THE INTERDEPENDENCE OF FISCAL AND MONETARY POLICY

INTERDEPENDENCE OF FISCAL AND MONETARY POLICY IN GUATEMALA

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The Interdependence of Monetary and Fiscal Policy in Guatemala*

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Abstract

This paper analyzes the interdependence of monetary and fiscal policy in Guatemala using the intertemporal budget constraint of the government. The estimation of the fraction that backs the outstanding debt and the estimations of the deficit-inflation relationship for Guatemala by using DOLS and ARDL regressions respectively, indicate the existence of fiscal dominance in 1980s and 1990s with a statistically significant deficit-inflation relationship. Then it changed to a monetary dominance between 1999-2008 with no statistically significance deficit-inflation relationship. In the more recent period, 2008-2019, the results suggest evidence of fiscal dominance again, but with a wider confidence interval and a fiscal-deficit relationship not statistically significant, which may be related to insufficient data observations for this period.

JEL Codes: E31, E50, E63.

Keywords: Fiscal Policy, Inflation.

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1 Introduction

This paper explores the interaction between the monetary and fiscal policy in Guatemala and its resulting effect on inflation during the last 40 years. Accordingly, it is worth recalling that the financing of the government spending can be with tax revenues, debt issue and/or seigniorage. Eventually, debt must be repaid (plus interests); thus, the two left are tax and seigniorage to back the government's debt. More formally, the concept of intertemporal budget constraint states that debt must be backed by a combination of the present discounted value of current and future primary surpluses and seigniorage revenues. When debt is backed by primary surpluses the regime is denominated "monetary dominance", when debt is backed by seigniorage the regime is denominated "fiscal dominance". Theoretically, the fiscal deficit leads to inflation, but empirically the relationship has been vague. Therefore, the relationship should be modeled intrinsically dynamic, distinguishing the short and long run.

Motivated by the work of De Resende (2007), this paper follows his methodology to determine the proportion of debt backed either by primary surplus or seigniorage, and identifies the corresponding periods of monetary or fiscal dominance in Guatemala. Additionally, motivated by the empirical analysis of Catao & Terrones (2003), this paper then quantifies the long-run relationship between deficit and inflation during the identified regimes aforementioned.

International financial institutions and rating agencies have recognized Guatemala's prudent fiscal policy, where fiscal deficit and debt as percentage of GDP (1.9 and 24.1 percent, respectively) were among the lowest in Latin America, on average, during 2008-2018 (International Monetary Fund 2019). Then, the question is: why worry about debt and fiscal deficit? First, to contribute with a quantitative comparison with respect to other countries, since the multi-country research done so far has not included Guatemala. Second, by looking back to history, to contribute with a numerical assessment of past episodes of high government spending to stimulate demand (because of the global financial crisis, natural disasters, balance of payments problems, or any other shock) that could provide some orientation to policymakers. Guatemala went through multiple challenges in the 1980s (high inflation rates, high depreciation, high international interest rates, difficulties to pay external debt, etc.) but had achievements in 1990s and 2000s (stabilization of exchange rate, bringing down inflation to one digit, strengthening the fiscal discipline through Constitutional ban for Central Bank to finance government, implementation of inflation targeting). This research aims to shed some light on where Guatemala stands historically and currently in terms of debt and fiscal deficit by applying the available econometric analysis, leaving the results on the table for further discussion.

The paper is organized as follows. Section 2 provides a brief historical review. Section 3 focuses on the literature review. Section 4 describes the models. Section 5 and 6 present

the data and the results, respectively. Section 7 concludes.

2 Historical Review of the Economic Performance, and Monetary-Policy Interactions

Throughout the 1980s, the Guatemalan economy suffered from internal and external unbalances, which were mitigated with monetary and fiscal policies with mixed results on inflation. The international recession at the end of 1970s affected Guatemala through oil prices increases, high international interest rates, and the external demand contraction which lead to a decrease of the national exports, the international reserves levels, and the balance of payments. The policymakers' response focused on stimulating the internal demand through maintaining the dynamic public spending in the execution of infrastructure projects[1] that resulted in a significant increase in the fiscal deficit in 1980-1981, which was financed by the Central Bank and external debt (see Figure 1). In parallel, the balance of payments deterioration resulted in a scarce of foreign currency. At the beginning, import quotas in 1982 and multiple exchange rate markets in 1984[2] were intended to ease the flow of U.S. Dollars; however, such scheme led to complex multiple exchange rates, the depreciation of the Quetzal, and significant inflationary effects in 1985. See Figure (1).

The implementation in 1986 of an economic program[3] contributed with positive steps in the monetary and fiscal efforts for the rest of the decade. The Central Bank started the gradual unification of the multiple exchange rate markets helping with the reversion of the Quetzal depreciation and the inflation rate at the end of the year. Additional measures were the reduction of the government financing by the Central Bank[4], the gradual liberalization of interest rates in the banking system, and more active participation through open market operations to reduce the liquidity excess. Regarding the fiscal policy, the improvement in the consumer and business confidence allowed the implementation of tax administration measures, increase in tax collection along with an austerity policy that led to fiscal deficit reductions.

The 1990s was marked by a sharp increase in inflation only in the first year and then a gradual reduction to one digit during the rest of the decade; in addition, the very relevant Constitutional ban on Central Bank financing the public sector implemented

[1] Hydroelectric, port, hospital and road.

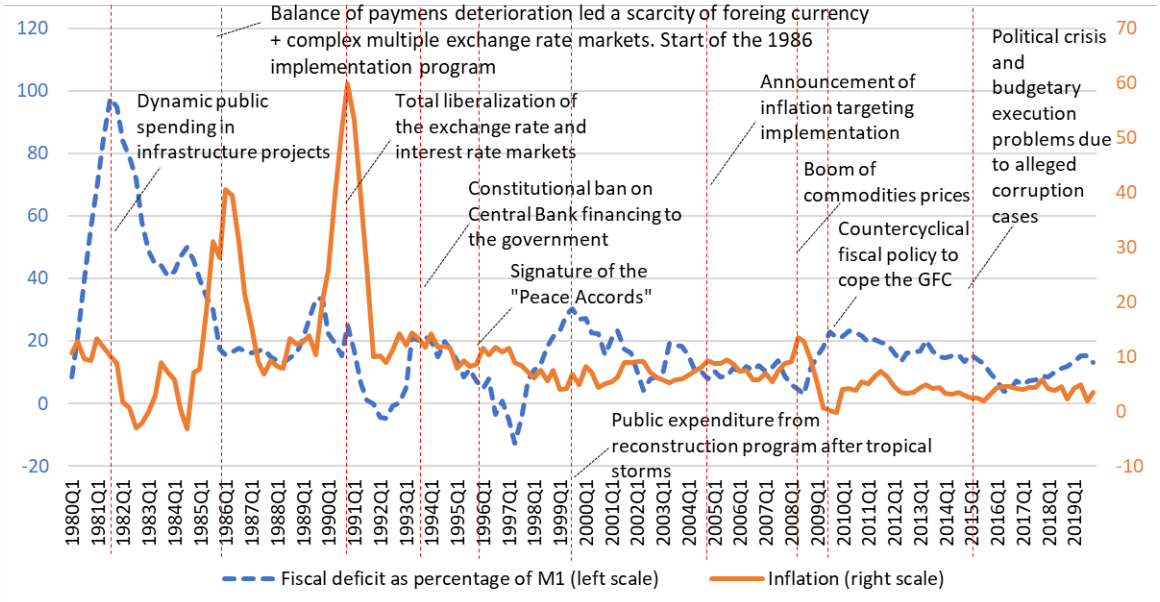
[2] Implemented in Nov 15th and known as "Régimen de Emergencia en las Transferencias Internacionales".

[3] The "Short-Run Economic and Social Realignment Program" in the second half of 1986.

