long run. This result can be interpreted as independence between fiscal and monetary policies. However, there might be a reaction of the policy rate to other variables like public debt or the interest rate paid for debt. We evaluate this. Again, we start analyzing if the policy rate reacts to the debt using OLS method. The results are shown in Table (5). We tried out different measures and forms of the debt variable as: total *Debt* in columns (1) and (2), a quadratic term of total *Debt* in column (3), external debt, *EDebt*, and domestic debt, *DDebt*, in column (4), debt growth, *Debt chg*, in column (5) and, the interest rate paid for the domestic public debt in column (6).

We find a positive and significant reaction of the policy rate to the *Debt chg* and the interest rate paid for the domestic debt. It was consistently found through the regressions a positive and significant effect of the lagged dependent variable, the output gap coefficients and a negative effect of the international reserves in most of the regressions. Results from column (6) are based on a sub-sample from 2009 due to data for the debt interest rate was available from that year. For this specific period we also find a positive and significant reaction of the policy rate to inflation deviation, but not a significant reaction to the international reserves.

Again, being aware of unit root problems for the OLS regressions, we explore for the existence of a long-run relationship between the policy rate and debt growth, and followed the same procedure shown for the primary deficit analysis. Table (14) in Appendix B presents the selection of lag order, and Table (15) in Appendix B shows the bound test for levels the equation. F- and t-statistics remain above the upper bound of critical values when the lag order is 1, indicating the existence of levels relation. We also tried out including other fiscal variables, like the total debt in levels, separating external and domestic debt, and including debt interest rate, but in all these cases the null hypothesis of no long-run relationship is no rejected (see Table 16 in Appendix B).

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

Variables	(1)	(2)	(3)	(4)	(5)	(6)
MPR_{t-1}	0.852***	0.773***	0.776***	0.768***	0.739***	0.652***
	[0.035]	[0.055]	[0.053]	[0.050]	[0.047]	[0.166]
$Inflation\ deviation(CPI)_{t-1}$	0.015	0.026	0.018	0.031	0.088	0.214***
	[0.085]	[0.083]	[0.090]	[0.084]	[0.106]	[0.056]
$Output\ gap_{t-1}$	0.527***	0.460**	0.444*	0.459**	0.567***	0.483**
	[0.199]	[0.210]	[0.224]	[0.210]	[0.207]	[0.189]
NER_{t-1}	0.115	0.120	0.126	0.125	0.072	0.062**
	[0.071]	[0.073]	[0.079]	[0.075]	[0.057]	[0.023]
$IR\ gap_{t-1}$	-0.480**	-0.568***	-0.567***	-0.569***	-0.434***	-0.109
	[0.187]	[0.187]	[0.191]	[0.191]	[0.149]	[0.066]
$Debt_{t-1}$	-0.036	-0.009	-0.112			
	[0.026]	[0.024]	[0.197]			
$Debt * Debt_{t-1}$			0.001			
			[0.002]			
$DDebt_{t-1}$				-0.006		
				[0.024]		
$EDebt_{t-1}$				-0.025		
				[0.074]		
$Debtchg_{t-1}$					0.043*	
					[0.024]	
$Debt\ interest\ rate_{t-1}$						0.128*
						[0.075]
$Trend$		-0.040*	-0.039*	-0.041**	-0.038**	-0.030**
		[0.022]	[0.021]	[0.019]	[0.019]	[0.013]
$Constant$	3.312**	4.905***	6.876	5.140***	4.982***	3.213**
	[1.273]	[1.805]	[4.885]	[1.731]	[1.484]	[1.220]
$Observations$	114	114	114	114	111	43
$R-squared$	0.964	0.965	0.965	0.965	0.964	0.915

Notes: Estimates of the reaction function of the Central Bank using equation (9). Dependent variable: monetary policy rate. Fiscal variables: public debt (Debt), domestic public debt (DDebt), external public debt (EDebt), public debt growth (Debtchg), interest rate of domestic debt. Estimation method: Ordinary Least Squares. Sample period: 1991:Q1-2019:Q4. Newey-West standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummies for seasonal patterns, fiscal events, and change of the exchange rate regime. Source: authors' calculations.

The results of the equations in levels, including debt growth, are presented in Table (6). We estimate four equations that were organized similarly to the previous estimations of the ARDL models. The debt growth has a significant effect on the policy rate of about 0.17% (see Table 6 columns 1 and 2). This effect is lower from 2000, but still significant at 10% (see column 4 Table 6). We find the effects of other variables on the policy rate are similar to those found in the previous estimations. The inflation deviation is positive, but only significant from 2000, contrary to the output gap that presents a significant effect when using the whole sample. The nominal depreciation effect is positive and significant, while the international reserves effect is negative. From 2000, both effects decrease near half, which might be related to the changes in the use of instruments to guide the monetary policy, mainly from 2006 with the adoption of a more flexible exchange rate regime.

Table 6: Estimate of the Reaction Function of the Central Bank to Debt Growth using ARDL model with EC

Equation Sample	(1) 1991-2019	(2) 1991-2019	(3) 2000-2019
Long-run effects:			
Inflation deviation (CPI)	0.331	0.384	0.724***
	[0.318]	[0.329]	[0.253]
Output gap	2.205**	2.024**	-0.393
	[0.872]	[0.854]	[0.417]
NER chg	1.245**		0.593**
	[0.542]		[0.225]
IR gap	-1.855**	-1.822**	-0.944***
	[0.766]	[0.771]	[0.352]
Debt chg	0.182**	0.168**	0.104*
	[0.081]	[0.083]	[0.055]
RER chg		0.771*	
		[0.430]	
Error Correction	-0.240***	-0.241***	-0.311***
	[0.056]	[0.057]	[0.064]
Observations	111	111	80
R-squared	0.475	0.462	0.606

Notes: Estimates of the levels equation for the reaction function of the Central Bank from the ARDL model with error correction like in equation (10). Dependent variable: monetary policy rate. Fiscal variable: debt growth. Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

According to Kripfganz & Schneider (2018), in the cases that we do not find evidence of a cointegration equation, a model in first differences can be estimated using OLS. Therefore, we run in first differences some models from 2009-2019 to consider variables that are only available for that period, like inflation expectations and the debt interest rate (see Table 7). Considering inflation expectations in the model is particularly relevant in a monetary regime of inflation targeting. According to Torres (2002), when inflation expectations deviate from its target the central bank acts accordingly to ensure the convergence of expected inflation and eventually of inflation to the inflation target.

