THE INTERDEPENDENCE OF FISCAL AND MONETARY POLICY

THE RELATIONSHIP BETWEEN FISCAL AND MONETARY POLICIES IN COLOMBIA: AN EMPIRICAL EXPLORATION OF THE CREDIT RISK CHANNEL

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The Relationship between Fiscal and Monetary Policies in Colombia: An Empirical Exploration of the Credit Risk Channel*

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Abstract

This paper aims to provide evidence on the relationship between fiscal and monetary policy in Colombia through an empirical exploration of the credit risk channel. Under this approach, fiscal policy plays an important explanatory role in the sovereign risk premium, which, in turn, could affect the exchange rate and inflation expectations. The Central Bank reacts to inflation expectations using the policy interest rate; consequently, such reaction could be indirectly influenced by fiscal behavior. Using monthly data from January 2003 to December 2019, we estimate both jointly and independently the reduced-form core equations of a system that describes the credit risk channel in a small open economy. Our findings are in line with the model predictions. Fiscal policy affected the country's sovereign risk during this period, but only slightly. Hence, there is insufficient evidence to sustain the idea that monetary policy has been significantly influenced by government fiscal management.

JEL Codes: E61, E63, E62, E52 .

Keywords: Policy interaction, fiscal policy, monetary policy, sovereign credit risk.

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1 Introduction

This paper provides evidence on the relationship between fiscal and monetary policies in Colombia by exploring empirically the credit risk channel. According to this approach, fiscal policy plays an important explanatory role in the sovereign risk premium, which, in turn, could affect the exchange rate and inflation expectations. Considering that the Central Bank of Colombia reacts to inflation expectations using the policy interest rate, such reaction could be indirectly influenced by the country's fiscal stance Favero & Giavazzi (2005).

The interactions under the credit risk approach employ five reduced-form equations which look standard, as we shall explain later. One corresponds to the risk premium (assessed through the Emerging Markets Bonds Index, EMBI); the second one to the nominal exchange rate; the third to inflation expectations; and the last two for the monetary and fiscal policy rules. The premises are compelling. For instance, when a country faces a weak fiscal stance, the investors' risk appetite for local treasury bonds is negatively affected and so is the country's sovereign risk rating. Since country risk usually affects the exchange rate and inflation expectations, a weak fiscal situation might lead to monetary policy tightening as a tool to control inflation. Both the resulting higher interest rates and the greater indebtedness due to the exchange devaluation translate into a weakening of the government's fiscal health. In extreme circumstances, these dynamics could transform into vicious circles, leading to episodes called by the literature as of fiscal dominance.

Using monthly data from January 2003 to December 2019, we estimate both jointly and separately the reduced-form core equations for a system describing the credit risk channel in a small-open economy. Estimates are made using the Generalized Method of Moments (GMM) technique with instrumental lagged variables to cope with potential endogeneity problems. Our benchmark model satisfies several statistical tests, intended to evaluate its adequate performance given the size of the system and the frequency of the monthly data. We also develop simulation exercises to assess the interaction between fiscal and monetary policies in the presence of stress in the sovereign credit risk.

In general, our findings are in line with the predictions from the theory. First, we find that fiscal policy in Colombia has affected the country's sovereign risk, albeit marginally. In fact, considering previous estimates (Julio-Román et al. (2013)), it seems that this impact has reduced in size in the last years. Second, the channels are verified empirically as expected: that is, the EMBI impacts the nominal exchange rate positively, which, in turn, affects inflation expectations, and the monetary authority considers the latest variable for its policy rule. Even so, there is not enough evidence to sustain the idea that Colombia's monetary policy stance has been influenced in any important way by the government's fiscal actions.

This paper is organized into five sections in addition to this introduction. Section 2 presents a brief literature review. Data and the core equations that describe the reduced form of the model are described in Section 3. In Section 4 we present the results. Section 5 contains the simulation exercises, and finally, our conclusions are summarized in Section 6.

2 A Brief Literature Review

The literature provides both a model-based and an empirical analysis framework for assessing the credit risk channel role, when explaining the relationship between fiscal and monetary policies. In the first approach, models are usually designed to simulate policies in a closed or small-open economy. Some of them focus on the role of public debt and its sustainability, such as Leeper (1991) and Bonam & Lukkezen (2019); others remark on the importance of sovereign risk premium and the specific forms in which fiscal and monetary policy rules interact. According to Leeper (1991), given an increase in public debt, the economy reaches equilibrium if the fiscal authority moves its instruments until debt growth is below the long-run interest rate. Meanwhile, Bonam & Lukkezen (2019) argue that sustainable public debt requirements serve as a tool for the stabilization of the economy in scenarios where the sovereign risk premium affects the economy through a credit risk channel.

Regarding the role of default risk and its impact on inflation, Schabert & van Wijnbergen (2014) develop a model for a small-open economy with perfect international capital mobility. They conclude that if there is a positive correlation between the probability of default and the burden of the debt service, macroeconomic stability is jeopardized. High interest rates can lead to an increase in the debt service burden, causing a sense of panic over debt default. These can produce an exchange depreciation and higher prices for domestic goods, so the Central Bank must react by increasing interest rates.

In line with the previous idea, Arellano et al. (2020) study the Brazilian downturn in 2015, characterized by a combination of an increase in the sovereign risk spread, high inflation, and tight monetary policy. Under sovereign default risk, they find that a contractionary monetary policy tends to be less powerful despite the relatively high policy interest rate likely to occur in this scenario. On the contrary, Roettger (2019) proposes a model to show that, on average, economies with a positive default risk feature lower inflation. This effect is rather indirect because a higher default risk comes with a more debt-elastic bond price, which causes a faster decrease in the marginal revenue from debt issuance. The government borrows less and consequently reduces its incentive to adjust real debt payments using inflation.

Corsetti et al. (2013) and Locarno et al. (2013) model the sovereign risk premium in greater depth. The former argue that the sovereign risk channel makes the economy more vulnerable because the Central Bank is not able to reduce the interest rate enough to mitigate the negative demand shock. On the other hand, using the Bank of Italy's DSGE model, the latter find that the short-run contractionary effects of a fiscal tightening stance can be mitigated by a decrease in the sovereign risk premium.