[4] The variable Central Bank financing to the government was not included in the model since this event was important only at the beginning of the 1980's and it was not relevant for the rest of the period of study. This view is reinforced by the Constitutional ban on Central Bank financing to the public sector in 1994. In contrast, long available series such as oil price and exchange rates have been affecting inflation in most of the period of study.

in 1994. In 1990 the Quetzal depreciated by 4.5 percent (2.71 percent in 1989) and the inflation rate increased sharply to a record peak of 60 percent (20 percent in 1989) associated to the total liberalization of the exchange rate market and the interest rates in the banking system, increases of the oil prices due to the Persian Gulf crisis, among others. However, the increase of the exchange rate and the inflation rate reverted the next year, to a downward trend reaching one digit rate in inflation. The constitutional ban of financing the government spending by the Central Bank was implemented in 1994 with the purpose of preserving the macroeconomic stability[5]. The signing of the "Peace Accords" in 1996, ended the internal war that lasted over 36 years, entailed an increase in public expenditure (social and capital investment), along with the expenditures from the reconstruction program after Tropical Storm Mitch hit the country in 1998; the aforementioned lead to an increase in the deficit in 1998 and 1999.

Figure 1: Inflation and Fiscal Deficit as Percentage of M1



Notes: Inflation refers to the annual percentage change of the headline inflation. Fiscal deficit as percentage of M1. Source: Banco de Guatemala and author's calculations.

Regarding events in the 2000-2008 period, the implementation of inflation targeting in 2005, the boom in the price of commodities in 2007, followed by the Global Financial Crisis in 2007-2008 influenced the inflationary process with a relative stability in the fiscal policy front. The Central Bank announced the adoption of the inflation targeting regime in 2005 aiming to consolidate the price stability. However, the increase of the oil prices and other commodities (specifically, maize and wheat[6]) had a relevant incidence in the

[5]Article 133 of the Constitution states this prohibition and also its exception in the case of catastrophes or public disasters, requiring the approval by two thirds of the members of Congress, at the President of the Republic's request.

[6]The significant increase of corn and wheat international prices led to increases in the some of the

inflation rates through imported inflation, placing inflation above its target (Banco de Guatemala 2007). Additionally, the historical high participation of imports from the U.S. in the total imports of Guatemala[7] and the significant correlation between the U.S. and Guatemala economic cycles (Banco de Guatemala 2020) suggest that the U.S. inflation had also been affecting inflation in Guatemala via imported inflation. The monetary authority reacted by increasing the policy interest rate from 5 percent in 2006 to 7.25 percent in 2008 to moderate the inflation expectations and second round effects. The Global Financial Crisis (2007-2008) started affecting the national economic activity in 2008, but the stronger effects were evident in 2009.

During the 2009-2019 period, the main developments occurred in the area of fiscal policy, initially as a countercyclical policy to address the depressive effects of the Global Financial Crisis and, subsequently, paralysis in procurement and inadequate budget execution in the face of the effects of the political tensions that began in 2005. The negative effects on the national economic activity were evident in 2009, when the inflation rate dropped to -0.28 percent, but afterwards stabilized at 4 percent on average since then (in line with the inflation target range of 4 +/- 1 percent). However, from the fiscal policy front, it started a countercyclical policy that led to an increase in the fiscal deficit and public debt during the 2009-2010 period to mitigate the negative effects in the economic activity given the contraction in trade, remittances and tourism that affected in parallel the tax revenue. In 2015, the prosecution of alleged high impact corruption cases led to a political crisis and then budgetary execution problems that reduced significantly the fiscal deficits in 2015-2017 and started slowly reverting in 2018-2019.

3 Literature Review

The economic literature addresses the interdependence of fiscal and monetary policies from different perspectives. Some literature analyzes the coordination and/or the optimal monetary-fiscal policy mix and how it affects welfare, considering the preferences in the trade-off between output and inflation, or under other settings like taxation options, lack of capital, sticky prices, among others. Research under this perspective includes the one of Alesina & Tabellini (1987), Debelle & Fischer (1994), Buti et al. (2001), Beetsma & Jensen (2002), Lucas Jr & Stokey (1983), Chari et al. (1991), Schmitt-Grohé & Uribe (2007), and Correia et al. (2008). Another set of literature explores how the actions from fiscal policy affect monetary variables like interest rates, sovereign spreads, and exchange rates. Among this literature is the one of Edwards (1984), Ferrucci (2003), and Obstfeld

relevant goods in the CPI basket, such as tortillas, bread, cereals, concentrated feed, among others.

[7]The participation of imports from the U.S. in the total imports of Guatemala (in value) was 39 percent in average during 1994-2020; far below, the country with the second highest participation was Mexico with 9.9 percent.

(1994).

The scope of this working paper is more related to the literature that studies how the government's intertemporal budget constraint affects monetary policy effectiveness and its consequence on inflation. Sargent & Wallace (1981) elaborate on the interaction between the monetary and fiscal policy, assuming two polar cases: i) the monetary policy dominates fiscal policy ("monetary dominance"); or, ii) the fiscal policy dominates monetary policy ("fiscal dominance"). In the first one, monetary policy sets the amount of revenue it will supply the fiscal authority through seigniorage, thus forcing the fiscal authority to limit the financing of its deficits by that seigniorage and bond sales to the public; the monetary authority then can permanently control inflation. In the second case, the fiscal authority independently sets its budget's current and future surpluses, determining the amount of revenue that must be raised through bond sales and seigniorage. The monetary authority is then constrained to finance with seigniorage any discrepancy between the revenue demanded by the fiscal authority and the amount of bonds than can be sold. This means creating money and tolerating additional inflation if the fiscal authority's deficits cannot be financed solely by new bond sales.

The Fiscal Theory of the Price Level (FTPL) places the fiscal policy in a more relevant role with respect to the monetary policy. It argues that the government's inter-temporal budget constraint determines the price level, even in the case of an independent monetary authority. Under the FTPL, the price level is determined as the quotient between the nominal value of the interest bearing debt and the present value of the surplus, which might include seigniorage revenues. For example, Woodford (1995), Woodford (1996), and Canzoneri et al. (2001) consider two regimes. First, if primary surpluses respond to the level of debt in a way that assures fiscal solvency, then money and prices can be determined by the supply and demand for money. Second, if primary surplus is determined independently of the level of debt, then the path of the money supply and the price level must satisfy the need for fiscal solvency. The first regime is called by Sargent (1982) and Woodford (1995) as "Ricardian" and by De Resende (2007) as one of "zero fiscal dominance" or "central bank independence". The second regime is called by Woodford (1995) as "non-Ricardian" and by De Resende (2007) as one of "complete fiscal dominance".

In a more empirical level, the findings suggest mixed evidence on the presence of fiscal dominance and monetary dominance. Canzoneri et al. (2001) found strong evidence of a monetary dominant regime for the United States of America by using a VAR model with annual data from 1951 to 1995. Bajo-Rubio et al. (2009) analyzed the countries participating in the Economic and Monetary Union (EMU) over the period 1970-2005 by estimating solvency equations for each country, but they stated that no firm conclusions can be drawn about the prevalence of either monetary or fiscal dominance. Sabaté et al. (2006) found evidence of fiscal dominance in Spain during 1874-1935 by using a stationary

VAR model. Tanner & Ramos (2003) analyzed data from Brazil for the period 1991-2000 and found evidence of monetary dominance concentrated in 1995-1997 after The Real Plan implementation (an economic stabilization plan to tackle inflationary spiral) but before the Asian Crisis. Ladeira Fialho & Portugal (2005) analyzed Brazil as well, but in the Post-Real Plan period, found a predominantly monetary regime. For Colombia, Lozano & Herrera (2008) applied a VAR model for the period 1990-2007 and found evidence of monetary dominance.