The results referent to the fiscal variables indicate that the primary deficit and debt growth do no have a significant effect (Table 7 column 1 and 2), but the there is evidence that the policy rate reacts positively to the debt interest rate (column 4 Table 7). The magnitude of debt interest rate coefficient is consistent with the OLS estimation in levels of Table (5). The magnitude also remains in first differences when considering the inflation expectation deviation, but due to a low degree of freedom the coefficient was no significant (column 3 Table 7).

The inflation deviation from the target has a positive and significant coefficient, while deviation from expected inflation is also positive, but not significant. All the other variables, except the output gap, have the expected sign but the significance does no remains through the four estimations, which seems to be due to the small sample size.

Table 7: Estimate of the Reaction Function of the Central Bank (First Differences)

Variables	(1)	(2)	(3)	(4)
$Inflation\ deviation(CPI)_{t-1}$	0.137*	0.127	0.150*	0.153*
	[0.077]	[0.086]	[0.075]	[0.076]
$Inflation\ exp.\ deviation(CPI)_{t-1}$	0.093	0.111	0.070	
	[0.094]	[0.138]	[0.103]	
$Output\ gap_{t-1}$	-0.177	-0.148	-0.071	-0.070
	[0.277]	[0.281]	[0.325]	[0.335]
NER_{t-1}	0.043	0.051*	0.032	0.038
	[0.030]	[0.029]	[0.029]	[0.027]
$IR\ gap_{t-1}$	-0.114	-0.090	-0.151*	-0.162*
	[0.088]	[0.098]	[0.087]	[0.082]
PD_{t-1}	-0.032			
	[0.060]			
$Debt\ chg_{t-1}$		-0.013		
		[0.036]		
$Debt\ interest\ rate_{t-1}$			0.136	0.139*
			[0.084]	[0.081]
$Constant$	-0.241*	-0.243*	-0.227*	-0.217*
	[0.138]	[0.143]	[0.123]	[0.123]
$Observations$	42	42	42	42
$R-squared$	0.265	0.264	0.303	0.298

Notes: Estimates of the reaction function of the Central Bank.Testing for the effect of the public debt on the monetary policy rate. Estimation method: Ordinary Least Squares. 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 of the exchange rate regime. Source: authors' calculations.

Then, we estimate the ARDL models with error correction term with some variations to check the robustness of our results. First, we use the passive basic interest rate (PIR) as dependent variable. It was used as the interest rate of the monetary policy in the reaction function estimated by Muñoz & Sáenz (2003)[16] and, according to Castro & Chaverri (2013), this one has near relation to the indicator of the policy rate. The results support the sign and statistical significance of our findings on the effects of the debt growth on the policy rate, as also confirmed there is no a significant effect of the primary deficit (see columns 1 and 2 Table (17) in Appendix B).

We also try out different specifications of the levels equation (see Table 17 in Appendix B). We consider a variable representing a negative outlook from the risk rating agencies that may have an impact on the policy rate, but there was not an effect and the results of the fiscal variables remain. We also test if there was a better assessment of monetary policy dynamics when considering other external variables like the current account and trade openness (Afonso et al. 2019, Karagiannides & Liambas 2019). The primary deficit results hold after the inclusion of trade openness and the coefficients of this variable was no significant. Data for the current account variable was available from 1999, with its inclusion in the equation the Debt chg was still positive and significant (see Table 17 in appendix B).

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 is no significant when the dependent variable is the passive interest rate or when the model is estimated in a sample from 2000. There are other variables that we consider important to include, for example the Central Bank deficit, and the inflation expectations deviation from target, however, according to the bound tests, in those cases the null hypothesis of no levels equation is not rejected (see Table 18).

In summary, the results of the OLS model initially suggest that the policy rate reacts positively to increases in the primary deficit, the growth of total debt and the domestic debt interest rate. However, to prevent making conclusions on spurious results, we evaluate the existence of cointegration relations between the policy rate and the fiscal variables by applying ARDL model with errors correction. We find evidence that, in the long run, the policy rate reacts positively to the growth of debt, but not to the fiscal deficit. We also find some evidence of a positive effect of the domestic debt interest rate on the policy rate in the 2009-2019 period.

These results suggest that the Central Bank does not consider the actions of fiscal policy in its reaction function. Financing pressures from the Central Government can affect inflation, and therefore the policy rate, through at least two channels. First, because the public debt is mostly domestic, a higher demand for public financing may lead to

[16] 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.

pressures in the financial market, reduce credit to the private sector, and increase local interest rates. In this scenario, the Central Bank would be expected to reduce the policy rate to lower debt burden, however, the evidence indicates that it increases it. Second, in developing countries the country risk rating is very sensitive to the level of debt and the fiscal outlook (Lozano-Espitia & Julio-Román 2020). An increase in country risk can affect interest rates and the exchange rate, but when we controlled for this variable the positive effect of the policy rate remain, indicating this was not the channel.

On one hand, this result is in line with the findings of Muñoz & Sáenz (2003) of a positive effect of domestic debt on the dependent variable. They explain it as a direct relationship between the need for government financing and the absorption needs of the Central Bank, through the interest rate that these institutions have to offer in the auction joint. On the other hand, Obando (2017) found an effect of the fiscal deficit in the long and medium run on the basic passive interest rate and indicated that the need for domestic financing to cover the fiscal gap was affecting interest rates.

6.3 Inflation and Fiscal Deficit

The previous finding provides evidence of a positive reaction of the policy rate to debt growth. One hypothesis is that the Central Bank reaction is positive when it faces the pressure of competing with the Finance Ministry for resources to finance the debt. 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 central banks have to use seigniorage to finance government expenditure. We study this topic for Costa Rica following Catão & Terrones (2005) work, who applied an ARDL model to evaluate the long-run relationship between fiscal deficit and inflation.

