The Covid-19 shock and the monetary policy response in Colombia

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Abstract

This paper analyses some of the challenges posed by the Covid-19 shock in Colombia, describes the monetary policy response and discusses the effects on the fiscal position. Evidence is presented for non-linear responses of EME risk premia (CDS) to their determinants, depending on the public debt-to-GDP ratio and the distribution of the risk premium. These findings are introduced in a DSGE model that includes the fiscal sector for Colombia (COFFEE model) to illustrate how increasing public debt levels may constrain monetary policy through a higher sovereign risk premium and a higher responsiveness of the latter to shocks affecting its fundamentals.

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1. Introduction

The unprecedented effects of Covid-19 on financial markets and the macroeconomy has led to strong policy responses on the part of Bank of the Republic and the Colombian government. This note describes the effects of the shock on Colombian financial markets, as well as the response of the central bank and the outcomes, with special attention to the asset purchase programmes implemented. It also discusses the effects on public finances and the ensuing fiscal challenges facing the country, along with the possible constraints imposed on monetary policy. The relationship between government debt and the sovereign risk premia (CDS) is a key consideration that we explore empirically for a sample of emerging market economies (EMEs).

2. The central bank response to the Covid-19 shock

Public and private bond purchases by Bank of the Republic were part of a wider response to the Covid-19 shock. This in turn depended on the effects of the shock on financial markets and the macroeconomy, and the perceived benefits and costs of different policy tools through time. In what follows, the main short-term effects of the shock are described, as well as the ensuing policy objectives. Finally, the main policy measures and their effectiveness are evaluated.

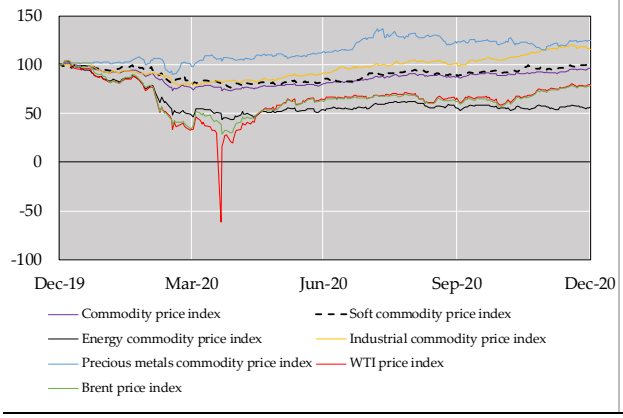
2.1 The shock

Colombia's external conditions and financial markets were particularly hard hit by the Covid-19 shock. The oil price drop that followed the shock was greater and more persistent than for other commodities, implying a stronger effect on the country's terms of trade (Graph 1). As oil-related revenues are important for public finances, this also meant a significant impact on the fiscal position and its outlook. These factors, coupled with a moderately high initial level of the government debt-to-GDP ratio (Graph A.1) and a comparatively large current account deficit (Graph A.1), may explain the relatively large jump in Colombian risk premia (Graph 1).

Graph 1

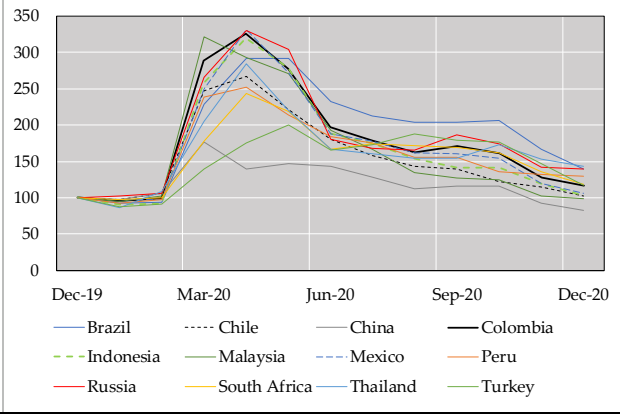
Commodity prices indices during the Covid-19 shock

December 2019=100



CDS indices in selected EME economies

December 2019 = 100

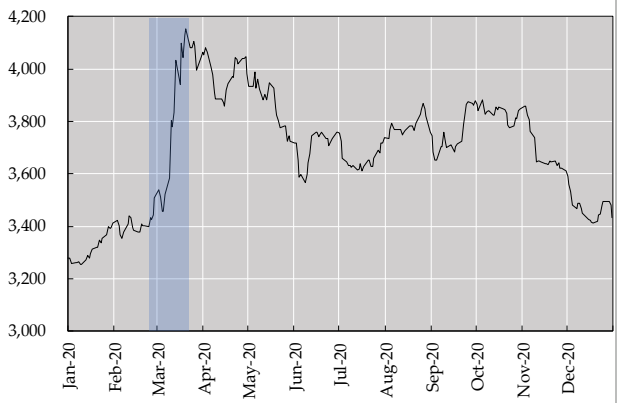


Source: Bloomberg and authors' calculations.