From a multicountry dataset analysis, the results tend to find a higher fiscal dominance and stronger relationship between debt, fiscal deficit, and inflation in emerging economies than in advanced economies. De Resende (2007), by using a dataset from 18 OECD countries and 20 developing economies during 1949 to 2005, found that fiscal dominance is more common among developing countries, which implies that debt plays a major role in the determination of the price level for these economies than for the OECD members. Similarly, Reinhart & Rogoff (2010) found a systemic relationship between high debt levels and inflation for emerging countries but not for advanced economies as a group when analyzing data on 44 countries spanning about 200 years. Zoli (2005) analyzed eight emerging economies (Argentina, Brazil, Chile, Colombia, Mexico, Poland, South Africa, and Thailand) and found clear evidence of fiscal dominance regime in Argentina and Brazil during the 1990's and early 2000's, while in the rest of countries the results are mixed. Catao & Terrones (2003), using panel techniques and spanning 107 countries over 1960-2001, found a strong positive relationship between deficits and inflation among high-inflation and developing countries, but not among low-inflation advanced economies.

The literature highlights the importance of strong fiscal fundamentals, even when there is central bank independence or an inflation targeting regime is implemented in order to succeed in tackling inflation. The stability of fiscal position is paramount: Woodford (1996) pointed it out as a precondition for the common central bank in a monetary union and Ramos-Francia & Torres García (2005) and Kumhof et al. (2010) deemed it for inflation targeting to be an efficient mechanism to reduce inflation. Blanchard (2004) and Favero & Giavazzi (2004) elaborate on the case of Brazil in 2002-2003 when inflation targeting measures had perverse effects and the country lost the control of inflation, given the high-debt-high-risk aversion in Brazil.

4 Model Description

This paper follows the models used by De Resende (2007) to analyze the interdependence between monetary and fiscal policy and the one used by Catao & Terrones (2003) to analyze the relationship between fiscal deficit and inflation. Both are shortly described below and developed further in Appendix (A).

4.1 Degree of Fiscal Dominance and Central Bank Independence

The model used by De Resende (2007) draws on the research by Aiyagari & Gertler (1985). De Resende (2007) assumes a representative consumer that maximizes utility and a government that spends an exogenous amount of resources G_t. Government expenditures may be financed by levying lump-sum taxes (τ_t), by issuing money (M_t), and by increasing public debt (B_t). The government is assumed to follow a long-run fiscal policy rule whereby it commits itself to raise large enough primary surpluses (in present value terms) to back a constant fraction of the currently outstanding debt. This fiscal policy rule means that a constant fraction (δ) of the outstanding government debt, including interest payments, is backed by the present discounted value of current and future primary surpluses. It also implies that a fraction $(1-\delta)$ of the currently outstanding debt is backed by the present discounted value of current and future seigniorage revenue.

The value of δ identifies a set of possible fiscal regimes with two polar cases: i) in the case where $\delta = 1$, the fiscal authority backs fully all outstanding debt; and, ii) in the case where $\delta = 0$, all outstanding debt is backed by the monetary authority in the form of current and future seigniorage revenues. De Resende (2007) call the first case as one of zero fiscal dominance and complete central bank independence and the second case as one of complete fiscal dominance.

As shown in Appendix (A), De Resende (2007) obtains the following equation:

$$M_t = \frac{\gamma}{(1-\beta)} C_t - (1-\delta) B_t, \tag{1}$$

where $C_t \equiv p_t c_t$ denotes nominal private consumption. Consider the empirical counterpart to this relation:

$$M_t = \alpha_0 + \alpha_1 C_t + \alpha_2 B_t + e_t, \tag{2}$$

where α_0 is an intercept, α_j for $j = 1, 2$ are constant coefficients, and e_t is a disturbance term that captures the specification error. In terms of the structural parameters of the model, $\alpha_1 = \frac{\gamma}{(1-\beta)}$, and $\alpha_2 = -(1-\delta)$. Although not all structural parameters can be identified from the OLS projection of M_t on C_t and B_t, it is possible to identify δ from the coefficient on the stock of debt.

De Resende (2007) highlights that the econometric strategy is valid only if M_t, C_t, and B_t are nonstationary variables and the OLS regression (2) forms a cointegrating relationship. For the estimation of the cointegrating vector, De Resende (2007) employs the dynamic ordinary least squares (DOLS) method proposed by Stock & Watson (1993). This method is asymptotically equivalent to maximum likelihood but exploits the functional relationship predicted by the model. This approach involves running the OLS

regression:

$$M_t = \alpha_0 + \alpha_1 C_t + \alpha_2 B_t + \sum_{s=-p}^{q} \xi_{1,s} \Delta C_{t-s} + \sum_{s=-p}^{q} \xi_{2,s} \Delta B_{t-s} + e_t, \tag{3}$$

where $\xi_{j,s}$ for $j = 1, 2$ and $s = -p, -p+1, ...q-1, q$ are constant coefficients.

4.2 Relationship Between Fiscal Deficit and Inflation

The Catao & Terrones (2003) methodology is used to analyze the relationship between fiscal deficit and inflation. Catao & Terrones (2003) point out that money is assumed to play a role in determining macroeconomic equilibrium through a reduction in transactions costs, enabling a fiscally dominant government to affect the nominal money demand and inflation. Catao & Terrones (2003) assume the maximization of a household's lifetime utility function and that the government spending, g_t, is financed with tax collection, the issuance of one-period bonds, or by printing money.

After the maximization, Catao & Terrones (2003) reach a stationary equilibrium and obtain the following equation (see Appendix A.1 for further details)

$$\frac{\pi}{1+\pi} = \frac{p[g - \tau + b^g \frac{(R-1)}{R}]}{M}, \tag{4}$$

which is the long-run relationship that Catao & Terrones (2003) examine in their econometric strategy.

Allowing for generality and making use of the approximation $\pi \approx \frac{\pi}{(1+\pi)}$, Catao & Terrones (2003) consider the following empirical counterpart of equation (4):

$$\pi = \psi \frac{(G - T)}{M}, \tag{5}$$

where $G - T \approx p[g - \tau + b^g \frac{(R-1)}{R}]$ is the nominal equivalent of the real budget deficit underlying the theoretical model, and ψ is the semi-elasticity parameter to be estimated.

To allow for richer dynamics in the way inflation adjusts to changes in the fiscal deficit or to any other variable, Catao & Terrones (2003) nest equation (5) in an auto-regressive distributed lag (ARDL) structure where dependent and independent variables enter the right-hand side with lags of order p and q, respectively:

$$\pi_t = \mu + \sum_{j=1}^{p} \lambda_j \pi_{t-j} + \sum_{l=0}^{q} \delta_l' x_{t-l} + \epsilon_t, \tag{6}$$

where π_t stands for the observed inflation rate at time t; μ represents fixed effects; and x_t is a (kx1) vector of explanatory variables which includes the expression on the right-hand

side of equation (5), i.e.,

$$x_t = \begin{bmatrix} \frac{(G_t - T_t)}{M_t} \\ x_t^* \end{bmatrix}, \tag{7}$$

and x_t^* is a (k-1,1) vector which includes all other explanatory variables; λ_j are scalars and δ_l are (kx1) coefficient vectors.

Catao & Terrones (2003) highlight that the advantage of working with this ARDL specification, where all right-hand side variables enter the equation with a lag, is to mitigate any contemporaneous causation from the dependent to the independent variable(s) which might bias the estimates. They also argue that this is an important consideration in the present context due to the presence of money on the right-hand side of equation (6) and the tight connection between money demand and inflation underlying the theoretical model. Another advantage of the ARDL model is its handling of small sample size and mixed or ambiguous integration of regressors.

Equation (6) can be re-parameterized and written in terms of a linear combination of variables in levels and first-differences as

$$\Delta\pi_t = \mu + \phi\pi_{t-1} + \varphi' x_t + \sum_{j=1}^{p-1} \lambda_j^* \Delta\pi_{t-j} + \sum_{l=0}^{q-1} \delta_l^{*'} \Delta x_{t-1} + \epsilon_t, \tag{8}$$

where $\phi = -(1 - \sum_{j-1}^{p} \lambda_j)$, $\varphi = \sum_{j=0}^{p} \delta_j$, $\lambda_j^* = -\sum_{m=j+1}^{p} \lambda_m$, $\delta_l^* = -\sum_{m=l+1}^{q} \delta' m$, with j=1,2,...,$p-1$, and l=1,2,...,$q-1$. By grouping the variables in levels, this can be rewritten as:

$$\Delta\pi_t = \mu + \phi[\pi_{t-1} - \theta' x_{t-1}] + \sum_{j=1}^{p-1} \lambda_j^* \Delta\pi_{t-j} + \sum_{l=0}^{q-1} \delta_l^{*'} \Delta x_{t-l}^* + \epsilon_t, \tag{9}$$

where $\theta = -\phi^{-1}\varphi$ defines the long-run equilibrium relationship between the variables involved (i.e., ψ, the coefficient on $(G_t - T_t)/M_t$, is the first element of this vector) and ϕ, the speed with which inflation adjusts toward its long-run equilibrium following a given change in x_t.