First, we test for the order of integration of the inflation rate and the fiscal deficit (see Table 10) 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. We implement an ARDL model due to its advantages (see Subsection 5.2) in addressing this kind of problems. Following the same procedure than in Sub-section 6.2, we started by selecting the lag order of the ARDL model. Based on the AIC and BIC criteria, $p = 1$ was the optimal lag order. The LM statistic for testing the hypothesis of no serial correlation for order 1 and 4 ($\chi^2(1)$ and $\chi^2(4)$, respectively) confirms that it is preferable to select a lower lag order of p=1 (see Table 19).

Then, we test for the the null hypothesis that there exists no level relation between the inflation rate and the fiscal deficit applying Pesaran et al. (2001) bounds test. The model specifications correspond to Case III of unrestricted constant and no trend. The values of $F-$ and $t-$statistics are compared with the critical value bounds at 5% (shown in Pesaran et al. 2001) according to the k number of independent variables. We tested for p to be equal to 1 based on the relevance of no serial correlation. The null hypothesis was rejected in all cases (see Table 20).

These testing results support the existence of levels equation in the specification of the conditional ECM. We estimate the levels equation from an ARDL$(p, q_1 ... q_k)$ with one lag in all the variables, the results are shown in Table (8). We present six different models to test for different specifications, all of them include short-run effects and dummy variables that control for some financial events, changes in the monetary regimes and seasonal patterns. The long-run effect of the fiscal deficit on inflation is positive, significant at 5% or 1% and with a magnitude near 0.26 in almost all regressions. This implies that an increase of 1% of the fiscal deficit to the GDP increases inflation by 0.26 percentage points on average, holding other factors constant. Column (1) Table (8) shows the result of considering only the long-run effect of fiscal deficit on inflation. From column (2) Table (8), we include the oil price change variable, which also has a positive and significant effect on long-run inflation, with a lower magnitude of around 0.01.

The monetary base coefficient has not a significant impact on the long run (column 3 Table 8). The exchange rate depreciation coefficient is positive and significant (column 4 Table 8), indicating the increase in inflation when the colon depreciates respect to the US dollar, which is our chosen model. We also included trade openness (column 5 Table 8) and the deficit of the Central Bank to the GDP (column 6 Table 8), but none of them had a significant long-run impact on inflation. These results suggest that in the long-run inflation has a relationship with the fiscal deficit, the oil prices and the nominal exchange rate. The estimated error correction coefficient, ϕ, in equation (12), is negative and near 0.8 in all regressions, which indicates that a deviation from equilibrium will converge toward long-run levels mostly in one quarter.

Table 8: Estimate of the long-run effect of fiscal deficit on inflation

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Long-run effects:						
Fiscal deficit	0.267***	0.263***	0.221**	0.262**	0.253**	0.252**
	[0.098]	[0.100]	[0.099]	[0.101]	[0.099]	[0.099]
Oil price chg		0.010**	0.010**	0.010**	0.011***	0.011***
		[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Monetary base			0.066			
			[0.208]			
NER chg				0.227***	0.249***	0.248***
				[0.080]	[0.080]	[0.080]
Trade openness					-0.024	-0.024
					[0.029]	[0.029]
CB Deficit						0.146
						[0.428]
Error Correction	-0.795***	-0.792***	-0.809***	-0.783***	-0.794***	-0.795***
	[0.081]	[0.082]	[0.082]	[0.083]	[0.083]	[0.084]
Observations	111	111	111	111	111	111
R-squared	0.641	0.641	0.651	0.644	0.653	0.653

Notes: Estimate of the long-run effect of fiscal deficit on inflation from an ARDL model with error correction like in equation (12). Dependent variable: inflation rate (QoQ variations). Fiscal variable: fiscal deficit. Sample period: 1991:Q1-2019:Q4. Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change of the exchange rate regime. Source: authors' calculations.

According to Kripfganz & Schneider (2018), the use of the bounds test requires error terms to be homoskedastic, serially uncorrelated and normally distributed. Table (21) shows the post estimation diagnostic tests of the error distribution assumptions of the six models previously estimated. For our core model (column 4 Table 21) the null hypothesis of no serial correlation was rejected with a significance of 10% under the LM test, so we applied the Durbin's alternative test of no serial correlation to check that result and now the null hypothesis was not reject. Therefore, we conclude there is a levels equation.

Previously, we observed in Figure (5) that the relationship between inflation and fiscal deficit seems to have changed from the financial crisis to the end of 2008. 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 9). The first sample considers quarters from 1992:Q2 to 2008:Q4 for models on the form ARDL($p, q_1 ... q_k$) with one lag. First, we estimated a more parsimonious model including only the fiscal deficit and those variables that were significant at least at 10%, in this case the oil prices was significant. The fiscal deficit was also significant with a magnitude around of 0.32 (see column 1 Table 9).

Then, we estimated a full model, including the fiscal deficit and all the explanatory variables considered in the full sample model. This time we only find a significant long-run effect of oil prices on inflation that was positive and close lo 0.01, while the fiscal deficit had a positive sign and was significant with a p-value of 0.105 (see column 2 Table 9). Because we might have dealing here with low power due to the sample size, we decided to keep only the fiscal deficit and those variables with a significant effect on inflation. The EC term is over 0.8 and significant in both models. The test bounds (Table 22) and diagnostic test (Table 23) are presented in the Appendix B.

Then, we explore for a relationship in the period 2000:Q1-2019:Q4[17] using the parsimonious model (column 3 Table 9). The fiscal deficit effect on inflation is not statistically different from zero, while the nominal exchange rate and the change in oil prices seem to have a positive and significant long-run effect on inflation. Then, we estimate the full model and the previous findings were confirmed, the fiscal deficit does not affect inflation and only the nominal exchange rate and the change in oil prices seem to have a significant long-run effect on inflation in that period (column 4 Table 9). The EC coefficient was negative and significant in all the regressions, but this was higher for the equations estimated in the second period, which indicates a that there is a faster adjustment to the equilibrium from 2000. The test bounds (Table 22) and diagnostic test (Table 23) are presented in the Appendix B.