Local financial markets were severely disturbed by these shocks. The FX spot market liquidity was hindered (Graph A.1), offshore forward FX net demand increased sharply (Graph A.1) and the COP/USD exchange rate skyrocketed (Graph 2). Also, amid heightened risk aversion and a large depreciation of the COP, some Colombian participants in the FX forward market received margin calls, while the access of Colombian banks to foreign funding became uncertain. The public bond market seized up and lost liquidity (Graph A.1), while prices collapsed (Graph 2). This was obviously problematic because it made it more difficult for the government to fund itself during the crisis, but also because it affected the market of an asset widely used as collateral and as a benchmark for local asset pricing. In these respects, the shock threatened to hamper the transmission mechanism of monetary policy.

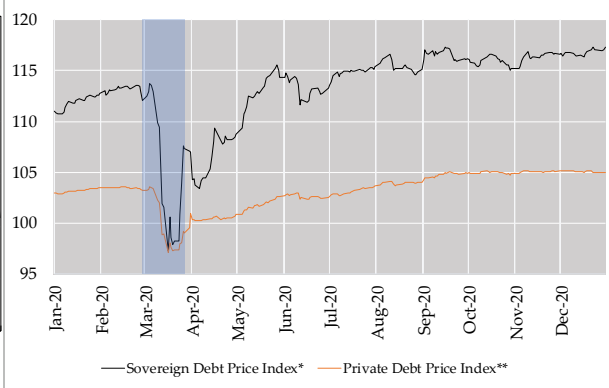
Graph 2

USD-COP exchange rate



Domestic public and private bond indices

January 2016 = 100



* Excludes short-term and inflation-indexed bonds. ** Bonds and CDs

Source: Bank of the Republic.

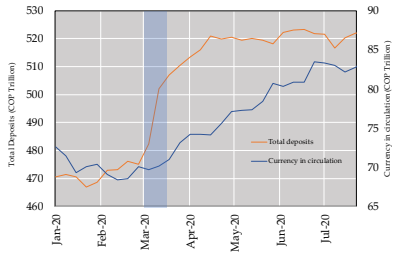
The losses in the public bond market and the uncertainty surrounding financial asset prices prompted a run on money market funds (MMF) (Graph A.1), which ended up in a large drop in private bond prices, especially commercial bank CDs (Graph 2), as the MMFs sold or reduced their demand for these securities. Strained MMF liquidity and fear of payment suspensions may have reinforced the pressure to withdraw funds from them. In the end, MMFs had to substantially reduce the maturity of their portfolios, increasing the weight of short-term commercial bank CDs, sight deposits and liquid public bonds (Graph A.1). This constituted a significant effect of the shock, for MMFs held 18% of bank and other financial intermediaries' liabilities in February 2020.

More generally, the Covid shock produced a pronounced increase in the preference for liquidity. Demand for cash and bank liabilities rose significantly, but with a marked bias towards sight deposits and short-term CDs (Graph 3). At the same time, demand for commercial loans spiked, as corporations increased borrowing in the face of falling cash flows. By contrast, consumer credit froze, as a result of exacerbated bank risk aversion (Graph 3). Overall, total bank loans sharply rose immediately after the shock. The simultaneous occurrence of a shift towards short-term bank liabilities, fast-growing bank loans and the reduction of interest and amortisation cash flows (due to debtor relief measures) increased bank liquidity risk, especially for smaller intermediaries that had no access to diversified funding sources.

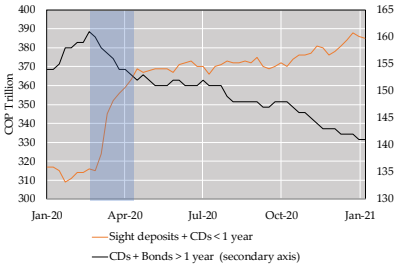
From a macroeconomic point of view, the ensuing lockdowns affected both aggregate supply and demand, but the latter was hit harder, as can be inferred from the collapse of output and employment along with a decline in core inflation measures.

Graph 3

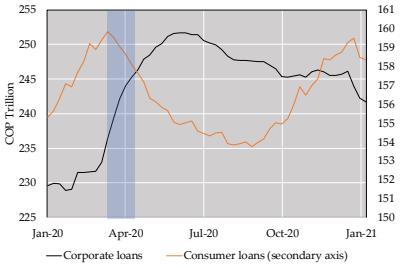
Currency in circulation and deposits



Deposits by maturity



Corporate and consumer loans



Source: Financial Superintendency and Bank of the Republic.

2.2 The central bank response

The immediate challenges facing the central bank were (i) ensuring the smooth functioning of the payment system, (ii) stabilising key financial markets under stress, and (iii) supporting an adequate provision of credit by local intermediaries when it was badly needed by firms and households. At a longer horizon, the central bank had to confront the impact of the shock on output and employment. For these purposes, the central bank undertook several actions, as summarised in Table 1.