5 Data

The dataset used for the empirical analysis is based on quarterly data from 1980 to 2019 resulting in a 160 observations time series. This period was chosen for two reasons: i) to include the 1980's events that placed the monetary and fiscal variables under a big stress in the recent economic history (detailed in the previous section "Historial review"), and ii) for data availability reasons for some of the variables, although with different frequencies.

For the monetary/fiscal dominance analysis and the DOLS model, this paper uses

the nominal per-capita data on monetary base, general government debt and household consumption expenditure in Quetzales, as in De Resende (2007). The monetary base (MB) is obtained from the Central Bank of Guatemala, available in annual frequency for 1980-1984 and in a monthly frequency for 1985-2019. The general government debt (internal + external) is obtained from the Ministry of Finance, available for 1980-1989 in annual frequency and for 1990-2019 in a monthly frequency. The household consumption expenditure is obtained from the IMF's International Financial Statistics (IFS), available in annual frequency for 1950-2019. It is complemented with the quarterly data of the National Accounts, base 2013, available from the Central Bank of Guatemala for 2014-2019 period. The population data is obtained from the World Population Prospects 2019 of the United Nations (UN), available in annual frequency from 1950 to 2100 (de facto population, projections as of July 1 of each year).

The part of the data available only in annual frequency for monetary base, general government debt and household consumption was interpolated with the Chow-Lin methodology, using a Rho=0.9, and using the M1 and CPI as indicators. Regarding the population, the series were interpolated using a cubic transformation.

For the analysis of the fiscal deficit-inflation relationship and the ARDL model, this paper uses the fiscal deficit of the central government series that comes from the Ministry of Finance, in millions of Quetzales, nominal, available in an annual frequency for the period 1980-1989 and in a monthly frequency for the period 1990-2019. The variable inflation refers to the year-on-year variation of the Consumer Price Index (CPI) published by the National Institute of Statistics (INE) in a monthly frequency, available from 1980-2019. M1 variable is obtained from the Central Bank of Guatemala, in millions of Quetzales, nominal, available for the period 1980-2019 in a monthly frequency. GDP comes from the Central Bank of Guatemala, National Accounts Year Base 2013, in millions of Quetzales, nominal, available in a quarterly frequency for the period 2001q1-2019q4. Because of the changes of the year bases of the national accounts[8], there are no available longer series for nominal GDP. Thus, the regression is performed only within the period 2001-2019, when the nominal GDP is included. Anyhow, the GDP series fits in one of the analyzed periods, as it will be explained in the results section below.

This paper includes the oil prices, foreign exchange rate, the U.S. inflation and the Food and Agricultural Organization (FAO) Monthly Real Cereals Price Index (a proxy of international prices of maize and wheat) as explanatory variables since they are relevant for Guatemalan inflation history (see the previous section Historical Review). The West Texas Intermediate Spot Price (FOB), in U.S. Dollars per barrel, is obtained from the U.S. Energy Information Administration in a monthly frequency from 1980-2019. The foreign exchange rate is obtained from the Central Bank of Guatemala, in Quetzales per U.S. Dollar, it refers to the weighted average of the sell and buy rate from the Foreign

[8]The year bases for GDP are: 1958, 2001, and 2013.

Exchange Institutional Market, available in annual frequency for the 1986-1990 period and in monthly frequency for the 1991-2019 period. The U.S. inflation is collected from the U.S. Bureau of Labor Statistics in a monthly frequency, available from 1980-2019 and it refers to the year-on-year variation of the CPI. The FAO Monthly Real Cereals Price Index is a measure of the monthly change in international prices of a basket of food commodities, specifically wheat, maize, barley and rice, using trade weights for 2014-2016 to aggregate prices.

The fiscal deficit was interpolated from annual to quarterly data for the period 1980-1989 using the Chow-Lin method, using a Rho=0.9 and the CPI as variable indicator. The foreign exchange rate was interpolated from annual to quarterly data for the period 1986-1990 by the quadratic frequency conversion option of EViews.

6 Results

This paper presents the results of: 1) the degree of fiscal/monetary dominance (the estimated value of δ) using DOLS regressions for the whole sample and subsamples identified with structural brakes; and 2) the statistical relationship between fiscal deficit and inflation using ARDL regressions for the whole sample and the subsamples identified in 1).

6.1 Degree of Fiscal Dominance and Central Bank Independence

The nonstationary test and cointegration test for the monetary base (mb), the household personal consumption (cons), and the general government debt (debt) show that all variables are nonstationary and form a cointegration relationship. Table (1) shows that the ADF unit root test with a constant and a deterministic trend confirms that the variables are I(1). The Engle-Granger cointegration test indicates that the null hypothesis of no cointegration is rejected at a 10 percent confidence level using the AIC length criteria; however, using the SIC length criteria the null hypothesis cannot be rejected.

Table 1: ADF Unit Root Test and Engle-Granger Cointegration Test Variables: Monetary base, household consumption expenditure and central government debt

Statistics	ADF Unit Root test on:			Engle-Granger Cointegration Test (lag length Criteria):	
	mb	cons	debt	AIC	SIC
p-value	1.00000	0.9817	1.00000	0.0688	0.7365
t-stat	3.247833	-0520504	2.063554	-3.664919	-1.996233
lags	8	7	2	13	13

Notes: For the ADF test the lag length selected, according the Shwarz Information Criterion, is a maximum of 13 lags. Abbreviations: mb = Monetary base; cons = household consumption expenditure; and debt = central government debt. Source: Author's calculations.

The monetary base and household consumption expenditure have a small peak at the fourth quarter, which is related to the increased consumer spending due to Christmas and New Year holidays. Therefore, the monetary base and household consumption expenditure were seasonality adjusted by using Census X-13.

All the variables were divided by the population in order to get the monetary base per capita (mbpc), consumption per capita (conspc), and the debt per capita (debtpc), following De Resende (2007) methodology.

Table (2) presents the estimates of the structural parameters using the DOLS regression described in equation (3) for the whole sample as well as subsamples to examine regime shifts in the DOLS estimation. As in De Resende (2007), we are assuming that the coefficient on debt, α_2, is allowed to change only but not the coefficient on nominal consumption, α_1. The reasoning behind this assumption is that α_1 is a "policy free" parameter that depends only on preferences. In other words, the subsamples were identified by checking structural breaks for α_2, meaning changes in the δ-Backing Fiscal Policy Rule. The structural breaks selection was based on the Bai-Perron procedure, allowing a maximum number of two breaks, following the sequential method at the 10 percent significance level.