[17]We included the period from 2000 to 2008 for no limiting the degrees of freedom for the analysis.

Table 9: Long-run effect of fiscal deficit on inflation

Equation Sample	(1) 1992:Q1-2007:Q4	(2) 1992:Q1-2007:Q4	(3) 2000:Q1-2019:Q4	(4) 2000:Q1-2019:Q4
Long-run effects:				
Fiscal deficit	0.317**	0.270	0.006	-0.010
	[0.154]	[0.163]	[0.126]	[0.119]
Oil price chg	0.012**	0.013**	0.010***	0.007*
	[0.006]	[0.006]	[0.003]	[0.004]
Monetary base		0.122		-0.272
		[0.277]		[0.273]
NER chg		0.224	0.175**	0.168**
		[0.187]	[0.067]	[0.067]
Trade openness		-0.042		0.026
		[0.036]		[0.040]
CB Deficit		0.184		-0.604
		[0.605]		[0.419]
Error Correction	-0.810***	-0.822***	-0.915***	-0.904***
	[0.126]	[0.131]	[0.133]	[0.126]
Observations	67	67	80	80
R-squared	0.666	0.683	0.679	0.736

Notes: Estimate of the long-run effect of fiscal deficit on inflation from an ARDL model with error correction like in equation (12). Dependent variable: inflation rate (QoQ variations). Fiscal variable: fiscal deficit. Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change of the exchange rate regime. Source: authors' calculations.

As robustness checks, we use as dependent variable the inflation measured as CPI annual variations instead of the quarterly variation. The coefficient of the fiscal deficit was positive and significant for the whole sample and the first period (see column 1 and 2 Table 24 in Appendix B). In both cases the magnitude of the effect was considerably higher than when using the quarterly variation of inflation, the higher size represents an accumulated effect of the fiscal deficit on the annual variation of inflation. Consistently with the previous results, not a significant effect of the fiscal deficit on inflation is found in the second period (see column 3 Table 24 in Appendix B). The lower EC coefficient indicates that the adjustment to the equilibrium takes place more slowly than when analysing quarterly data.

Another robustness check was to estimate the effect of the primary deficit instead of the fiscal deficit (see columns 4 to 6 of Table 24 in Appendix B). The results supported the finding of a positive effect of the budget deficit on inflation for the whole sample (column 4 Table 24) and the first period sample (column 5 Table 24), with a higher magnitude, mainly in the first period.

In general, according to the results, there is some evidence of a positive long-run effect of the fiscal deficit on inflation in the 90s when Costa Rica showed an annual inflation rate average of around 14%. Then, for the period in which the country showed an average inflation rate of one digit, there is no evidence of a relationship. Our finding is in line with those found by Catão & Terrones (2005), that concluded that budget deficits are inflationary in developing and high inflation countries.

7 Concluding Remarks

As stated at the beginning of this document, its main objective is to contribute to the literature on the interdependence between fiscal and monetary policies for developing countries, but also to provide the Central Bank of Costa Rica with information 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, we found that primary balances were exogenously determined by public liabilities in a VAR model. However, there was some evidence that the primary balance Granger causes public liabilities, and specifically the monetary base. These results are mixed and do not allows us to determine clearly a monetary or fiscal regime. This problem is common in the empirical literature that has applied this approach. In addition, this methodology does not reveal clearly the reaction of the monetary authority to the fiscal policy.

Therefore, the second methodology intended to provide evidence on the relationship between the Central Bank's monetary policy rate and the fiscal variables by estimating the augmented Taylor rule with the inclusion of determinants such as the primary deficit, debt growth and the debt interest rate. We implemented regression analysis and also evaluated the existence of cointegration relations between the policy rate and the fiscal variables by applying ARDL model with EC term.

We find evidence that, in the long run, the policy rate reacts positively to the growth of debt, but not to the fiscal deficit. We also find evidence of a positive effect of the domestic debt interest rate on the policy rate in the 2009-2019 period. These results suggest that the Central Bank does not accommodate to fiscal policy actions. For example, as the public debt is mostly domestic, a higher demand for public financing leads to pressures in the financial market, reduce credit to the private sector, and increase local interest rates. In such as counter-cyclical scenario, the central bank is expected to reduce the policy rate, however, the evidence indicates that it increases it. Additionally, we discard the increase in the policy rate was generated in response of a negative outlook in the country risk.

Finally, the third approach, an ARDL model with EC, was implemented to provide evidence on the long-run effects of fiscal deficits on inflation. This analysis revealed a long-run effect of the fiscal deficit on inflation, mainly before 2008. For the Costa Rican case, our findings seem to be in line with the conclusion of Catão & Terrones (2005), who argue that fiscal deficits are inflationary in developing countries with already high inflation rates.

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 figures for fiscal deficit increased to 8.7% of GDP and the government debt reached 68% 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 countercyclically 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. These pressures are probably going to increase and push for a higher coordination degree between the authorities.