Objectives and actions of the central bank response — Table 1

Objectives / Actions	Protecting the payments system	Preserve the supply of credit	Stabilising key financial markets	Provide an economic stimulus
Temporary liquidity (repo operations)				
Increase in the allotment counterparties, collaterals, and maturities	X	X	X	
Outright purchases of public and private securities	X	X	X	
Reduction of banks' reserve requirements	X	X		X
Auction of FX Non-delivery forwards			X	
Auctions of FX swaps	X	X	X	

Sources: Bank of the Republic.

To stabilise the FX market, the CB offered dollars in the NDF market as a way to strengthen a net supply hampered by risk aversion. Auctions of FX swaps also helped to restore normality in the FX market, while providing a backstop in case of a

reduction of foreign funding to local banks. To buttress the payment system, mitigate financial intermediaries' liquidity risk, support loan supply and help stabilise markets in distress, temporary liquidity sources were expanded. The amounts available, tenor, counterparts and collateral of central bank repo operations were expanded. Repos backed by private bonds and bank loans were made available in addition to the existing public bond-backed ones. The acceptance of private bonds (mostly commercial bank CDs) as collateral and the admission of MMFs as counterparts for central bank repo operations were in part aimed at relieving the private bond market and coping with increased banks' liquidity risk and term mismatches. Bank loan-backed repos were introduced to enhance liquidity in general, but especially for those intermediaries with more limited funding sources.

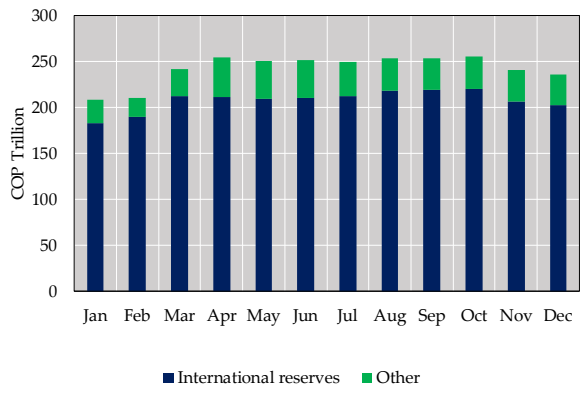
These facilities, however, increased only the supply of temporary central bank liquidity amid unprecedented uncertainty in the economy and in financial markets. To ensure the provision of long-lasting liquidity, support credit supply and deal with increased bank liquidity risk, reserve requirements were reduced (on average from 7% to 5%), releasing funds for about 10% of the monetary base of February 2020 (prior to Covid-19 crisis). This was also an important tool for addressing possible liquidity shortages for intermediaries without a diversified funding base. Moreover, the reduction of reserve requirements may have also influenced lending interest rates through its impact on the cost of financial intermediation and bank spreads.

Outright purchases of public and private bonds were an important component of the central bank policy response, as they were intended to expand long-term liquidity along the reduction in reserve requirements. Even more importantly, they were central in restoring normality in stressed security markets. The purchases were made between March and April 2020 (Graph 4). Public bonds were bought in the secondary market by means of the electronic platform that supports it. Private bonds were purchased through auctions held by the central bank. Only highly rated bank CDs or bonds with remaining maturities of three years or less and with at least 30 days after issuance were accepted. Public and private bond purchases were about 2.8% and 8.5% of the monetary base of February 2020 (before the Covid shock), respectively.

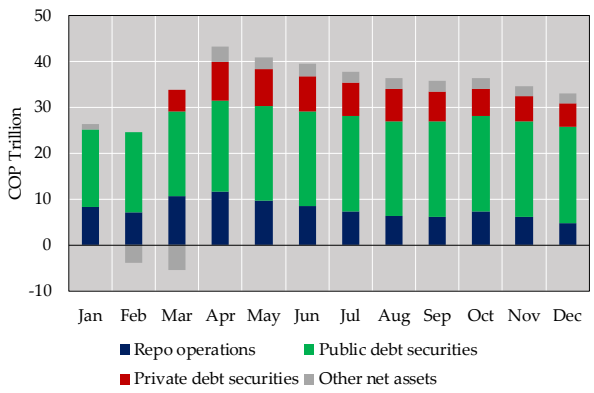
Central bank's assets

Graph 4

Central bank's assets (2020)



Central bank's assets other than international reserves (2020)

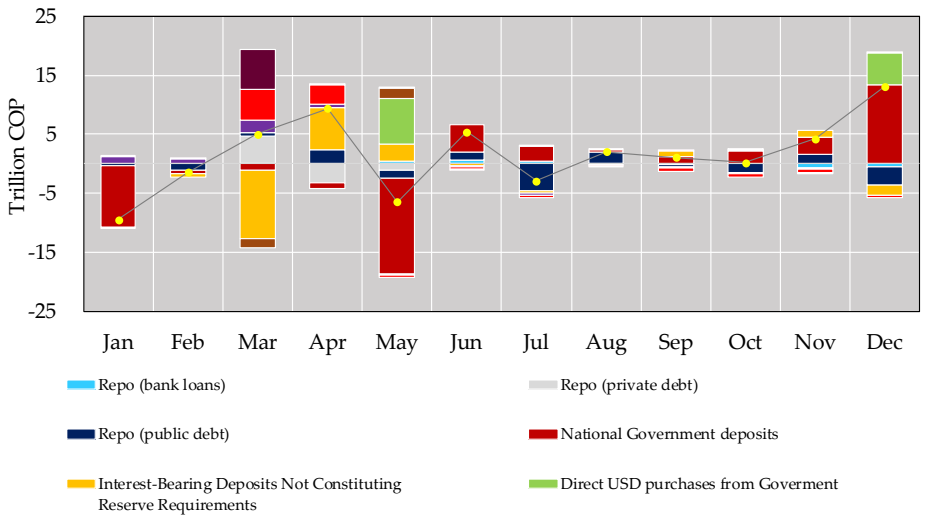


Source: Bank of the Republic.