On the empirical literature side, it is worthwhile to recognize that several papers carry out estimations of a broad set of reduced-form equations to infer the channels in which credit risk and fiscal and monetary policy rules interconnect. Büyükbaşaran et al. (2020) and Ankargren & Shahnazarian (2019) analyze coordination between fiscal and monetary policies for Turkey and Sweden, respectively. Both papers use a dynamic system of macroeconomic variables with a Bayesian SVAR model to argue that these policies are substitutes when a shock is caused by them, but they are complementary in the event of a supply or demand shock. Jawadi et al. (2016) argue that, in the case of BRICS, policy coordination can be useful in boosting recovery after a crisis or avoiding inflationary pressures during economic booms. In turn, Hodula & Pfeifer (2018) find that a mix of monetary and fiscal policies, aimed at stimulating real activity for the case of the Czech Republic, can generate systemic risk, causing output losses, deterioration of public revenues, deflationary pressures, and an increase in debt service.

For the European Monetary Union (EMU), some papers explore the determinants of sovereign bond yield spreads. Costantini et al. (2014) suggest that the main determinants are government debt and liquidity risk differentials, followed by accumulated inflation and fiscal balance differentials. Meanwhile, Afonso & Ramos-Félix (2014) and Afonso et al. (2015) conclude that local conditions such as financial and macroeconomic determinants play a crucial role in explaining bond spreads, especially during crisis periods.

Regarding the importance of local conditions, Afonso & Ramos-Félix (2014) find that those economies with worse macroeconomic and fiscal fundamentals are more vulnerable to a sovereign debt crisis. In this case, the real effective exchange rate, VIX, and bid-ask spreads act as transmission mechanisms. Meanwhile, Hallerberg & Wolff (2008) focus on the quality of national institutions as a tool to smoothen short-term negative external shocks. Specifically, they argue that better institutions not only improve long-term fiscal prospection, but also make national budget deficits less important, since markets will infer that a country with a good institutional system could manage a temporary shock.

Continuing with the empirical approach, Favero & Giavazzi (2005) explore how the risk could affect domestic macroeconomic policies in the case of Brazil. The authors propose a set of estimates and simulations to explain how the cost of servicing public debt fluctuates with sovereign risk, how far it is associated with international factors, and how default risk interacts with domestic monetary and fiscal policies through the exchange rate and the domestic interest rate.

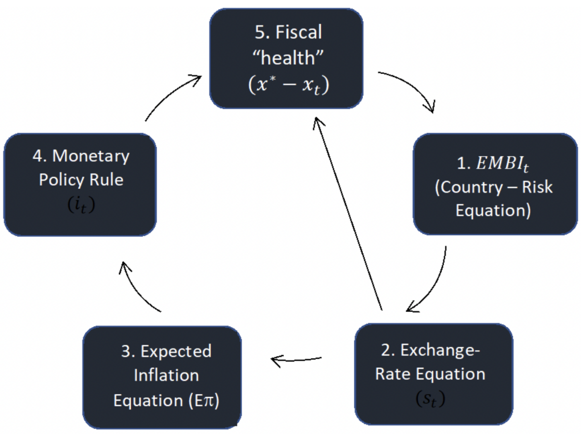
The purpose of this paper is also to explore the credit risk channel for the case of Colombia empirically. Previously, Julio-Román et al. (2013) explored the first of the four pieces of such channel, i.e., the relationship between the sovereign risk premium and the fiscal stance. Nonetheless, in this paper we extend the results by assessing the other parts of the model to explain the credit risk channel as whole. Our paper differs from Favero & Giavazzi (2005) seminal article in two ways, which could be interpreted as our contribution to the empirical literature. On the one hand, we implement a joint estimation of the equation system employing instrumental variables and, on the other, we extend some equations of the system according to the particularities of the Colombian economy.

3 Model and Data

3.1 The Reduced Form Model

Figure 1 explains how the credit risk channel operates regarding interactions between fiscal and monetary policies. As is illustrated, the system contains five equations that include the main macroeconomic variables and summarize the way in which these interact in a small-open economy. The credit risk is captured by the EMBI, which plays a key role in the system. It could be influenced by fiscal health, and its behavior could be transmitted to the monetary policy through the nominal exchange rate and inflation expectations. In addition to the variables enclosed in the monetary and fiscal rules, this analysis focuses on the role of the EMBI spread, nominal exchange rate and inflation expectations[1].

Figure 1: The Credit Risk Channel in the Reduced-Form Model



Notes: Authors' design

[1]We employ two fiscal rule scenarios: A Ricardian regime and a non-Ricardian one. The equations associated with monetary rule, EMBI spread, nominal exchange rate and inflation expectations remain unaltered under both scenarios.

Equation 3.1 describes the EMBI spread. $EMBI_t$ corresponds to the spread between the yield on government bonds in an emerging country, denominated in US dollars, and the yield on a US Treasury bond of the same term.[2] $Spread_t^{US(10)}$ is the corporate bond spread, i.e., the spread between the yield on BAA US corporate bonds with maturities of 20 years and above and the yield on 10-year US Treasury bonds, and $\Delta\ Spread_t^{US(10)}$ is the first difference of the corporate bond spread.

$$EMBI_t = \gamma_1 EMBI_{t-1} + \gamma_2^{'} Spread_t^{US(10)} + \gamma_3^{'} \Delta Spread_t^{US(10)} + \epsilon_{1,t}. \tag{3.1}$$

In Equation 3.1, $\gamma_2^{'}$ incorporates a time-varying response of EMBI to $Spread_t^{US(10)}$ with two features (Equation 3.2): i.) such relationship is of non-linear nature, and ii.) it depends on the state of the fiscal policy, which is equal to the difference between the observed primary fiscal balance (x_t) and a primary fiscal balance that keeps the public debt constant (x_t^*) (see Favero & Giavazzi (2005) and Julio-Román et al. (2013)). The primary balance is the difference between revenues and expenses from the Central National Government (CNG), excluding interest payments.

$$\gamma_{2,t}^{'} = \gamma_2 (1 + e^{-(x^* - x_t)})^{-1}. \tag{3.2}$$

In Equation 3.3, and following Burrnside (2005), x_t^* is equal to a fraction of CNG's net debt[3] as a share of GDP at a previous period (b_{t-1}). This depends on three variables: a weighted average between the interest rates paid on domestic and foreign public debt, adjusted by nominal exchange rate depreciation (see Equation 3.4)[4] $\bar{\imath}_t$, the real GDP growth, n_t, which is the annual variation of quarterly real GDP, and the inflation rate, π_t, which is the annual variation of the monthly Consumer Price Index (CPI).

$$x_t^* = (\frac{\bar{\imath}_t - n_t - \pi_t}{1 + n_t + \pi_t}) b_{t-1}, \tag{3.3}$$

$$\bar{\imath}_t = (1 - \mu)((1 + i_t)^{\frac{1}{12}} - 1) + \mu((1 + i_t^{US} + EMBI_t)^{\frac{1}{12}} - 1)\frac{s_t}{s_{t-1}}. \tag{3.4}$$

The monetary policy rule follows Equation 3.5, where the current policy interest rate, i_t, depends on what happens with this variable at $t-1$, but also on inflation expectations one year into the future (defined by Equation 3.6), the inflation target π_t^*, and the GDP gap y^*, as it is stated by a traditional Taylor Rule. The current policy interest rate is defined as the nominal interest rate at which the Central Bank (BR) lends to financial

[2] The Emerging Market Bond Index (EMBI) spread was introduced by J.P. Morgan in 1992. More recently, the EMBI+, the EMBI-Global and the EMBI-Global Diversified Index have been introduced by this agency.