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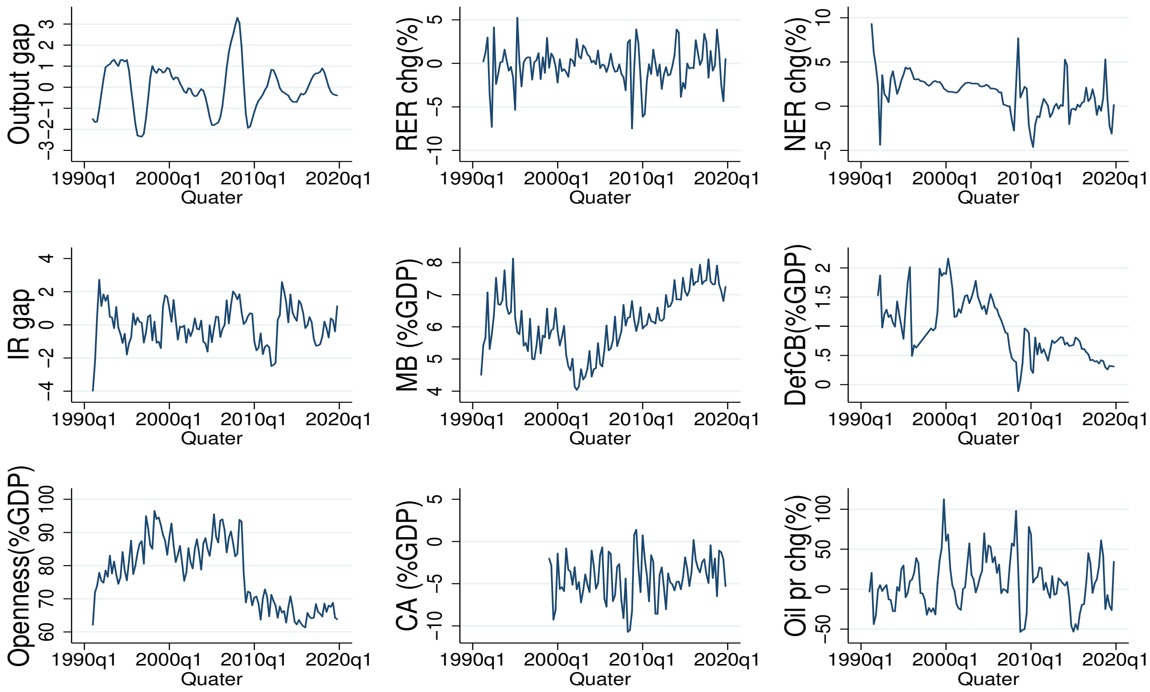
Appendix

A Data

Figure 9: Graphs of control variables, 1991:Q1-2019:Q4



Notes: 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).

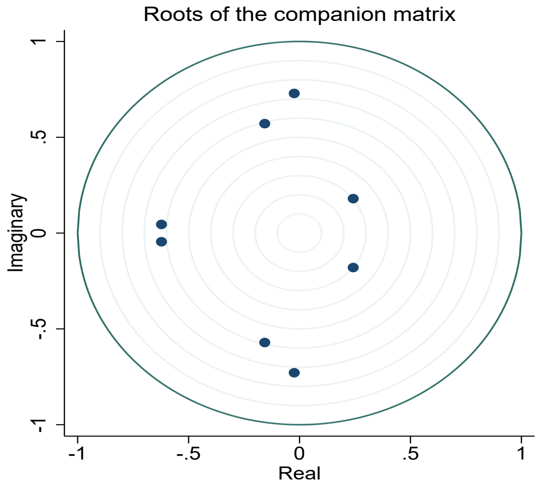
Table 10: Unit root tests

Variables	Augmented Dicky-Fuller test				
	(1) NCNT	(2)CNT	(3) CT	(4)Diff.	Lags
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
Inflation deviation (CPI)	-4.90 ***	-4.89 ***	-5.11 ***	-8.73 ***	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
Variables	Phillips-Perron test				
	(1) NCNT	(2)CNT	(3) CT	(4)Diff.	Lags
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
Inflation deviation (CPI)	-4.06 ***	-4.03 ***	-4.18 ***	-9.90 ***	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

Notes: Unit root tests for different specifications (NCNT: Without intercept nor trend; CNT:With intercept without trend; CT: With intercept and trend; Diff: First differences). ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' elaboration with data from BCCR, MH, INEC.

B Supplementary Tables and Figures

Figure 10: VAR's stability graphic test



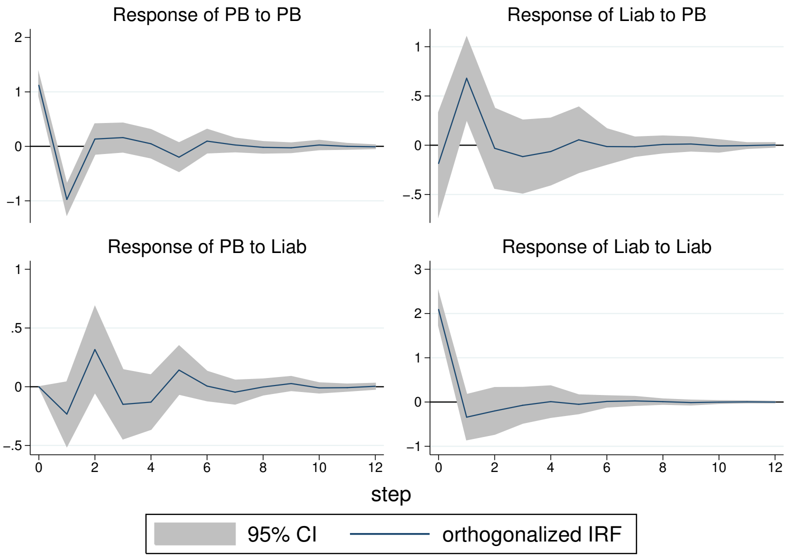
Notes: Stability graphic test estimated from the results of the VAR model represented in Equation (8). Sample period: 1991:Q1-2019:Q4. Source: authors' calculations.

Table 11: Granger causality tests: primary deficit and public debt (or monetary base)

Null hypothesis	Chi-square	DoF	P-value
Debt does not Granger cause PB	2.20	4	0.70
PB does not Granger cause Debt	6.27	4	0.18
MB does not Granger cause PB	4.34	4	0.36
PB does not Granger cause MB	8.71*	4	0.07