In addition to the above-mentioned policy measures, the central bank purchased FX from the government in May and December 2020, and augmented access to the IMF´s Flexible Credit Line in order to bolster international liquidity. The resulting increase in international reserves enhanced long-term domestic liquidity, as the government spent the proceeds from the FX sales, complementing the effects of local asset purchases and the cut in reserve requirements. It is noteworthy that the resulting monetary expansion was sterilised to the extent necessary to stabilise short-term money market interest rates around the policy rate, which has remained well above zero or an effective lower bound in Colombia since the beginning of the Covid-19 crisis. The sterilisation was carried out mostly through short-term (seven- to 14-day) deposits of banks at the central bank, deposits of the Treasury at the central bank and the gradual reduction of the stock of repos (Graph 5).

To support economic activity and employment, the central bank gradually reduced the policy interest rate from 4.25% to 1.75% between March and September 2020. This contrasts with the faster reaction by the central banks in other EMEs. The response by the Colombian central bank took into account, among other things, the relatively high initial values of the public debt-to-GDP ratio and the current account deficit, as well as the sharp increase in the country's risk premium, the strong depreciation of the COP and the stress in local asset markets. The possibility of exacerbating some of these dynamics was perceived as a risk of monetary expansion and a constraint on the monetary policy response. Furthermore, given the nature of the shock that involved lockdowns and the interruption of normal spending behaviour, the short-term effects of an interest rate reduction on economic activity were deemed small. Overall, then, the risks and benefits of monetary policy relaxation suggested that a slower monetary policy reaction was appropriate. As external and domestic financial conditions improved, and the economy was gradually opened, transmission mechanisms were restored and monetary stimulus was increased.

Monetary base change drivers — Graph 5



Source: Bank of the Republic.

Finally, the policy response must be understood as part of a wider effort by Colombian authorities to deal with the shock. These measures included income support for households, subsidies to formal employment and suspension of some

taxes and contributions, among others. On the financial policy side, the government implemented loan guarantee programmes and special lending facilities through second-tier state financial institutions. The Financial Superintendency adopted temporary regulatory forbearance to accommodate loan relief programmes undertaken by financial intermediaries and set the rules for the subsequent provisioning and adequate revelation of credit risk, as well as the restructuring of some segments of the loan portfolio.

2.3 The effectiveness of the central bank policy response

In general, the central bank policy response was effective. Local financial markets were stabilised, as illustrated by the normalisation of market liquidity indicators (Annex Graph A.2) and the appreciation of the COP and local financial assets (Graph 2). Doubtless, the rapid reaction of monetary and fiscal authorities in advanced economies greatly contributed to the restoration of more normal conditions in EME financial markets. However, event studies suggest some significance of the role played by EME central bank asset purchases in stabilising local markets (eg Hartley and Rebucci (2020) and Fratto et al (2021)).

These studies find a response of local bond yields to central bank asset purchase programme announcements that is stronger in EMEs than in advanced ones and, according to the estimates, the response in Colombia seemed to be among the largest of all the countries considered. It is worth mentioning that in the events examined for Colombia, there were no simultaneous announcements of policy rate cuts (asset purchases were explicitly aimed at stabilising markets), so that the event study results are "cleaner" than in other episodes. By contrast, the coincidence of the Bank of the Republic's announcement with one of the Fed's announcements (March 23) may obscure the significance of the effects of the local announcement.

Withdrawals from MMFs stopped and then reversed (Annex Graph A.2), while the payment system kept functioning smoothly. However, the liability composition of banks and other financial intermediaries have remained more tilted toward shorter-term instruments (Graph 3, middle panel). This might reflect the public's lasting preference for liquidity in an environment still affected by Covid-19 infection and the uncertainty regarding future lockdowns and restrictions on mobility. Furthermore, this episode may also signal potential liquidity risks for MMFs that are not adequately covered by current regulation, so an evaluation of the latter may be in order.[2]

With stable local financial asset markets and buttressed bank liquidity, the successive cuts in the policy interest rate were transmitted to deposit and lending rates (Graph 6), while credit to households started to recover in the third quarter of 2020 (Graph 3, right-hand panel). This is compatible with the relatively fast improvement in durable consumption observed in the second half of 2020. Commercial loans, however, have shown a decline from their peak early after the shock. This is in part due to the repayment of loans initially taken out by corporations to maintain their liquidity. Evidently, the sharp contraction of the economy (–6.8% in 2020) has played an important role in total commercial credit slowdown.