[3] Net debt corresponds to gross debt minus the government's financial assets.

[4] In Equation 3.4, μ denotes the share of foreign public debt, i.e., the percentage of the total public debt held by foreign lenders; i and i^{US} denote the interest rates paid on domestic and foreign public debt, respectively; and s represents the nominal exchange rate.

institutions overnight. Inflation expectations come from a monthly survey conducted by BR to economic analysts and correspond to the analysts' forecast of inflation 12 months ahead. The inflation target is the one set by the Board of Directors of the Central Bank, and the GDP gap is the difference between observed GDP and its trend, which is estimated using a Hodrick Prescott filter.

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1(E_t\pi_{t+12} - \pi_t^*) + \beta_2 y_t^*) + \epsilon_{2,t}. \tag{3.5}$$

We model inflation expectations using a reduced-form extension of the hybrid New Keynesian Phillips Curves, NKPC (Equation 3.6).

$$E_t\pi_{t+12} - \pi_t^* = \delta_1\pi_{t-1} + \delta_2(E_{t+3}\pi_{t+12} - \pi_t^*) + \delta_3 y_t^* + \delta_4(\Delta s_t - \pi_t^*) + \epsilon_{3,t}. \tag{3.6}$$

Following the NKPC prescription, inflation expectations adjusted by the inflation target, $(E_t\pi_{t+12} - \pi_t^*)$ are driven by forward-looking information, i.e., further-ahead inflation expectations, $(E_{t+3}\pi_{t+12} - \pi_t^*)$, current information (e.g. the current output gap y_t^* as a proxy for marginal costs which is common in the literature), and backward-looking information (i.e. past realized inflation). To examine whether there is lack of some potentially important but omitted variables, we follow Hubert & Mirza (2014), by including the adjusted current nominal depreciation rate of the peso ($\Delta s_t - \pi_t^*$) , where s_t, is defined as the rate at which the monthly amount of Colombian pesos paid in exchange to one US dollar changes.

Equation 3.7 is a reduced form of the nominal exchange rate depreciation, which comes because of combining equations (3.1), (3.5), (3.6), and a traditional uncovered interest rate parity condition[5]. In this case, Δs_t is the nominal depreciation of the Colombian peso, i_t is the Colombian policy interest rate already defined in Equation 3.5, and i_t^{US} is the overnight nominal interest rate at which depository institutions trade federal funds with each other.

$$\Delta s_t = \alpha_1(i_{t-1} - i_{t-1}^{US}) + \alpha_2 EMBI_{t-1} + \alpha_3\Delta(EMBI)_t + \epsilon_{4,t}. \tag{3.7}$$

Finally, the fiscal rule is straightforward (Equation 3.8): it is a linear combination of the inertial behavior of the primary fiscal balance and how important it is for the fiscal authority to respond to changes in the primary fiscal balance to keep the public debt ratio constant. From this, two cases emerge: when $\phi = 1$, the fiscal authority only cares for what happens with the observed primary fiscal balance (in other words, x_t is exogenous); in this case, we call this rule a non-Ricardian one. On the contrary, when $\phi = 0$, x_t^*, is the main concern and all changes in the observed primary fiscal balance seek to follow

[5] In other words, we use the equation: $E_t s_{t+1} - s_t = (i_t - i_t^{US}) + \zeta_t$.

x_t^*. Such a rule is labeled as Ricardian.

$$x_t = \phi x_{t-1} + (1 - \phi)x_t^* + \epsilon_{5,t}. \tag{3.8}$$

For the purposes of this paper, we simulate what could happen with the Colombian economy whether the fiscal rule is Ricardian or not. Nevertheless, we avoid the case where $\phi = 0$, and we use instead a quasi-Ricardian rule, where $\phi = 0.75$, as an attempt to make our simulations more realistic.[6]

From this framework, we expect to capture how a rise in the sovereign risk premium causes a reduction in net capital inflows and a nominal and real depreciation of the local currency that impacts inflation expectations, the ratio of public debt to GDP, and x_t^*. The extent to which such a rise in sovereign risk affects monetary policy will depend on the nature of the fiscal policy rule. If the rule is Ricardian, the fiscal authority will adjust the primary balance to address the increasing debt and the monetary authority will engage in fewer changes to interest rates to anchor inflation expectations. On the other hand, if the fiscal rule is non-Ricardian, the inertial behavior of the fiscal authority will hinder the action of monetary policy by controlling sovereign shock and anchoring inflation expectations. This implies that monetary authority could engage in further changes involving its monetary instruments to counteract the negative effects of this shock on inflation.

3.2 Data

Table (1) reports the descriptive statistics of the variables used in the analysis, their original frequency, and sources. The econometric models being applied are GMM with instrumental variables and OLS, following a double strategy: joint estimation for all the system and independent estimation of each equation. To carry out the EMBI spread estimation, Equation 3.1, we employed monthly observations of the EMBI-Spread, domestic and external public debt interest rates, and the central government's primary balance. In turn, the inflation target, inflation expectations (which come from a survey of market analysts), the monetary policy interest rate, and the domestic real GDP gap are employed in the estimation of the monetary policy rule (Equation 3.5). The inflation expectations Equation 3.6 uses a subset of these variables (inflation expectations, GDP gap) plus the observed nominal USD/COP exchange rate. To check robustness in our results, we also include proxies for inflation expectations at longer horizons and one-year inflation expectation extracted from the public debt bonds market, known as the Breakeven Inflation

[6] 0.75 is the same value used in the simulations made by Favero & Giavazzi (2005) and is a realistic value for a Latin American country, such as Colombia.

(BEI)[7] and a variation of it[8], which does not consider neither Inflation Risk Premia nor Liquidity Risk (denoted as $NIRBEI$).

To capture the influence from the financial external environment, the exchange rate Equation 3.7 uses the Federal Funds interest rate, the US 10-year Treasury Yield, and Moody's BAA of US Corporate Bonds spread. It is worthwhile also to mention that the annual inflation rate (from the CPI index), the total net public debt, and the annual growth of real GDP are necessary to calculate the primary balance that keeps public debt constant (x_t^*). Moreover, the real GDP gap comes from a Hodrick-Prescott filter applied to real GDP (2015=100).