The results suggest that there is statistical evidence of a low degree of fiscal dominance when analyzing the period as a whole. However, when considering structural breaks, the regime shifts from a high fiscal dominance (in 1980q4-1999q2) to a central bank independence (in 1999q3-2008q4) and going back to a period of fiscal dominance in the most recent period (2009q1-2019q4). As mentioned in the subsection (4.1), $\delta = 1$ means zero fiscal dominance (or equivalently, central bank independence) and a $\delta = 0$ means complete fiscal dominance (or equivalently, no central bank independence). In Table (2), this paper obtained a value of δ of 1.19 as point estimate and around [1.08-1.29] as a 95 percent confidence interval for the whole sample, meaning zero fiscal dominance

(column 1). When examining by structural breaks, $\delta = 0.70$ with a 95 percent confidence interval of [0.54-0.86] in the 1980q4-1999q2 period (column 2) it is interpreted as evidence of fiscal dominance. This result coincides with the period of the Central Bank financing public expenditure, the high levels of government spending (new infrastructure projects, social spending related to the Peace Accords agreements and natural disasters reconstruction), the increase of public debt (internal and external) and sharp increases in inflation. Then, in the 1999q3-2008q4 period, the point estimate of δ goes up to 1.31 with a 95 percent confidence interval of 1.07-1.56, suggesting Central Bank independence (column 3). This result can be associated to more discipline in the government spending and the implementation of an inflation targeting regime to strengthen price stability. Finally, in the 2009q1-2019q4 period (column 4), the value of δ moves down to 0.4 with a 95 percent confidence interval of [-0.16-0.96]. During this last period, the countercyclical fiscal policy implemented to mitigate the Global Financial Crisis effects took place but also the paralysis in public expenditure and procurement as a result of the political crisis and side effects of the anti-corruption efforts.

Table 2: Estimates of Structural Parameters with DOLS Regressions

	Specification models			
	(1)	(2)	(3)	(4)
α_1	0.300591***	0.590957***	0.108151	1.731895***
	(4.459043)	(12.11917)	(0.998899)	(4.038058)
α_2	0.18509***	-0.298868***	0.314206**	-0.599625**
	(3.597399)	(-3.711376)	(2.589356)	(-2.160368)
C	-27.6924	235.9897***	-319.8933***	-3560.788***
	(-0.54207)	(4.733097)	(-12.17688)	(-4.880392)
δ:				
Point estimate	1.185090	0.701132	1.314206	0.400375
95% conf. interval	[1.083 - 1.287]	[0.541 - 0.861]	[1.069 - 1.559]	[-0.161 - 0.961]
Lag & lead criteria	AIC	AIC	SIC	FIXED
# of leads	9	11	7	2
# of lags	8	11	8	2
Sample	1980q4 - 2019q4	1980q4-1999q2	1999q3-2008q4	2009q1-2019q4
Observations	157	75	38	44
R2	0.995093	0.998805	0.999226	0.968085

Notes: The table contains the results of the DOLS regression specified in equation (3) for the whole period and different subperiods which were identified by allowing structural breaks on α_2 (coefficient on debt) but not on α_1 (coefficient on nominal consumption).
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information Criterion; SIC=Swcharz Criterion; FIXED=Fixed number.
Source: Author's calculations.

Although the evidence of a fiscal dominance regime in the most recent period is statistically significant, it is very imprecise given the wide confidence interval. This interval might narrow with newly observed data coming in the future: as Tanner & Ramos (2003) pointed out for the case of Brazil, the finding might reflect insufficient data[9].

By easing the assumption of allowing only α_2 to change and instead allowing both parameters (α_1 and α_2) to change, the results for the new structural breaks maintain the same interpretation as before, except for the first period. The first period (1980q4-1999q2) becomes shorter (1980q4-1988q1) and it moves in the direction to a zero fiscal dominance, which might be counterintuitive since this period is characterized by high fiscal government spending (these results are presented in the Appendix B). The argument that allows both parameters to break is that α_2 depends on preferences, as α_1 does, in the sense that δ is a "deep parameter" that reflects the government preferences on backing its debt either by the fiscal or the monetary authority without a publicly announced policy commitment. Since both depend on preferences, both should be allowed to break.

To reinforce the assessment on the significant shifts from fiscal dominance to monetary dominance and the wide confidence intervals for the δ estimate, M1 is used instead of monetary base (mb); however, the results do not vary substantially (presented in the Appendix C). Similar to Table (2) results, the shift regimes go from some fiscal dominance (1980q4-1999q2) with a δ estimate of 0.87, to monetary dominance (1999q3-2008q4) with a δ estimate of 1.0 and reverting to a fiscal dominance again (2009q1-2019q4) with a δ estimate of 0.44. Unfortunately, the confidence intervals did not narrow by using M1. The exercise of allowing both parameters to break while using M1 instead of monetary base was performed as well (see Appendix D): again, the first period became shorter (1980q4-1988q1) and became as a zero fiscal dominance regime, which might be counterintuitive as explained before.

The values of δ found for Guatemala in this paper are similar to the values obtained by De Resende (2007) for advanced economies; however, the switch of regime is something that Guatemala has in common with developing economies. Advanced economies tend to values of δ around 1 while developing economies tend to values lower than 1. Specifically, the countries with $\delta > 1$ (as Guatemala in this paper) are Australia, Canada, Germany, Israel, among others. While advanced economies maintained the monetary dominance (by keeping values of δ around 1) when structural breaks are present, Guatemala switched from one regime to another as the rest of developing economies found in De Resende (2007).

[9]For example, this paper is not taking into account the significant fiscal impulse that the Government of Guatemala is implementing to mitigate the negative effects from the COVID-19 crisis. The Congress approved a exception to the Constitutional ban on Central Bank financing the public sector in April 2020, to deal with the COVID-19 crisis.

6.2 Relationship Between Fiscal Deficit and Inflation

This section presents the findings of the relationship between fiscal deficit and inflation represented by equations (6) and (9).

The stationarity tests confirm that the data in levels is I(1), as shown in Table (3). In this paper, the variables are also transformed to year-on-year percent variations (from one quarter to the same quarter of the previous year). The reasons for this transformation are the following: i) the transformation helps to eliminate the seasonality of the variables, ii) the transformation facilitates the comparison between the quarters from one year to another, and iii) the transformation helps to break the correlation between variables. Therefore, the results of the regressions obtained below should be read as the percentage change in the year-on-year variation of the dependent variable given a 1 percent change in the year-on-year variation of the explanatory variable.

Table 3: Augmented Dickey-Fuller and Phillips-Perron Tests

Variables	ADF		PP	
	t-stat	p-value	t-stat	p-value
CPI	-3.128664	0.1033	-2.952463	0.1492
Fiscal deficit/M1	-3.540627	0.0385	-3.478852	0.0451
Fiscal deficit/GDP	-2.370295	0.3917	-2.759651	0.2168
Oil	-2.480371	0.3375	-2.448396	0.3534
Exchange rate	-0.822802	0.9602	-1.107712	0.9232
CPI U.S.	-3.149833	0.0987	-4.288721	0.0042
Cereals	-2.378836	0.385	-2.480169	0.3359

Notes: ADF: Augmented Dickey Fuller test. Shwarz Information Criterion for lag length selection (maximum lags 13). PP: Phillips-Perron test. Newey-West Bandwith, automatic selection criteria. Spectral estimation method: Bartlett kernel. Source: Author's calculations.

When analyzing the whole sample (1980q1-2019q4), the results indicate no statistically significance of the relationship between fiscal deficit over M1 and inflation in any of the six models, even after controlling for other explanatory variables. As shown in Table (4), oil price variation, exchange rate variation, and cereals price variation present statistically significant values in at least one of the models. While adding more explanatory variables intends to enrich the analysis, it is relevant checking the number of cointegrating relationships[10]. When the U.S. inflation variable is added in column 5, the number of cointegrating relationships increases to three. Column 6 includes again the U.S. inflation but it forces to exclude the exchange rate and cereals variables in order to maintain one cointegrating relationship. Regarding the error correction, the estimated

[10] Pesaran et al. (2001) points out that ARDL analysis is inappropriate in situations where there may be more than one level relationship involving the dependent variable.

coefficient (with the expected negative sign in the six model specifications) ranges from -0.11 to -0.44. This means, for instance, that 44 percent of departures from the long-run equilibrium is corrected in each period.