A key feature in this episode in Colombia has been the absence of a significant substitution of local assets for foreign ones. As previously shown, demand for

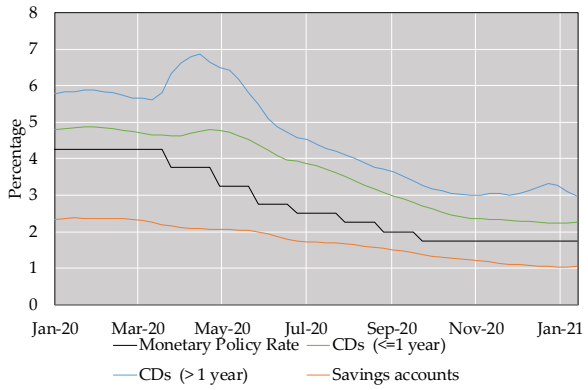
[2] For example, whereas bank liquidity regulation includes higher requirements for larger counterparts (institutional investors), MMF regulation lacks this feature.

domestic liquid assets jumped after the shock (Graph 3 left-hand panel) and the country's net portfolio outflows have been smaller than in other EMEs (Annex Graph A.2). An initially credible macro-financial policy framework and a relatively cautious fiscal and monetary policy response may explain this behaviour. Another reason was the large adjustment that authorities allowed in the prices of local assets before any action was announced or taken. Only after a substantial depreciation of the COP and local bonds had occurred did the central bank announce interventions in those markets. This may have prevented the formation of expectations of a future sharp depreciation, thus permitting a fast adjustment in the markets and limiting outflows.

Graph 6

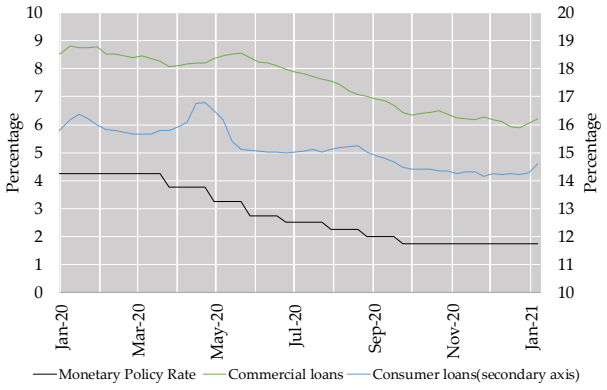
Deposit interest rates

Four-week moving average



Lending interest rates

Four-week moving average



Source: Bank of the Republic.

Finally, it is worth noticing that the central bank's asset purchases can hardly be characterised as QE measures. To begin, they were undertaken at point in which the policy interest rate was well above zero or a level that could be interpreted as an effective lower bound. Hence, they were not meant to replace or complement the interest rate as a way of altering the monetary policy stance. Their primary objective was to stabilise financial markets in the short term. Consequently, they were not systematically calibrated to respond to inflation or output gaps. Moreover, once bond markets were stabilised, no further purchases were announced or made, and there has been no rollover of principal and interest payments from the purchased bonds. Also, the stock of bonds purchased was a relatively small fraction of central bank assets (3.2% at its peak in April 2020).

2.4 Challenges posed by the Covid shock to the process of monetary policymaking

The magnitude and the widespread nature of the unprecedented Covid-19 shock also imposed several technical challenges on the analyses and the forecasts that guide monetary policymaking. Among these challenges, the central bank staff had to develop new tools and strategies to better understand the impact of lockdowns, to estimate the magnitude and persistence of supply and demand effects, to account for the influence of some central bank policy actions (eg changes in banks' reserve requirements), and to assess the consequences of record low interest rates for capital inflows and bank profitability. One crucial challenge was the analysis of the shock's effects on the fiscal position and the implications for monetary policy. In the next

section, we discuss one such implication, namely the effect of the fiscal position and international financial conditions on the sovereign risk premium, the macroeconomy and monetary policy.

3. Monetary policy implications of the Covid-19 shock's fiscal effects

We start by providing some background on the evolution of Colombia's public finances in the years prior to the Covid-19 pandemic and how they shaped increasingly fragile initial conditions. Next we briefly describe the fiscal response to the pandemic and set out some elements that could affect the channels through which fiscal policy can affect monetary policy. We put special emphasis on how the level of debt can affect the economy's financial conditions and how these, in turn, constrain monetary policy. Then we explore the empirical relation between public debt and risk premia. Finally, we use a DSGE model to illustrate some effects of fiscal policy on the macroeconomy and monetary policy.