The primary balance, real GDP, and net debt are calculated on a quarterly basis, which makes the use of a temporal conversion method necessary. For our purposes, we use the Litterman method[9] with the option that each three-month observation matches the sum (real GDP) or the average (primary balance and net debt) of the quarterly data. Finally, our timespan covers data from 2000 to 2019, although it differs depending on the availability of each variable for the first periods of this 20-year window. Specifically, the primary balance is available beginning in January 2001, the domestic and external national debt interest rates from June 2001, the 12-month-ahead inflation expectations from September 2003, and the BEI measures are available from January 2006. Nevertheless, during our estimation procedure, we used the maximum time-window available for all the variables included in the system of equation.

The descriptive statistics for all variables depict how under the inflation targeting regime, adopted since the early years of the century, variables such as inflation or interest rates move in a relatively narrow interval, compared with previous periods of time such as the nineties, for example. It also shows the presence of enough dispersion in key variables such as the EMBI, the exchange rate, and the Net Debt, which will later allow us to design experiments to determine how the behavior of fiscal and monetary policies could mitigate external credit shocks. It also presents a summary of units for all variables.

4 Results

Results are presented following a double empirical estimation strategy. First, all endogenous variables of the system described in Section 3 are estimated jointly, using a

[7]The Breakeven inflation is defined as the implicit expected inflation derived from specific-term Treasury Constant Maturity Securities and Treasury Inflation-indexed Constant Maturity Securities of the same term.

[8]Specifically, we use the One-Year Breakeven Inflation minus an estimation of the inflation risk premia (an extra yield that investors require to hold assets exposed to inflation risk instead of others which offer an inflation-adjusted returns). This variable is free from a Liquidity Premia, which is found to be zero for the Colombian case. See Arango & Melo (2002), Hördahl & Tristani (2012), and Grishchenko & zhi Huang (2012) for more details.

[9]See Litterman (1983) for details.

Table 1: Descriptive Statistics for the Sample Period

Variable (Units)	Frequency	Source	Mean	Median	Max	Min	Std. Dev.	Obs
Primary Balance (% GDP)	Quarterly	Ministry of Finance and Public Credit of Colombia (MHCP)	-0.41	-0.50	2.16	-2.45	0.95	228
Primary Balance* (%GDP)	Monthly	Authors' calculations.	-0.36	-0.41	1.55	-1.70	0.65	203
Real GDP Growth (%)	Quarterly	National Administrative Department of Statistic of Colombia (DANE)	3.97	3.77	9.29	-1.25	2.13	216
EMBI Spread (BPs)	Monthly	Bloomberg	3.05	2.15	9.86	1.08	1.85	240
12-months-ahead Inflation Exp. (%)	Monthly	Central Bank of Colombia (BR)	4.02	3.64	6.34	2.85	0.85	196
One-Year Break-Even Inflation (%)	Monthly	Central Bank of Colombia (BR)	3.65	3.44	6.42	1.62	1.12	168
One-Year Break-Even Inflation minus Inflation Risk Premia (%)	Monthly	Central Bank of Colombia (BR)	3.72	3.42	6.64	1.75	1.07	168
Implic. Interest Rate on Debt (%)	Monthly	Authors' calculations	1.08	1.07	1.12	1.06	0.02	223
Inflation(%)	Monthly	DANE	5.00	4.72	10.00	1.76	2.07	240
Policy Interest Rate (%)	Monthly	BR	6.28	6.00	12.00	3.00	2.49	240
Exchange Rate(US$/COP)	Monthly	BR	$2,383	$2,300	$3,433	$1,731	$469	240
BAA Spread (BPs)	Monthly	St. Louis' Federal Reserve	2.62	2.57	6.01	1.55	0.75	240
Net Debt (%GDP)	Quarterly	MHCP	37.91	37.37	48.84	28.17	4.98	204
Fed Funds Rate (%)	Monthly	St. Louis' Federal Reserve	1.78	1.16	6.54	0.07	1.92	240
Interest rate on Domestic Public Debt (%)	Monthly	MHCP	6.55	5.94	12.92	4.65	1.56	223
Interest rate on Foreign Public Debt (%)	Monthly	MHCP	9.94	8.99	15.71	7.53	2.04	223
Inflation Target (%)	Monthly	BR	4.38	3.50	10.00	3.00	1.87	240
Proportion of Domestic Public Debt (Prop. Of Total Public Debt)	Monthly	MHCP	0.65	0.66	0.73	0.47	0.07	223

Notes: Authors' calculations.

GMM technique with instrumental variables to control for potential endogeneity problems[10]. The resulting model is used for the simulation exercises that we shall present in Section 5. Alternatively, equations are estimated independently (i.e., equation by equation) using OLS and 2SLS when needed, as it was done in previous papers Favero & Giavazzi (2005).

4.1 Joint Estimation

The results of the joint-GMM-benchmark-estimation are summarized in the first column of Table (2). Its selection considers both a suitable structure of instruments (chosen by means of the Hansen's test) and the usual statistical individual-and joint significance levels. To check robustness of our benchmark model, we include results for alternative future horizon of inflation expectations as well as the One-Year Break-Even Inflation instead of 12-months-ahead inflation expectation from survey of experts (columns from 2 to 6).

Starting with the EMBI spread equation, the estimated coefficients have the expected signs and are statistically different from zero. A relatively high autoregressive coefficient was found (0.96), suggesting an important persistence of the country risk perception. According to the risk channel approach, the EMBI is mainly determined by the global appetite for risk $\gamma'_{2,t}$ although such response is non-linear and depends on the government's fiscal stance. For the sample 2003.01 to 2019.12, the magnitude of the coefficient that governs this relation is relatively small (0.07), suggesting that the transmission mechanism between the fiscal balance and the EMBI is rather modest. With respect to previous estimates for Colombia Julio-Román et al. (2013), the parameter is lower, but there are clear differences specially related with the sample and the estimation technique. On the other hand, the EMBI is considerably affected by the changes of the corporate bond spread across time, since this relation exhibits a coefficient of large magnitude (1.1).

Figure 2 depicts both theoretically (Panel 2a) and empirically (Panel 2b) how $\gamma'_{2,t}$ evolves when $(x^* - x_t)$ changes. When the difference between the primary balance that stabilizes the debt ratio and the observed primary balance is positive (negative), the positive effect on the EMBI spread is higher (lower). Such difference also reflects the fiscal health indicator. To the extent that such difference increases, the fragility of public finances (bad fiscal health) is larger, and vice versa. Notice that, using observed data (Panel 2b), we did not find a concentration of values at the extreme sides of the exponential function. On the contrary, they were located at the center of the distribution,

[10]Specifically, it is the result of applying the efficient-GMM procedure to the system of equations explained in Section 3 with the following options: an identity matrix as the weighting matrix in the first-step parameter estimates and a heteroskedasticity and autocorrelation consistent (HAC) weight matrix with the Bartlett kernel with three lags. It also was selected after a filtering process created to discard models with Hansen's J p-values close to one, following the ideas of Roodman (2009).