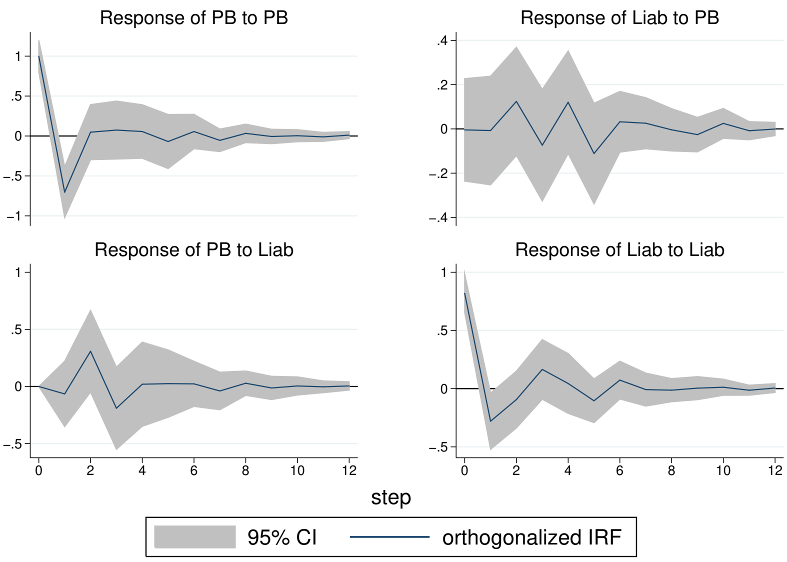
Notes: Granger causality test for primary balance and public debt (or monetary base). DoF: degrees of freedom. MB: monetary base. PB: primary balance. MB: monetary base. * indicates significance at 10%. Source: authors' calculations.

Figure 11: Impulse Response Functions between primary balance and public liabilities, 1991:Q1-2007:Q4



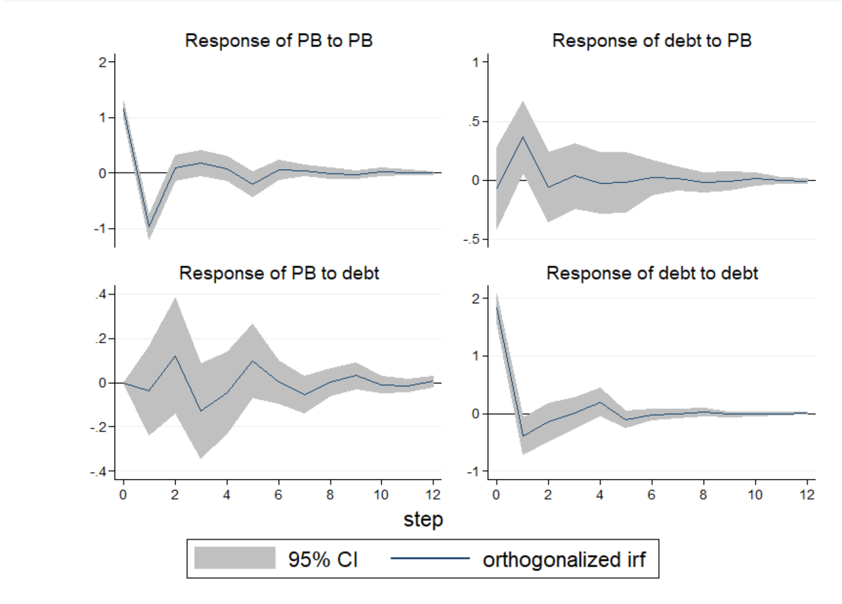
Notes: Impulse Response Functions are estimated from the results of the VAR model represented in Equation (8). Sample period: 1991:Q1-2007:Q4. Liab: liabilities. PB: primary balance. CI: confidence intervals. Source: authors calculations.

Figure 12: Impulse Response Functions between primary balance and public liabilities, 2008:Q1-2019:Q4



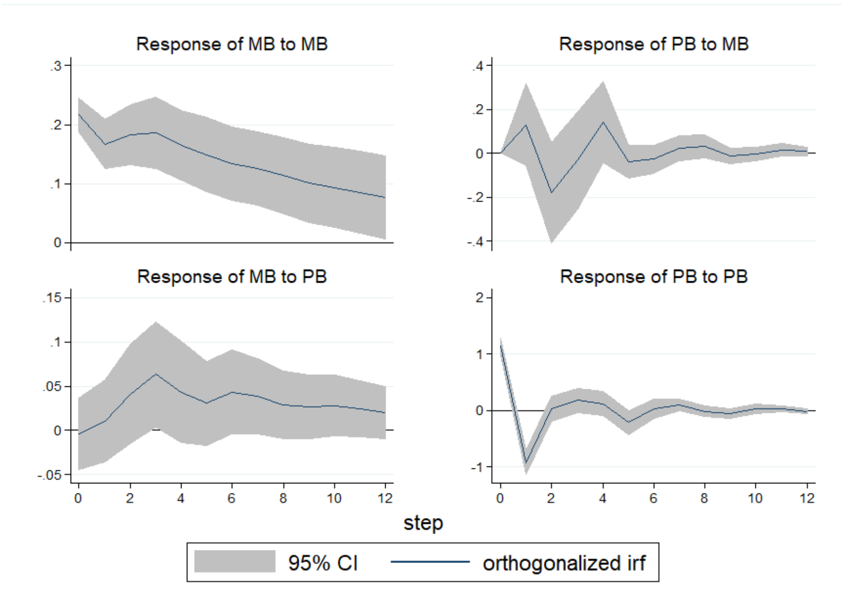
Notes: Impulse Response Functions are estimated from the results of the VAR model represented in Equation (8). Sample period: 2008:Q1-2019:Q4. Liab: liabilities. PB: primary balance. CI: confidence intervals. Source: authors' calculations.

Figure 13: Impulse Response Functions between primary balance and public debt



Notes: Impulse Response Functions are estimated from the results of the VAR model using a modified version of equation (8), where public liabilities variable (Liab) is replaced by public debt. Sample period: 1991:Q1-2019:Q4. PB: primary balance. CI: confidence intervals. Source: authors' calculations.

Figure 14: Impulse Response Functions between primary balance and monetary base



Notes: Impulse Response Functions are estimated from the results of the VAR model using a modified version of equation (8), where public liabilities variable (Liab) is replaced by monetary base. Sample period: 1991:Q1-2019:Q4. MB: monetary base. PB: primary balance. CI: confidence intervals. Source: authors' calculations.