3.1 Context, initial conditions and the Covid-19 shock

In the last two decades Colombia has employed two tools as part of the institutional framework to guide fiscal policy. The first one is the Medium Term Fiscal Framework (MTFF), a document presented to Congress by law since 2004 which outlines the projections of central government´s main fiscal variables (revenues, primary and total deficit and debt) for a 10-year horizon and a strategy for following the forecasted path. The MTFF provides an intertemporal fiscal sustainability context in which the budget decisions are made. The second tool is a fiscal rule, which has been in place since 2011. Each year the fiscal rule consultative committee sets the targets for the central government's structural and overall deficits and the MTFF aligns those targets with the medium-term strategy. Countercyclical considerations regarding GDP and oil revenues are included in the rule. The fiscal rule determines budget policy and links public spending to government revenue for a given year.

From 2015 the Colombian economy experienced shocks that eroded its public finances, leaving both the economy and public finances in a weak state to face the Covid-19 shock. In particular, the fall of oil prices in the second half of 2014, from more than USD 100 per barrel to USD 50 per barrel in 2015, turned out to be a highly persistent shock. This resulted in a permanent reduction of oil-related revenue. Table 2 shows that the loss of revenue ranged from 2.5% of GDP through 1.5% of GDP between 2015 and 2018. This was accompanied by an increase in public debt, which went up from about 40% to 50% of GDP in the same period. In addition, other shocks such as the migration of about 1.8 million people from Venezuela between 2016 and 2019, required temporary deviations from the parameters of the fiscal rule to ensure that the government could meet the associated expenditure needs. These shocks, resulted in an increasing level of debt, despite tax reforms in 2014, 2016, 2018 and 2019 and although the fiscal rule targets were met every year.[3]

[3] Part of the policy discussion in Colombia is that, given the structure and rigidity of public spending, tax revenue must be enhanced systematically to support a prudent path of public debt.

3.2 Fiscal response to the Covid-19 shock and implications for monetary policy

The Covid-19 shock has been met with a significant fiscal policy response, resulting in a substantial impact on public finances. The Ministry of Finance (MoF) invoked the escape clause to suspend the fiscal rule in 2020 and 2021, allowing for a larger deficit. Table 2 shows estimates of the impact on revenue, expenditure, the fiscal balance, and the debt-to-GDP ratio in 2020. The government made emergency monetary transfers to help low-income households, and took measures to strengthen liquidity and facilitate access by companies to both loans and subsidies. Regarding the latter, the central government postponed the deadline for income tax payments, and local governments did the same for industry and commerce tax payments, among others. It also authorised automatic tax refunds for low-risk taxpayers, granted benefits on 2019 tax obligations, and suspended the consumption tax for restaurants. According to the National Tax and Customs Department (DIAN), these measures generated a liquidity and disposable income boost close to COP 10 trillion (1% of GDP).

Evolution of Colombia's central government balance and debt 2013–20

Percent of GDP — Table 2

	2013	2014	2015	2016	2017	2018	2019	2020p
Total revenue	16.9	**16.7**	**16.1**	**14.9**	**15.6**	**15.3**	**16.2**	**15.2**
Tax revenue	14.3	14.3	14.5	13.6	13.8	13.9	14.0	12.9
From oil sector	*1.5*	*1.2*	*0.6*	*0.0*	*0.2*	*0.6*	*0.4*	*0.3*
Other revenue	2.7	2.3	1.6	1.3	1.9	1.4	2.2	2.3
Ecopetrol	*1.9*	*1.4*	*0.5*	*0.1*	*0.1*	*0.3*	*1.1*	*0.6*
Total expenditure	**19.3**	**19.1**	**19.2**	**18.9**	**19.3**	**18.4**	**18.7**	**23.7**
Covid-19 emergency								*2.0*
Overall deficit	**2.4**	**2.4**	**3.0**	**4.0**	**3.6**	**3.1**	**2.5**	**8.6**
Gross debt	**36.6**	**39.9**	**44.6**	**45.6**	**46.4**	**49.4**	**50.3**	**67.5**

Sources: Ministry of Finance and authors' estimates.

Additionally, the government capitalised the National Guarantee Fund with 0.3% of GDP which, according Ministry of Finance estimates, allowed the Fund to extend guarantees up to 4.8% of GDP, which in turn may represent new loans for working capital up to 8% of GDP. Through the Formal Employment Support Program, the government provides companies that meet the requirements (mainly a 20% reduction in revenue) with a payroll subsidy equivalent to 40% of the minimum wage per employee. According to the government, by the end of 2020, the programme, which started in April 2020 and will continue until March 2021, transferred 0.5% of GDP to companies, seeking to preserve about 3.6 million jobs. Table 3 presents the size of some of the expenditure programmes put in place as a response to the pandemic.

The debt-to-GDP ratio rose in 2020 to 67.5% and according to our projections using COFFEE, a DSGE model used at the central bank, it is projected to increase and stay near 70% for the next few years(Graph 7).[4] Is this level of government indebtedness a factor that could pose a risk to macroeconomic and financial stability

[4] These projections may differ from the official projections of the Ministry of Finance and are presented here for analytical purposes only.