Table 2: Econometric Results

Coefficient	Joint estimation[a]						Independent estimation[b]
	Benckmark[c]	$E_{t+6}\pi_{t+12}$[d]	$E_{t+9}\pi_{t+12}$[e]	$E_{t+12}\pi_{t+12}$[f]	BEI_t[g]	NIPBEI[h]	
EMBI spread equation - eq. 3.1							
γ_1	0.958***	0.953***	0.956***	0.951***	0.957***	0.962***	0.9663***
$\gamma_{2,t}^{'}$	0.0650**	0.0718**	0.0672**	0.0786***	0.0676**	0.0576**	0.0534*
γ_3	1.102***	1.108***	1.114***	1.189***	0.936***	0.910***	0.9817***
Monetary policy rule equation - eq. 3.5							
ρ	0.972***	0.973***	0.973***	0.974***	0.962***	0.955***	0.952***
β_0	3.182***	3.012***	3.040***	2.873***	4.100***	3.975***	4.1696***
β_1	4.818***	5.330***	5.481***	5.413***	3.072***	3.438***	1.6181***
β_2	3.272***	3.418***	3.357***	3.505***	2.189***	1.446**	1.3552***
Exchange rate equation - eq. 3.7							
α_1	-0.885*	-0.865*	-0.949**	-0.790*	-1.319**	-1.357**	-0.1428*
α_2	1.833**	1.789*	1.946**	1.683*	3.036**	3.114**	0.2732**
α_3	5.883***	6.180***	6.277***	6.304***	8.064***	8.226***	3.9601***
α_4	7.572*	6.785	7.302*	8.194**	7.333***	7.366***	9.7068***
α_5	10.30***	10.37***	10.34***	9.954***	6.599***	7.164***	11.805***
Inflation expectations equation - eq. 3.6							
δ_1	0.0963***	0.106***	0.111***	0.155***	0.115**	0.156***	0.0551***
δ_2	0.534***	0.669***	0.607**	0.0941	0.640***	0.481***	0.6227***
δ_3	0.0309	-0.0558	-0.0654	0.00341	-0.0443	0.110*	-0.0358
δ_4	-0.0309	0.0966***	0.102***	0.107***	0.105*	0.136***	0.0216*
Fiscal policy rule equation - eq. 3.8							
φ_1	0.970***	0.972***	0.971***	0.967***	0.954***	0.959***	0.9634***
φ_2	0.0164	-0.0266	-0.377	-0.481	0.175	0.151	-0.1644
J-value	-0.0164	18.83	18.2	19.61	19.62	17.6	-
J p-value	0.538	0.596	0.637	0.546	0.546	0.674	-

Source: Authors' calculations.

[a] In this estimation we instrument the endogenous variables EMBI spread, exchange rate and inflation expectations with their lags. We use lags from 1 to 11, except for the exchange rate, where we use one lag. Significance levels are: '***' 1%, '**' 5%, and '*' 10%.

[b] In this exercise, all equations are estimated by OLS, except for the Equation 3.7, which is estimated by GMM.

[c] We use the 12-months-ahead inflation expectations from surveys as the inflation expectations variable in equations 2 and 4.

[d] We use the sixth lead of 12-months-ahead inflation expectations from surveys as an explanatory variable in Equation 4.

[e] We use the ninth lead of 12-months-ahead inflation expectations from surveys as an explanatory variable in Equation 4.

[f] We use the twelfth lead of 12-months-ahead inflation expectations from surveys as an explanatory variable in Equation 4.

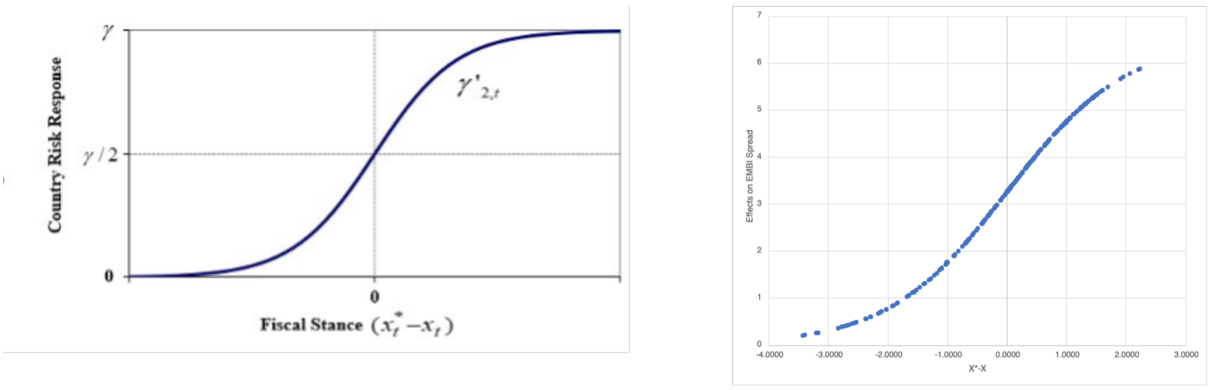
[g] In equations 2 and 4, we replace the 12-months-ahead inflation expectations from surveys for the One-Year Breakeven Inflation.

[h] We use the One-Year Breakeven Inflation less the Inflation Risk Premia, assuming that the Liquidity Risk is zero, as the Inflation variable in equations 2 and 4.

meaning that the fiscal stance has remained in a "neutral area" (in other words, Colombia did not experience neither good nor bad fiscal health extreme episodes for prolonged periods between 2003 and 2019).

Figure 2: EMBI-Colombian Elasticity with Respect to Corporate US Bonds, Affected by the Colombian Fiscal Health $(x^* - x_t)$

(a) Theoretical Approach (b) Estimates for Colombia



Notes: Authors' calculations.