Table 4: Estimates with ARDL regressions. Sample: 1980q1 - 2019q4

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: inflation						
Long-run elasticities (θ):						
Fiscal deficit/M1	9.685309	7.675721	1.078583	-10.10652	0.256066	7.452513
	(0.653383)	(0.520109)	(0.093387)	(-0.884008)	(0.041612)	(0.286569)
Oil price variation		0.05656	0.087639***	0.054766**	-0.038047*	0.023527
		(0.669798)	(2.888626)	(1.975004)	(-1.816367)	(0.200543)
Exchange rate variation			0.819982***	0.250387	0.591091***	
			(9.946954)	(1.302208)	(12.1381)	
Cereals price variation				0.160645***		
				(2.837858)		
U.S. inflation					3.488409***	6.536858***
					(6.487912)	(2.51593)
C	8.100728***	7.780876**	4.349406**	6.14972***	-2.05525	-9.625158
	(2.631974)	(2.462263)	(2.361588)	(3.55635)	(-1.300676)	(-1.211761)
Error correction coefficient (ϕ)	-0.152166***	-0.153868***	-0.265213***	-0.183278***	-0.443159***	-0.113658***
Number of lags (q,p,p,p,p,p)	(3,0)	(3,2,3)	(1,0,0,0)	(1,0,0,0,0)	(1,0,0,1,0)	(1,0,0,0)
Lag selection criteria	AIC	ARS	SIC	SIC	SIC	AIC
Bound test: F-statistic						
F-statistic Value	9.1483	7.0570	20.8698	6.7035	24.0303	3.6088
I(0) - I(1) Limits 5% Signif	3.62 - 4.16	3.1 - 3.87	2.79 - 3.67	2.56 - 3.49	2.56 - 3.49	2.79 - 3.67
Serial correlation LM test: p-value	0.0000	0.0000	0.0187	0.1623	0.0007	0.0000
Heteroskedasticity test: p-value	0.0000	0.0003	0.0006	0.0010	0.1648	0.0000
R2	0.3089	0.3469	0.4691	0.2830	0.5872	0.1100
F-Statistic	282.9545	115.6588	361.2687	84.8884	310.0711	211.5499
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of cointegrating relationships:						
Trace statistic	1	1	1	1	3	1
Max-Eigen statistic	1	1	1	1	1	1
Sample	1980q1-2019q4	1980q1-2019q4	1980q1-2019q4	1991q1-2019q4	1980q1-2019q4	1980q1-2019q4
Observations	160	160	160	160	160	160

Notes: The table contains the results of the ARDL regression specified in equation (9) for the whole period by aggregating the relevant variables considered in this research.
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information criterion; SIC=Swcharz criterion; HQ=Hannan-Quinn criterion; ARS=Adjusted R-squared. For each lag selection criteria, the number of lags was selected by an automatic selection. Serial correlation LM test refers to Breusch-Godfrey testing Ho.: No serial correlation. Heteroskedasticity test refers to Breusch-Pagan-Godfrey testing Ho.: Homoskedasticity. Source: Author's calculations.

The number of lags are selected by an automatic selection following different criterions: Akaike, Swcharz, Hannan-Quinn and Adjusted R-squared. This paper has chosen the criterion that combined the better results in terms of the significance of the long-run elasticities as well as the Bounds, serial correlation and heteroscedasticity tests; however, the serial correlation and heteroscedasticity were present in the six models specifications (except in the model with more than one cointegrating vector).

Alternatively, the paper divides the sample in the subsamples identified by the structural breaks in the fiscal dominance analysis explained in the previous model. The specification model selected for the subsamples was based on the results obtained for the whole

sample in Table (4). The models with at least one statistically significant value, with one cointegrating relationship and with the highest error correction coefficient were selected: the model specification used in column 3 and 4 in Table (4). Since the FAO Cereal Price Index is available only starting from 1990's, we use the model specification in column 4 for the subsamples 1999q3-2008q4 and 2009q1-2019q4 and the model specification in column 3 for the subsample 1980q1-1999q2. Table (5) presents the results of the re-estimation of the long-run elasticities for the subsamples.

Table 5: Estimates with ARDL regressions. Sub-samples: 1980q1-1999q2; 1999q3-2008q4; 2009q1-2019q4

	(1)	(2)	(3)	(4)
Dependent variable: inflation				
Long-run elasticities (θ):				
Fiscal deficit/M1	17.72885*	8.596906	-3.784057	
	(1.83964)	(0.970059)	(-1.042637)	
Fiscal deficit/GDP				-11.14348
				(-1.510106)
Oil price variation	0.194744***	0.012174**	0.022733***	0.01805**
	(3.480595)	(2.166127)	(2.961884)	(2.189573)
Exchange rate variation	0.62306***	-0.222079**	0.012528	0.149343
	(10.08091)	(-2.320099)	(0.125132)	(1.108637)
Cereals price variation		0.024796*	0.047362***	0.063468***
		(1.785716)	(3.098873)	(3.392649)
C	7.21403***	5.947048***	4.462381***	4.941448***
	(4.456973)	(4.942891)	8.093229	(7.534987)
Error correction coefficient (ϕ)	-0.507125***	-0.901034***	-0.725955***	-0.623812***
Number of lags (q,p,p,p,p,p)	(1,0,1,1)	(4,1,1,1,0)	(1,2,2,2,1)	(1,2,2,2,1)
Lag selection criteria	AIC	SIC	AIC	AIC
Bound test: F-statistic				
F-statistic Value	14.2098	12.6027	11.2639	11.2162
I(0) - I(1) Limits 5% Signif	2.79 - 3.67	2.56 - 3.49	2.56 - 3.49	2.56 -3.49
Serial correlation LM test: p-value	0.2543	0.1705	0.1730	0.1735
Heteroskedasticity test: p-value	0.7850	0.0797	0.2555	0.8773
R2	0.7003	0.8317	0.8338	0.8537
F-Statistic	105.4203	19.5400	12.7145	15.1207
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000
Sample	1980q1-1999q2	1999q3-2008q4	2009q1-2019q4	2009q1-2019q4
Observations	78	38	44	44

Notes: The table contains the results of the ARDL regression specified in equation (9) for the whole period and different subperiods which were identified as fiscal or monetary dominance.
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information criterion; SIC=Swcharz criterion; HQ=Hannan-Quinn criterion; ARS=Adjusted R-squared. For each lag selection criteria, the number of lags was selected by an automatic selection. Serial correlation LM test refers to Breusch-Godfrey testing Ho.: No serial correlation. Heteroskedasticity test refers to Breusch-Pagan-Godfrey testing Ho.: Homoskedasticity.
Source: Author's calculations.

The long-run relationship between the fiscal deficit over M1 and inflation turned to be statistically significant during the higher fiscal dominance regime (1980q1-1999q2) and became not statistically significant in the zero fiscal dominance one (1999q3-2008q4). The estimated long-run elasticity between fiscal deficit over M1 and inflation went down from 17.7 (column 1, Table 5) to 8.6 (column 2), although statistically significant in the first period only. The coefficients of the other explanatory variables were positive and statistically significant, except the exchange rate variation which turned to be negative (opposite to the expected sign) in the period of zero fiscal dominance. The speed of the adjustment of inflation to a given change of the system increased significantly, in comparison to the one obtained by analyzing the whole period, particularly in the period of zero fiscal dominance (error correction coefficient around 90 percent). As before, an automatic selection of the number of lags following SIC or AIC criterion was done. There is no heteroscedasticity nor serial correlation in any of the subsamples.

In the more recent period (2009q1-2019q4) identified as of fiscal dominance, contrary to the expected, the long-run elasticity of the fiscal deficit over M1 was negative although not statistically significant. In general, the results are the same either scaling fiscal deficit by M1 or GDP. The long-run elasticity of fiscal deficit over M1 changed from 8.6 to -3.8 in the more recent period and remained not statistically significant (see column 3, Table 5). The rest of variables were statistically significant and with the expected positive sign. Scaling the fiscal deficit by GDP (instead of M1), the overall results do not change (see column 4, Table 5); however, the long-run elasticity is higher when scaling the fiscal deficit by GDP rather than by M1. The reason M1 is scaled by GDP for this period only, is because of not availability of a long nominal GDP series given the changes of the year base of the national accounts.

7 Concluding Remarks

This paper found evidence of fiscal dominance and a statistically significant relationship between fiscal deficit and inflation for Guatemala during 1980-1990; however, those findings were reverted to a Central Bank independence and no strong relationship between fiscal deficit and inflation during 1999-2008. These results coincide with important economic developments, for the first regime: i) the Central Bank financing the public expenditure, and ii) the high levels of government expenditure in new infrastructure projects and social spending related to the Peace Accords agreements and natural disasters reconstruction. For the second regime, the implementation of inflation targeting to strengthen the price stability.