Some expenditure measures in response to Covid-19 Table 3

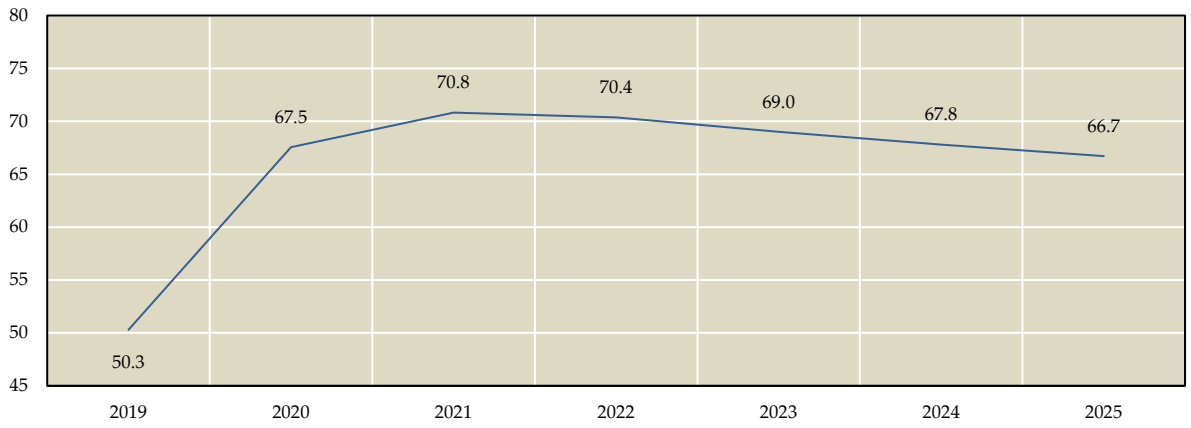
Measure	% of GDP
Monetary transfers to low-income households	0.6
Electricity and water subsidies for low-income households	0.3
Support for health sector	0.3
Support for formal employment	0.7
Total for included measures	**1.8**

Source: Ministry of Finance.

and constrain monetary policy? If so how? As a first step to tackling these questions, we make some computations on debt limits beyond which further negative shocks could put debt sustainability at risk. We employ two methodologies. First, we follow Mendoza and Oviedo (2009) and compute the "natural debt limit", the maximum level of debt that can be sustained in adverse scenarios were revenues to fall permanently and expenditures to fall to the minimum feasible. Under the assumptions in Appendix A we obtain a debt limit of 60.6% of GDP. Second, we follow Gosh et al (2013) and apply their methodology to calculate the "fiscal fatigue" debt level. This is a level of debt above which the increase in debt results in a higher probability of default, which in turn increases the risk premium and the interest costs to a point where the primary surplus cannot increase further and stabilise debt. Using this approach, we obtain a debt limit of 68.4% of GDP.

Central government gross debt

% of GDP Graph 7



Source: Ministry of Finance, authors' estimates using the COFFEE model.

To summarise, before the Covid-19 shock, public finances had been deteriorating because of shocks and a shortfall of tax revenues given expenditure needs. As a result, the initial conditions when the pandemic hit were increasingly fragile from the fiscal policy perspective. The fiscal policy response required by the pandemic put the current and forecasted debt-to-GDP ratio at levels where further negative shocks could become a threat to sustainability. This was recognised in the 2020 MTFF, which projects a fiscal reform of 2% of GDP in order to put debt in a downward path. The current policy discussion is about the timing and the feasible size of the reform, as well as the mix of fiscal instruments that will be modified.

Turning to the implications for monetary policy, as long as the country retains access to international markets (likely under the current global financial conditions of low interest rates and ample liquidity), the effects of increased deficits and public debt ratios would impact monetary policy through (i) the sovereign risk premium; (ii) the sensitivity of the risk premium to external financial shocks; (iii) the timing and size of a fiscal reform; and (iv) the currency composition of public debt, among others.

We now study these elements and how they might affect monetary policy.

3.3 Assessing sovereign risk fundamentals in a small open economy

3.3.1 Literature review

The empirical literature has explored a large set of macroeconomic variables to explain sovereign debt spreads and CDS. In this literature, there is ample evidence that sovereign risk is influenced by the level of debt relative to GDP, by variables related to debt sustainability, and by covariates that could affect the likelihood of repayment (Delatte et al (2014)). Furthermore, these elements can be classified into local and global risk factors (Daehler et al (2020)).

Regarding local risk factors, Ahmed et al (2017) noticed that EMEs with stronger fundamentals fared better during stress episodes such as the taper tantrum in 2013. Ertugrul and Ozturk (2014) found cointegrating relations between CDS spreads and local financial market indicators for selected EME countries. Particularly, they found that the CDS market is cointegrated with the foreign exchange market, the equity market and the bond market after controlling for external factors. They argue this result indicates evidence that there is a transmission from the financial markets to the CDS market for the whole-country sample. Kocsis and Monostori (2016) showed that in the specific cases of Poland, Russia and Turkey, domestic fundamentals explain more of CDS spread variance than global factors.