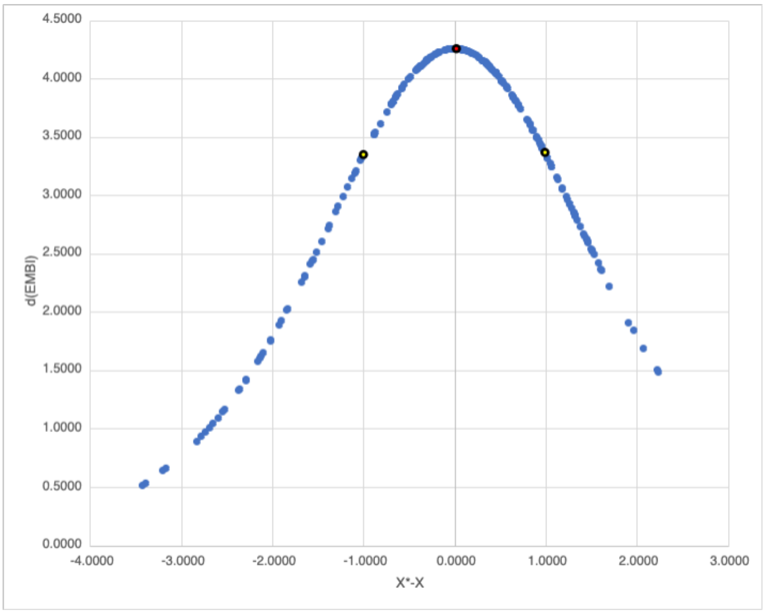
Figure 3 depicts the variation in the EMBI spread when the primary balance differential changes for a given value for the appetite for risk[11]. We found that the EMBI spread reacts relatively more when the difference between the primary balances is close to zero. On the contrary, when such difference increases in absolute value, the EMBI spread variation is lower. Notice that a marginal change in the fiscal balance from equilibrium implies a 4.3 basis points (bp) increase in the EMBI Spread (red mark on Figure 3), while a difference of 100 bp between the primary balances spread will cause a lower change in the EMBI, equal to 3.6 bp (yellow marks on Figure 3).

Results for the monetary policy rule have the expected sign and show high persistence (0.97), which implies a smooth adjustment of the policy interest rate to its benchmark levels, as predicted by the Taylor rule (Hofmann & Bogdanova (2012)). The resulting coefficient for the 12-month-ahead inflation expectations deviation from the inflation target is 0.13 (by solving $(1 - \rho) * \beta_1$), which means that the Central Bank reacts by increasing the policy interest rate when inflation expectations tend to be unanchored (in this case, above the target). At the same time, a 0.09 coefficient (by solving $(1 - \rho) * \beta_2$), shows that the Central Bank also reacts to changes in the output gap, although less intensely, to guarantee that demand shocks do not affect the long-run inflation target. It is important to remark that the estimated relative magnitudes of the last two coefficients are consistent with the traditional prescription of the Taylor rule (do not the levels of each independently).

In the case of the exchange rate equation, the coefficient that captures its sensitivity to

[11] We use the average for all the sample, which is equal to 2.62. See Table (1) for details.

Figure 3: Estimated Effects on EMBI (b.p) when Fiscal Health Changes



Notes: Authors' calculations.

the interest rate differential is negative, as expected. The meaning is straightforward: for a given US policy interest rate, a 100-basis points (bp) increase in the Colombian policy interest rate will appreciate the nominal exchange rate by 88.5 bp. The negative effect of such differential could be explained by the fact that when it increases, it also creates an incentive to an increase in portfolio capital inflows that, in turn, end appreciating the nominal exchange rate.

On the other hand, a nominal exchange rate depreciation could be caused by an increase in the lagged sovereign risk premium or by upsurges in the speed at which the EMBI spread increases, which is also responsible for an even greater depreciation. The positive and non-negligible impact on the nominal exchange rate from both the EMBI level (lagged) and its changes are a crucial link for the interactions between the monetary and fiscal policies, as we already explained in Section 3. It is worth mentioning that the dummy variable coefficients are statistically significant, since they represent periods of major depreciation possibly associated with external factors not captured by the system.

Regarding inflation expectations, defined as the spread between inflation expectations 12-months ahead and the inflation target, our findings suggest that it reacts more to prospective than to past information. Following Hubert & Mirza (2014), professional forecasters pay more attention to long-term forward-looking information in forming their short-run expectations (the coefficient of 0.53, more than five times bigger than the previous-period observed inflation of 0.1). The output gap has the predicted sign, although it is not statistically significant, as it usually happens when the Neo-Keynesian

Phillips Curve is estimated. Furthermore, the pass-through from the exchange rate to inflation expectation is positive and statistically significant, implying that when there is a nominal depreciation of the exchange rate, agents believe there would be surge in inflation in the short term (0.07).

Finally, the basic fiscal rule we estimated has a high persistence, given that the coefficient for the lagged primary balance is close to 1 (0.97). Also, notice that since the coefficient φ_2 is not statistically significant, we could argue that the long-run fiscal primary balance tends to be in equilibrium. These findings could mean that the primary balance would be almost completely exogenous, and that the government reacts according to its own plans without bearing in mind some stabilization mechanism.

We recognize that the fiscal results can be a straight consequence of the simple way in which the fiscal rule was modeled. We do not consider the output as a determinant of the fiscal primary balance because the equation system that describes the credit risk channel does not include an equation for output determinants (i.e., output gap). Therefore, it is also important to remark that our emphasis has consisted in providing evidence of how the fiscal policy (through the EMBI, exchange rate, and inflation expectations) affects the monetary policy without considering the second-order effects that could come from variations in output. In this regard, we argue that our strategy aims at identifying the credit risk channel and its impact on the monetary policy rule through inflation expectations, holding the effect through variations in output and the output gap constant.

4.2 Robustness Analysis

The scope of this subsection is to analyze what could happen with our results when we perform two different experiments: first, we modify the variable $(E_{t+3}\pi_{t+12} - \pi_t^*)$ in Equation 3.6, by replacing it for variables that express inflation expectations for longer-term leads. For this, we use the sixth, ninth and twelfth leads of this variable as proxies for longer-term inflation expectations as a way of testing how it modifies the behavior of the inflation expectations at period t (Equation 3.6) and the whole system dynamics. Columns 2 to 4 in Table (2) display the results.

In general, we observe little changes in coefficients' magnitudes and statistical significance. The only meaningful exception is the coefficient δ_2 in column 4 (equation of inflation expectations), which becomes statistically insignificant and less than δ_1. From this experiment we infer that all the Equation parameters estimated are robust, no matter what lead of inflation expectations we use. This is valid up to the ninth lead, and it is only the coefficient for the proxy for a longer-term inflation expectation that loses their statistical significance and their predicted relationship with δ_1, although it retains its correct sign.