Table 12: Statistics for selecting the lag order of the ARDL model that includes the primary deficit

p	Without deterministic trend				With deterministic trend			
	AIC	BIC	$\chi^2(1)$	$\chi^2(4)$	AIC	BIC	$\chi^2(1)$	$\chi^2(4)$
1	414.4	469.1	1.7	4.4	410.8	468.3	2.2	4.9
2	403.7	474.6	6.8***	10.4**	395.8	469.4	3.6*	5.4
3	392.4	479.4	8.0***	14.6***	392.4	482.2	5.9**	11.2**
4	390.0	492.9	7.7***	16.3***	391.6	497.3	7.7***	16.4***

Notes: p is the lag order of the ARDL model for the conditional EC model in equation (10) with and without deterministic trend. It shows the statistics for AIC and BIC information criteria, Breusch-Godfrey Lagrange Multiplier (χ^2) for 1 and 4 lags. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 13: F- and t-statistics for testing the existence of a levels equation: including primary deficit

p	Case III		Case IV	
	F	t	F	t
1	7.9***	-4.1*	8.6***	-4.6**
2	5.8***	-4.1**	7.2***	-5.1**
3	4.6**	-3.5	4.3*	-3.3
4	3.4	-3.7*	2.7	-2.8

Notes: It shows the F- ant t- statistics for testing the existence of a levels equation. p is the lag order of the ARDL model for the conditional EC model in equation (10) with and without deterministic trend. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 14: Statistics for selecting the lag order of the ARDL model that includes the growth of public debt

p	Without deterministic trend				With deterministic trend			
	AIC	BIC	$\chi^2(1)$	$\chi^2(4)$	AIC	BIC	$\chi^2(1)$	$\chi^2(4)$
1	403.1	457.3	4.3	4.4	401.6	458.5	2.2	4.6
2	397.8	468.0	9.4*	10.4**	386.7	459.6	4.2**	6.8
3	395.2	481.3	15.6***	14.6***	388.4	477.2	5.2**	8.7**
4	385.7	487.6	18.5***	16.3***	384.3	488.9	0.7	14.5***

Notes: p is the lag order of the ARDL model for the conditional EC model in equation (10) with and without deterministic trend. It shows the statistics for AIC and BIC information criteria, Breusch-Godfrey Lagrange Multiplier (χ^2) for 1 and 4 lags. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 15: F- and t-statistics for testing the existence of a levels equation: including debt growth

p	Case III		Case IV	
	F	t	F	t
1	6.9***	-4.2**	7.3***	-4.6*
2	3.9*	-3.3	6.1***	-4.8**
3	3.6*	-2.5	4.8**	-3.6
4	3.5	-3.7*	3.4	-3.6

Notes: It shows the F- ant t- statistics for testing the existence of a levels equation. p is the lag order of the ARDL model for the conditional EC model in equation (10) with and without deterministic trend. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 16: F- and t-statistics for testing the existence of a levels equation: including other fiscal variables

		Statistics	
Fiscal variable	k	F	t
Debt	5	7.2*	-3.4
EDebt and DDebt	6	6.1**	-3.3
Debt interest rate	6	5.6*	-3.3

Notes: It shows the F- ant t- statistics for testing the existence of a levels equation. k is the number of independent variables of the ARDL model for the conditional EC model in equation (10) with 1 lag and without deterministic trend. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 17: Estimate of the levels Reaction Function of the Central Bank: Robustness Checks

Dependent Variable	Passive interest rate		Monetary policy rate			
Equation	(1)	(2)	(3)	(4)	(5)	(6)
Long-run effects:						
Inflation deviation (CPI)	-0.133	-0.025	0.066	0.373	0.010	0.834**
	[0.214]	[0.268]	[0.239]	[0.311]	[0.250]	[0.370]
Output gap	0.878	1.111	1.483*	2.142**	1.511*	-0.055
	[0.683]	[0.672]	[0.782]	[0.852]	[0.791]	[0.655]
NER chg	1.349***	1.151***	1.351**	1.204**	1.429**	0.812**
	[0.451]	[0.418]	[0.529]	[0.534]	[0.552]	[0.343]
IR gap	-2.209***	-2.287***	-2.178***	-1.823**	-2.205***	-1.132**
	[0.691]	[0.643]	[0.803]	[0.751]	[0.811]	[0.529]
Primary deficit (% of GDP)	0.462		0.580		0.422	
	[0.570]		[0.659]		[0.685]	
Debt chg		0.157**		0.178**		0.173**
		[0.068]		[0.080]		[0.076]
Openness (% of GDP)					-0.093	
					[0.153]	
Negative outlook			2.644	2.960		
			[3.972]	[3.908]		
CA						-0.083
						[0.294]
Error Correction	-0.266***	-0.277***	-0.239***	-0.244***	-0.238***	-0.225***
	[0.054]	[0.054]	[0.051]	[0.056]	[0.051]	[0.052]
Observations	114	111	114	111	114	83
R-squared	0.559	0.581	0.540	0.488	0.536	0.578

Notes: Estimates of the levels equation for the reaction function of the Central Bank from the ARDL model with error correction like in equation (10). Standard errors in brackets. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 18: F- and t-statistics for testing the existence of a levels equation: including other control variables

Equation	Variable	k	F	t
	Equations including the primary deficit and:			
(1)	Deficit of Central Bank (% of GDP)	6	5.9**	-3.8
(2)	Current account balance (% of GDP)	6	5.3***	-3.9
(3)	Inflation Expectation deviation	6	4.5*	-3.0
(4)	Inflation Expectation deviation (SM)	6	5.6*	-3.0
	Equations including debt growth and:			
(5)	Deficit of Central Bank (% of GDP)	6	6.1***	-4.2
(6)	Trade openness (% of GDP)	6	6.2***	-4.2
(7)	Inflation Expectation deviation	6	4.3	-2.9
(8)	Inflation Expectation deviation (SM)	6	5.5*	-3.0

Notes: Bound tests for cointegration relation: F- ant t- statistics for testing the existence of a levels equation. k: number of independent variables. SM: secondary market ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 19: Statistics for selecting the lag order of the inflation equation

	Statistics			
p	AIC	BIC	$\chi^2(1)$	$\chi^2(4)$
1	291.1	337.1	2.2	7.9*
2	293.3	344.7	4.9**	8.3*
3	294.3	351.2	3.9**	7.7
4	297.0	359.3	4.5**	7.7