The third and more recent period, 2008-2019, is less clear: statistically significant, the point value demonstrates some degree of fiscal dominance but the confidence interval is much wider while the relationship between fiscal deficit and inflation was not statis-

tically significant. This outcome might simply reflect insufficient data as Tanner and Ramos (2002) pointed out in their analysis for the Brazilian economy. In Guatemala, the most recent period is marked by the fiscal expansion to tackle the negative effect of the Global Financial Crisis but also the contraction in expenditure given the political crisis in 2015. However, this paper is not taking into account the Central Bank financing of the government stimulus, approved by Congress in April 2020, to mitigate the effects of the COVID-19 crisis.

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Appendix

A Model Description

A.1 Degree of Fiscal Dominance and Central Bank Independence

According to De Resende (2007), the objective of the representative consumer (with perfect foresight) is:

$$max_{c_t,n_t,m_t,b_t,k_t} \sum_{t=0}^{\infty} \beta^t u(c_t, m_t/p_t, 1-n_t), \tag{10}$$

where $\beta \in (0,1)$ is the subjective discount factor. In each period, consumers choose consumption (c_t), labor (n_t), and next-period holdings of capital (k_t), money (m_t), and nominal one-period government debt (b_t). p_t is the aggregate price level. Capital and labor are rented each period to a representative competitive firm. The inclusion of real balances (m_t/p_t) reflects the convenience of using money in carrying out transactions. Since the model is concerned with the composition of government liabilities, m_t is interpreted as the consumer's holdings of the monetary base.

The consumer's optimization problem is subject to a no-Ponzi-game condition and to the sequence of budget constraints (expressed in real terms):

$$c_t + \frac{m_t}{p_t} + \frac{b_t}{p_t} + k_t = w_t n_t + r_t k_{t-1} + \frac{m_{t-1}}{\pi_t p_{t-1}} + i_{t-1}\frac{b_{t-1}}{\pi_t p_{t-1}} - \tau_t, \tag{11}$$

for all t; where τ_t is a lump-sum tax, $\pi_t = p_t/p_{t-1}$ is the gross inflation rate, $i_(t-1)$ is the gross nominal interest rate on government debt which is set in period t-1 and paid in period t, w_t is the wage rate, and r_t is the gross return on capital between periods t-1 and t. In equilibrium, the absence of arbitrage profits will require r_t to equal the real gross interest rate $\frac{i_{t-1}}{\pi_t}$.

First-order necessary conditions for the representative consumer's problem include:

$$1/c_t = \beta(i_t/\pi_{t+1})(1/c_{t+1}), \tag{12}$$

$$m_t/p_t = \gamma c_t i_t/(i_t - 1). \tag{13}$$

Equation (12) is an Euler equation for consumption and equation (13) defines money demand as a function of consumption and the return on money.

Regarding the government, in every period, the government spends an exogenous amount of resources G_t. Government expenditures may be financed by levying lump-sum taxes (τ_t), by issuing money (M_t), and by increasing public debt (B_t). The government is subject to a no-Ponzi-game condition and to a dynamic budget constraint (expressed

in real terms):

$$G_t + (i_{t-1} - 1)\frac{B_{t-1}}{p_t} = \tau_t + \frac{(M_t - M_{t-1})}{p_t} + \frac{(B_t - B_{t-1})}{p_t}. \tag{14}$$

Forward iteration on equation (14) and the government's no-Ponzi condition imply an intertemporal budget constraint:

$$i_{t-1}\frac{B_{t-1}}{p_t} = \sum_{j=0}^{\infty}\frac{\tau_{t+j}}{R_t^{(j)}} + \sum_{j=0}^{\infty}\frac{M_{t+j} - M_{t+j-1}}{p_{t+j} + R_t^{(j)}} - \sum_{j=0}^{\infty}\frac{G_{t+j}}{R_t^{(j)'}} \tag{15}$$

$$= T_t + S_t - G_t, \tag{16}$$

T_t, S_t, and G_t are the present value of tax receipts, seigniorage revenue, and government expenditure, respectively. Without loss of generality, De Resende (2007) assumes that the government's present value budget constraint holds with equality.

The government is assumed to follow a long-run fiscal policy rule whereby it commits itself to raise large enough primary surpluses (in present value terms) to back a constant fractions of the currently outstanding debt. More formally:

Definition (The δ-backing Fiscal Policy): Given a sequence of prices $i_{t+j-1}, p_{t+j}{}_{j=0}^{\infty}$ and an initial stock of nominal debt B_{t-1}, a δ-backing fiscal policy is a sequence G_{t+j}, τ_{t+j}, $B_{t+j}{}_{j=0}^{\infty}$ such that, for all t:

$$T_t - G_t = \delta i_{t-1}\frac{B_{t-1}}{p_t}, \tag{17}$$

where $\delta \in [0, 1]$.

De Resende (2007) points out that this fiscal policy rule means that a constant fraction (δ) of the outstanding government debt, including interest payments, is backed by the present discounted value of current and future primary surpluses. Since the government's intertemporal budget constraint is always satisfied, it follows that:

$$S_t = (1 - \delta)i_{t-1}\frac{B_{t-1}}{p_t}. \tag{18}$$

Hence, the policy (17) also implies that a fraction $(1-\delta)$ of the currently outstanding debt is backed by the present discounted value of current and future seigniorage revenue.

The price level is determined by the clearing of the money market

$$M_t = m_t. \tag{19}$$

Money supply is determined by the combination of the fiscal rule and the government's intertemporal budget constraint, while money demand is given by the consumer's intertemporal condition relating money and consumption in equation (13). From equation

(18), money supply can be written after some manipulation as

$$\frac{M_t}{p_t} = \frac{i_t}{i_{t-1}}[(1-\delta)i_{t-1}\frac{B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} - \sum_{j=1}^{\infty}(\frac{M_{t+j}}{p_{t+j}R_t^{(j)}}\frac{i_{t+j}-1}{i_{t+j}})]. \tag{20}$$

Using the equilibrium condition (equation 19) and money demand (equation 13) in equation 20 yields:

$$\gamma c_t = (1-\delta)i_{t-1}\frac{B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} - \sum_{j=1}^{\infty}(\frac{m_{t+j}}{p_{t+j}R_t^{(j)}}\frac{i_{t+j}-1}{i_{t+j}}). \tag{21}$$

After some algebra, De Resende (2007) obtains the following equation:

$$p_t = \frac{(1-\beta)(M_{t-1} + (1-\delta)i_{t-1}\beta_{t-1}}{\gamma c_t}. \tag{22}$$

This equation describes the aggregate price level as a function of consumption and of the beginning-of-period stocks of money and debt. As an alternative, one can use the fact that $M_{t-1} + (1-\delta)i_{t-1}B_{t-1} = M_t + (1-\delta)B_t$, to write the price level in terms of the end-of-period stocks of money and debt:

$$p_t = \frac{(1-\beta)[M_t + (1-\delta)B_t]}{\gamma c_t}. \tag{23}$$

Equations (22) and (23) are equivalent, but the empirical analysis of equation (23) would not require data on the gross nominal interest rate. The model implies that the price level depends not only on the money stock, but also on the proportion of the outstanding debt that is backed by money. By rewriting the equation (23), De Resende (2007) develops his econometric strategy explained in the subsection (4.1).

A.2 Relationship Between Fiscal Deficit and Inflation

According to Catao & Terrones (2003), the representative household maximizes the following lifetime utility function:

$$\sum_{t=0}^{\infty}\beta' u(c_t l_t), \tag{24}$$

where β is the subjective discount factor ($0 < \beta < 1$) and where c_t is the period-t consumption, and l_t is period t-leisure.