The second experiment consist of replacing the inflation expectations from surveys for two market-based inflation expectations: the One-Year Breakeven Inflation (column 5) and the One-Year Breakeven Inflation minus the Inflation Risk Premia, assuming that the Liquidity Risk is zero[12] (column 6). As in the previous case, we find minor changes in estimated coefficients' magnitudes and statistical significance. The only noticeable variation is that δ_3 in column 6 is now statistically significant at 0.1 and it holds a positive sign as predicted by the theoretical New Keynesian Phillips Curve. It is worth noting that in all cases the set of instruments are considered exogenous because the results of the J-test give us enough statistical evidence to not reject the null hypothesis of exogenous instruments, at the usual significance levels.

In consequence and given the importance of the inflation expectations equation in the system, we infer that our benchmark model is adequate, since it holds similar behavior as in the models that include inflation expectations implicit in the Colombian public debt market dynamics and that come from the agents' predictions about its future behavior.

4.3 Independent Estimation (Equation by Equation)

Results of the independent estimation (equation by equation) are presented in the last column of Table (2) (column 7). All the equations of the system are estimated by OLS, except for the nominal exchange rate depreciation equation 3.7, which is estimated by GMM due to the evident endogeneity problem that it holds. As in the joint estimation case, here we also use lags of endogenous variables as instruments. The main purpose for presenting the results of this alternative estimation is that they allow us to compare them with those obtained by the joint estimation; therefore, this can also be used as a robustness exercise. The independent estimation is the empirical strategy used in previous papers Favero & Giavazzi (2005), but clearly this method does not take advantage of all the information used in the joint estimation.

As observed, the sign and statistical significance of all the parameters are similar vis-à-vis the joint estimation case. Regarding the size of the parameters, those obtained from the independent estimation are similar to the joint estimation ones. There are only few cases where the size of the parameters is below or above, although they are close to one of them.

Taking all the estimations together, this paper provides evidence in favor of the credit risk channel as a link between fiscal and monetary policies in Colombia. Fiscal policy appears to affect the country's sovereign risk in a moderate and indirect way through international investors' risk appetite. In turn, the country's sovereign risk appears as an important explanatory variable in the nominal exchange rate equation. Finally, the monetary authority seems to consider inflation expectations when managing the policy interest rate, and the inflation expectations appear to be affected especially by volatility

[12] Their definitions are already discussed in subsection 3.2.

of the nominal exchange rate.

5 Simulations

The simulations developed in this section are made to corroborate the results presented in Section 4, especially under stresses in the sovereign credit risk. In doing so, we predict the paths for the main endogenous variables of the system using the estimated parameters from the benchmark model (column 1 of Table 2) and a set of initial observed values, chosen carefully from a date which reflects a true negative state of external credit risk. The adverse shock on the external prices of commodities (oil) that the Colombian economy faced since mid-2014 was selected for this purpose.

The collapse of oil prices caused an important reduction in government revenues, generating an increment on the primary fiscal deficit and in the risk perception on public debt. The negative impact on fiscal accounts was fully reflected in 2016. In this year, both the EMBI and the BAA Spread recorded maximum values (in February). At the same time, inflation expectations were above the inflation target (around 1.5 percent), and the nominal exchange rate depreciation reached unprecedented values. Considering all these observed facts, we chose February of 2016 as the initial date for the experiment. Table (3) summarizes the initial values for the key variables in the simulation exercises as well as the average values two years before the shock.

Table 3: Initial and Previous Values for Key Variables of the Model

Variables	Two years before the commodity shock prices (Averages)	Initial values for simulation (Feb-2016)
EMBI	152.8	392.3
BAA Spread	2.9	3.6
FED Funds	0.1	0.4
Nom. Exchange rate (USD/COP)	$1,833.1	$3,354.7
Policy interest rate	4.2	6.1
Inflation	2.6	7.6
Inflation Expectation	3.2	4.5
Inflation target	3.0	3.0
CGDP	0.1	-0.7

Notes: The sources are FRED, Bloomberg, the Colombian Ministry of Finance and Public Credit, and *Banco de la República*.

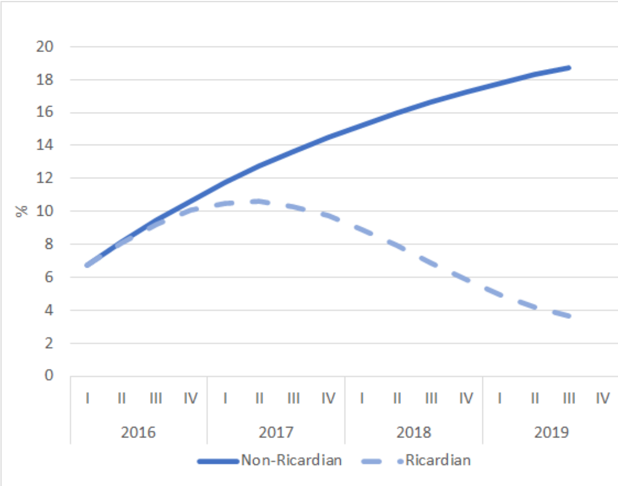
The results of the simulation exercises are shown in Figure 4. The model predictions for the endogenous variables were made under Ricardian and non-Ricardian fiscal regimes. In particular, the variables predicted for a 24-months-ahead horizon, are the monetary policy interest rate, the EMBI spread, the nominal exchange rate, inflation expectations, and the CNG's Primary Balance (CGPB). We depict them on a quarterly basis for better exposition. It is important to emphasize that this simulation should not be interpreted as an impulse-response analysis. Instead, it provides an insight on the possible trajectory of relevant variables when keeping the economic environment under an external stress.

The main message derived from the exercises suggests that a more Ricardian-oriented fiscal policy allows the Central Bank to reduce the movement of the policy interest rate to re-anchor inflation expectations as compared with the non-Ricardian regime. The upper side of Figure 4 shows how, with a high degree of country-risk associated to a persistent fiscal deficit, the Central Bank would have needed to continuously increase its policy interest rate along the all period (2016 to 2019) under the non-Ricardian regime (solid blue line in Figure 4a) to bring inflation expectations close to the target (Figure 4d). By contrast, under a Ricardian regime such increase would have been only for a fewer quarter (4 in 2016).