Notes: p is the lag order of the ARDL model for the conditional EC model in equation (12) without deterministic trend. It shows the statistics for AIC and BIC information criteria, Breusch-Godfrey Lagrange Multiplier (χ^2) for 1 and 4 lags. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 20: F- and t-statistics for testing the existence of a levels equation of inflation

Statistics	Equations (1)	(2)	(3)	(4)	(5)	(6)
F-statistic	51.6***	33.5***	26.0***	24.5***	20.4***	16.8***
t-statistic	-9.8***	-9.7***	-9.9***	-9.5***	-9.6***	-9.5***
k	1	2	3	3	4	5

Notes: Bound tests for cointegration relation: F- ant t-statistics for testing the existence of a levels equation for regressions in Table (8). *k*: number of independent variables. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 21: Diagnostic tests for the inflation equation

Test	Statistic	Equations (1)	(2)	(3)	(4)	(5)	(6)
LM test for autocorrelation[1]	χ^2	2.2	2.4	3.0*	3.1*	1.5	1.7
Durbin's alternative test[1]	F	1.9	2.0	2.5	2.6	1.2	1.4
Breusch-Pagan / Cook-Weisberg test[2]	χ^2	1.2	1.2	3.2*	2.6	1.9	2.0
IM test for Skewness[3]	χ^2	19.8	19.7	15.6	21.3	26.1	29.1*
IM test for Kurtosis[3]	χ^2	1.3	1.3	1.4	1.2	0.7	0.7

Notes: Diagnostic tests for the levels equations in Table (8). * indicates significance at 10%. LM: Lagrange Multiplier. IM: Cameron and Trivedi´s information matrix. Null hypothesis: 1/no serial correlation, 2/constant variance, 3/Normality. Source: authors' calculations.

Table 22: F- and t-statistics for testing the existence of a levels equation of the inflation: Subsample analysis

Statistic	Equations (1)	(2)	(3)	(4)
F-statistic	14.0***	6.2***	13.2***	8.8***
t-statistic	-6.4***	-6.3***	-6.9***	-7.2***
k	2	6	3	6

Notes: Bound tests for cointegration relation: F- ant t- statistics for testing the existence of a levels equation for regressions in Table (9). *k*: number of independent variables. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 23: Diagnostic tests for the inflation equation: Subsamples analysis

Test	Statistic	Equations (1)	(2)	(3)	(4)
LM test for autocorrelation[1]	χ^2	2.00	0.17	2.59	1.79
Durbin's alternative test[1]	F	1.50	1.29	2.04	1.33
Breusch-Pagan / Cook-Weisberg test[2]	χ^2	1.81	3.21*	0.37	0.71
IM test for Skewness[3]	χ^2	14.6	25.56	17.83	8.07
IM test for Kurtosis[3]	χ^2	0.95	0.13	0.69	6.09**

Notes: Diagnostic tests for the levels equations in Table (9). * indicates significance at 10%. LM: Lagrange Multiplier. IM: Cameron and Trivedi´s information matrix. Null hypothesis: 1/no serial correlation, 2/constant variance, 3/Normality. Source: authors' calculations.

Table 24: Estimates of the long-run effect of fiscal deficit on inflation: Robustness Checks

Dependent Variable	Inflation (YoY chg)			Inflation (QoQ chg)		
Equation	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All	1992-2008	2000-2019	All	1992-2008	2000-2019
Long-run effects:						
Fiscal deficit	1.537**	2.039**	-0.111			
	[0.663]	[0.792]	[0.446]			
Primary deficit				0.366***	0.566***	0.180
				[0.126]	[0.189]	[0.146]
Oil price chg	0.074**	0.077**	0.042**	0.010***	0.014**	0.009**
	[0.028]	[0.036]	[0.018]	[0.004]	[0.006]	[0.003]
NER chg	0.716		0.185	0.231***		0.180***
	[0.481]		[0.229]	[0.080]		[0.064]
Error Correction	-0.212***	-0.243***	-0.350***	-0.772***	-0.782***	-0.930***
	[0.042]	[0.063]	[0.072]	[0.082]	[0.126]	[0.132]
Observations	111	67	80	111	67	80
R-squared	0.440	0.440	0.564	0.653	0.662	0.686

Notes: Estimate of the long-run effect of fiscal deficit on inflation from an ARDL model with error correction like in equation (12). Standard errors in brackets. YoY chg: annual variation. QoQ chg: quarterly variation. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. All the regressions include dummy for seasonal patterns, fiscal events and change of the exchange rate regime. Source: authors' calculations.

Table 25: F- and t-statistics for testing the existence of a levels equation of the inflation: Robustness Check

	Equations					
Statistics	(1)	(2)	(3)	(4)	(5)	(6)
F-statistic	11.7***	7.2***	14.6***	25.7***	14.2***	13.8***
t-statistic	-5.0***	-3.8**	-4.9***	-9.4***	-6.2***	-7.0***
k	3	2	3	3	2	3

Notes: Bound tests for cointegration relation: F- ant t- statistics for testing the existence of a levels equation for regressions in Table (24). k: number of independent variables. ***, **, * indicates significance at 1%, 5%, and 10%, respectively. Source: authors' calculations.

Table 26: Diagnostic tests for the inflation equation: Robustness Check

Test	Statistic	(1)	(2)	(3)	(4)	(5)	(6)
LM test for autocorrelation[1]	χ^2	2.7	1.0	3.3*	2.7	1.3	0.9
Durbin's alternative test[1]	F	2.2	0.8	2.6	2.2	1.0	0.7
Breusch-Pagan / Cook-Weisberg test[2]	χ^2	0.3	0.3	0.1	3.0*	2.1	0.2
IM test for Skewness[3]	χ^2	20.0	14.5	10.9	18.8	13.7	21.7
IM test for Kurtosis[3]	χ^2	4.2**	3.4*	0.1	1.0	1.1	0.4

Notes: Diagnostic tests for the levels equations in Table (24). *,** indicates significance at 10% and 5%, respectively. LM: Lagrange Multiplier. IM: Cameron and Trivedi´s information matrix. Null hypothesis: 1/no serial correlation, 2/constant variance, 3/Normality. Source: authors' calculations.