In each period, the household is endowed with a positive quantity of a good y_t. Out of this endowment, the household pays taxes and can either consume or transfer the after-tax endowment over time through risk-free bond and money holdings. As result,

the household is subject to a sequence of budget constraints given by:

$$c_t + \frac{b^p_{t+1}}{R^*_t} + \frac{m_{t+1}}{p_t} = y_t - \tau_t + b^p_t + \frac{m_t}{p_t}, \tag{25}$$

where b^p_t is the real value of the household holdings of one-period risk-free bonds that mature at the beginning of period t, these assets are denominated in period t consumption units; m_{t+1} denotes the household's holdings of money balances between t and $t+1$; τ_t is a lump-sum tax at period t; p_t is the price level; and R^*_t is the international real gross rate of return on one-period bonds. The initial stocks of b^p_0 and m_0 are given and $y_t \ll \infty$.

In each period t, the household has one unit of time which can be allocated to leisure, l_t, or shopping activities, s_t, so that $l_t + s_t = 1$. The amount of time spent on shopping is assumed to be directly related to the level of consumption, c_t, and inversely related to the amount of real balances the household holds between t and $t+1(\frac{m_{t+1}}{p_t})$:

$$s_t = S(c_t, \frac{m_{t+1}}{p_t}). \tag{26}$$

First order conditions with respect to c_t, l_t, b_{t+1}, and m_{t+1} yield the following money demand function:

$$\frac{m_{t+1}}{p_t} = M^d(c_t, \frac{1}{R^*_t(1+\pi_t)}), \tag{27}$$

where M^d is increasing on consumption (c_t), and decreasing on the international real interest rate R^*_t as well as on the domestic inflation rate $\pi_t = \frac{p_{t+1}}{p_t} - 1$.

Regarding the government, the government spending g_t is financed with tax collection, the issuance of one-period bonds, or by printing money. So, the respective budget constraint is given by:

$$\frac{b^g_{t+1}}{R^*_t} = \tau_t + b^g_t - g_t + \frac{M_{t+1} - M_t}{p_t}, \tag{28}$$

where b^g_t is the real value of the government's net bond holdings denominated in consumption units of period t, and M_t is currency issued by the government at the beginning of the period t. Both b^g_0 and M_0 are given. Whenever $b^g_t < 0$, the government is a net borrower in period t.

With money supply equal to money demand ($m_t = M_t$) and $b_{t+1} = b^p_{t+1} + b^g_{t+1}$ for all t, the economy wide budget constraint is thus:

$$\frac{b_{t+1}}{R^*_t} = y_t - c_t - g_t + b_t, \tag{29}$$

where b_{t+1} is the net holding of foreign bonds of the economy as a whole and b_0 is given, so that the current account is defined as $b_{t+1} - b_t$.

In the absence of trade restrictions and taxes, both purchasing power parity condition and the uncovered interest rate parity conditions hold, resulting in the equalization of

onshore (R_t) and offshore real interest rates (R_t^*). Stationary equilibrium in this small open economy then implies $R = R^* = \beta^{-1}$ and:

$$\frac{M}{p} = M^d(c, \frac{1}{R(1+\pi)}) = \vartheta(\pi). \tag{30}$$

Substituting equation (30) into equation (28) yields:

$$\frac{\pi}{1+\pi} = \frac{p[g - \tau + b^g \frac{(R-1)}{R}]}{M}, \tag{31}$$

which is the long-run relationship that Catao & Terrones (2003) use in their econometric strategy explained in the subsection (4.2).

B Estimates with DOLS Regressions (allowing α_1 and α_2 to change while using monetary base)

Table 6: Estimates of Structural Parameters with DOLS Regressions

	Specification models			
	(1)	(2)	(3)	(4)
α_1	0.300591***	0.652009***	0.326865***	1.731895***
	(4.459043)	(28.91358)	(4.368411)	(4.038058)
α_2	0.18509***	-0.029731**	0.105716	-0.599625**
	(3.597399)	(-4.416162)	(1.105286)	(-2.160368)
C	-27.6924	-48.57648***	-28.69696	-3560.788***
	(-0.54207)	(-14.93938)	(-0.509126)	(-4.880392)
δ:				
Point estimate	1.185090	0.970269	1.105716	0.400375
95% conf. interval	[1.083 - 1.287]	[0.957 - 0.984]	[0.915 - 1.296]	[-0.161 - 0.961]
Lag & lead criteria	AIC	AIC	SIC	AIC
# of leads	9	4	0	2
# of lags	8	4	0	2
Sample	1980q4 - 2019q4	1980q4-1988q1	1988q2-2008q4	2009q1-2019q4
Observations	157	30	83	44
R2	0.995093	0.999922	0.981413	0.968085

Notes: The table contains the results of the DOLS regression specified in equation (3) for the whole period and different subperiods which were identified by allowing structural breaks on α_2 (coefficient on debt) and α_1 (coefficient on nominal consumption) while using monetary base instead of M1.
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information Criterion; SIC=Swcharz Criterion; FIXED=Fixed number.
Source: Author's calculations.

C Estimates with DOLS Regressions (allowing α_2 to change only while using M1)

Table 7: Estimates of Structural Parameters with DOLS Regressions

	Specification models			
	(1)	(2)	(3)	(4)
α_1	0.458927***	0.607602***	0.751957***	1.733634***
	(5.797227)	(10.97781)	(4.952514)	(5.334955)
α_2	0.197385***	-0.127012*	0.002399	-0.5543295**
	(3.192394)	(-1.835210)	(0.013133)	(-2.629599)
C	-259.07030	14.50253	-634.4508***	-2653.269***
	(-4.576053)	(0.390955)	(-6.697148)	(-4.839821)
δ:				
Point estimate	1.197385	0.872988	1.002399	0.4456705
95% conf. interval	[1.075 - 1.320]	[0.735 - 1.011]	[0.633 - 1.372]	[0.020 - 0.872]
Lag & lead criteria	AIC	AIC	SIC	AIC
# of leads	13	0	4	2
# of lags	0	0	0	2
Sample	1980q4 - 2019q4	1980q4-1999q2	1999q3-2008q4	2009q1-2019q4
Observations	157	75	38	44
R2	0.995466	0.964251	0.994949	0.986561

Notes: The table contains the results of the DOLS regression specified in equation (3) for the whole period and different subperiods which were identified by allowing structural breaks on α_2 (coefficient on debt) only while using M1.
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information Criterion; SIC=Swcharz Criterion; FIXED=Fixed number.
Source: Author's calculations.

D Estimates with DOLS Regressions (allowing α_1 and α_2 to change while using M1)

Table 8: Estimates of Structural Parameters with DOLS Regressions

	Specification models			
	(1)	(2)	(3)	(4)
α_1	0.458927***	0.271213***	0.39183***	1.738342***
	(5.797227)	(21.54107)	(3.453166)	(4.96402)
α_2	0.197385***	0.112808***	0.406152***	-0.557662**
	(3.192394)	(11.32642)	(2.853258)	(-2.429824)
C	-259.07030	-19.82559**	-572.4444***	-2657.582***
	(-4.576053)	(-4.905152)	(-7.031828)	(-4.680842)
δ:				
Point estimate	1.197385	1.112808	1.406152	0.442338
95% conf. interval	[1.075 - 1.320]	[1.092 - 1.133]	[1.123 - 1.689]	[-0.021 - 0.906]
Lag & lead criteria	AIC	AIC	SIC	AIC
# of leads	13	5	1	2
# of lags	0	5	0	2
Sample	1980q4 - 2019q4	1980q4-1988q1	1988q2-2009q1	2009q2-2019q4
Observations	157	30	84	43
R2	0.995466	0.999991	0.988793	0.985803

Notes: The table contains the results of the DOLS regression specified in equation (3) for the whole period and different subperiods which were identified by allowing structural breaks on α_2 (coefficient on debt) and α_1 (coefficient on nominal consumption) while using M1.
***, **, * denote 1%, 5%, and 10% level of significance. t-statistics in parenthesis.
AIC=Akaike Information Criterion; SIC=Swcharz Criterion; FIXED=Fixed number.
Source: Author's calculations.