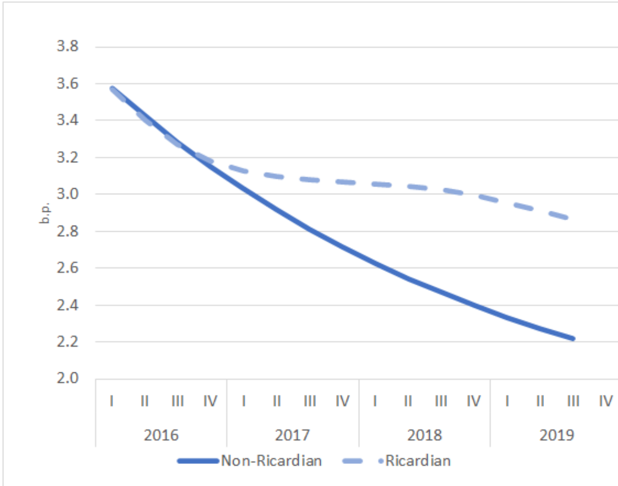
Also, please note that when the government is more committed to adjusting the fiscal imbalance (dashed line in Figure 4e), the country risk becomes stable (Figure 4b), and the pressures on the nominal exchange rate are softened (Figure 4c). In line with the previous findings, the tacit coordination between fiscal and monetary policies in the Ricardian regime, which implies that each one is committed to its objectives and has a set of instruments available for achieving its own goals, is the ideal scenario for macroeconomic stabilization.

Figure 4: Simulated Macroeconomic Trends under Stress in the Sovereign Credit Risk

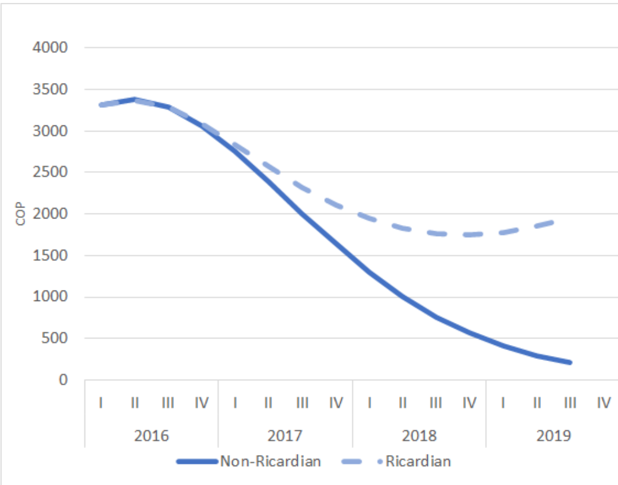
(a) Monetary Policy Interest Rate



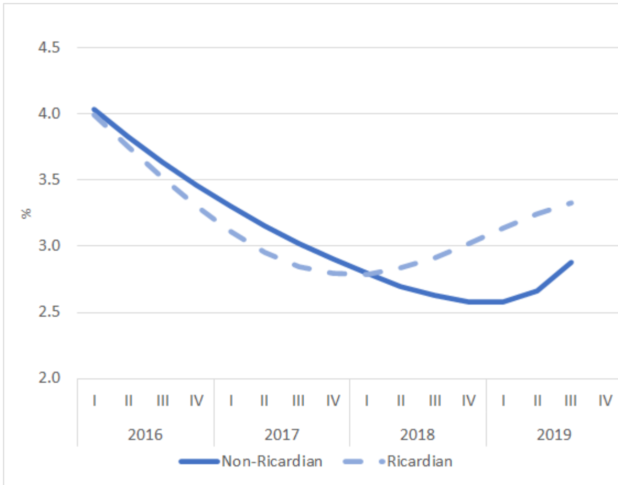
(b) EMBI Spread



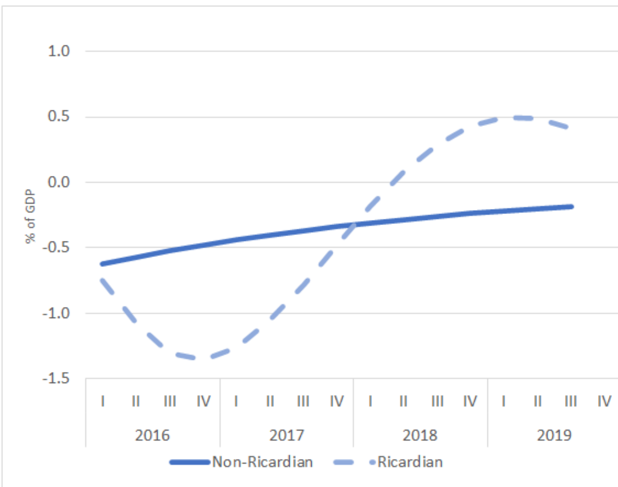
(c) Nominal Exchange Rate



(d) Inflation Expectations 12-Months-ahead



(e) Central Government Primary Balance



Notes: Authors' calculations.

6 Concluding Remarks

The EMBI spread is one of the most important indicators of sovereign credit risk in emerging economies, as it is closely related with the so-called macro fundamentals and, therefore, is usually followed by foreign investors to assess the performance of emerging markets. In this paper we use the EMBI spread as a proxy for the credit risk channel through which the interaction between fiscal and monetary policies in Colombia may be empirically explained.

The macro-level interactions under the credit risk approach are indeed compelling. When a country faces weak fiscal health, foreign investors' risk appetite for local treasury bonds is negatively affected, and, therefore, the country's sovereign risk rating. Since the country risk usually affects the exchange rates and inflation expectations, a weak fiscal situation might lead to a monetary policy tightening to control inflation. Both the resulting higher interest rates and the greater indebtedness due to the exchange devaluation could weaken fiscal health even further, thus leading to potential extreme situations of fiscal dominance.

Using Colombia's monthly data for the period 2003-01 to 2019-12, we estimated, both jointly and separately, the reduced-form core equations for a system describing the credit risk channel in a small-open economy. We used the estimates to develop simulation exercises for explaining the dynamics between fiscal and monetary policies, especially under stresses in the sovereign credit risk.

Based on our estimates, we concluded that the fiscal policy has played an important explanatory role in the sovereign risk premium, affecting both the exchange rate and inflation expectations. Nonetheless, the fiscal policy impact on the country's sovereign risk is slight. Considering previous estimates for Colombia, it seems more reduced in size in the last years. Although the interaction between the rest of variables works as expected empirically, there is not enough evidence to support that monetary policy has been importantly influenced by the government's fiscal management.

The low EMBI-Colombian sensitivity to global risk appetite due to fiscal fragility has important implications for the economy. From a fiscal point of view, it may imply a reduction of the financial costs as well as better access to debt markets. In terms of capital cost, these results may have a positive effect on the interest rate in the long run, benefiting the financial cost of investment.

Important messages are derived from the simulation exercises. For instance, they suggest that a more Ricardian-oriented fiscal policy allows the Central Bank to be less active with its policy interest rate to re-anchor inflation expectations, as compared with the non-Ricardian regime. Moreover, when the government is more committed to adjusting the fiscal imbalance, sovereign risk becomes stable, and the pressures on the exchange rate are softened. Therefore, coordination between fiscal and monetary policies in which each one is committed to achieving its objectives with its available set of instruments is the preferred scenario for macroeconomic stabilization.

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