Concerning global risk factors, Longstaff et al (2011) found that the bulk of sovereign credit risk can be linked to global factors. In their analysis, a single principal component accounts for 64% of the variation in sovereign credit spreads. Furthermore, sovereign credit spreads are more closely related to the US stock and high-yield markets than they are to local economic measures. Likewise, Fender et al (2012) observed a relation between daily CDS spreads for EME sovereigns and global and regional risk premia that is stronger than that between CDS spreads and country-specific risk factors. Finally, Daehler et al (2020) showed that COVID mortalities and infections were not as important in explaining CDS spreads in the first half of 2020 as were variables capturing fiscal space, economic activity, actions by the Fed and the ECB, and the change in oil prices.

In addition to the debate regarding the impact of local and global risk factors, the literature has analysed the possibility of non-linearity in the determination of sovereign risk spreads (Aizenman et al (2011), de Grauwe and Ji (2013), Gerlach et al (2010), Montfort and Renne (2011), Borgy et al (2011), Favero and Missale (2012), Delatte et al, (2014), Brzoza-Brzezina and Kotłowski (2020)). In general, this literature has explored whether the pricing of sovereign risk is linear during bearish episodes, whether shocks to economic fundamentals are exacerbated by endogenous factors that create non-linearities, and whether there are particular levels of gross debt or net foreign assets that can trigger non-linear behaviour in sovereign risk pricing.

3.3.2 Some stylised facts of EME CDS

To illustrate some stylised facts regarding CDS dynamics, we explored several empirical specifications for a panel of 12 EMEs.[5] We focus on five-year CDS since this is the variable most commonly used by both practitioners and policymakers. Our baseline linear specification is a fixed effects model (FE) in which EME CDS depends on the level of gross government debt to GDP,[6] the cyclical component of a commodity terms of trade indicator,[7] a broad measure of US financial conditions,[8] and a country-specific EME CDS index.[9] There is evidence that the series are stationary in the sample period (January 2010–October 2020). This setting allows us to capture local risk factors, broad global financial conditions, and the country-specific external financial environment for each country while keeping a relatively parsimonious specification. Table 4 shows the results of the linear FE model used as a baseline.

Panel regression (FE) for selected EME CDS

Dependent variable: CDS for selected EMEs — Table 4

Variable	Coefficient
Debt to GDP	1.73 ***
	[0.18]
Commodities terms of trade cycle	–0.01 **
	[0.63]
US Financial conditions	13.43 *
	[7.02]
EM CDS Index	0.88 ***
	[0.04]
Constant	101.01
	[65.44]
Effects specification: cross section fixed (dummy variables)	
R-squared: 0.64	
Observations: 1560	

Notes: Standard errors are corrected for heteroskedasticity. Sample: January 2010 to October 2020. (*): significant at the 10% level; (**): significant at the 5% level and (***): significant at the 1% level.

Source: Authors' calculations.

[5] Our estimations use information for Brazil, Chile, China, Colombia, Indonesia, Malaysia, Mexico, Peru, Russia, South Africa, Thailand and Turkey from January 2010 to October 2020. The series are shown in Appendix B.

[6] We use the general government gross debt reported in the IMF's WEO report. We kept the debt levels relative to GDP constant for all the months of a given year.

[7] We use the IMF's country-specific commodities terms of trade. The commodity terms-of-trade index proxies the windfall gains and losses of income associated with changes in world commodity prices (Gruss and Kebhaj (2019)). The cyclical component is computed using the Hodrick-Prescott filter on the log of the index.

[8] We use the National Financial Conditions Index computed by the Chicago Fed. The series are normalised with mean of 0 and variance of 1. An increase of this indicator represents a tightening of financial conditions.

[9] The EME CDS indices used in the estimations were constructed for each country i using the weights obtained from the first principal component of the selected CDS series. To reflect exogenous financial conditions external, the CDS of country i is excluded. The EME CDS index for each country is shown in Appendix B. Individual series and panel unit root test are shown in Appendix B and C.

In this linear specification, we found that there is a positive relationship between the gross government debt and CDS spread, that a positive commodity terms of trade gap decreases CDS spreads, that a tightening of US financial conditions increases EME sovereign risk, and that CDS increase along with a rise in the country specific EME CDS index.[10]

Nonetheless, the linear specification may hide some important features regarding the dynamics of sovereign risk pricing. Thus, we use two alternative estimation strategies. The first one consists in estimating a panel smooth transition regression (PSTR) model. This approach allows us to explore the non-linear relation between CDS spread and its covariates. The second one relies on the estimation of a panel quantile regression (PQR) to model the conditional distribution of EME CDS.

Panel smooth transition regression. The PSTR model developed by Gonzalez et al (2005) allows the estimation of a non-linear specification for CDS as a function of an observable variable as follows[11]:

$$CDS_{it} = \mu_i + \beta_1' X_{it} + \beta_2' X_{it} g(q_{it}; \gamma, c) + u_{it} \quad (1)$$

For $i = 1, \dots, N$ and $t = 1, \dots, T$ where μ_i represents individual fixed effects, X_{it} is a set of covariates and u_{it} are i.i.d errors.

In this setting, $g(.)$ is a logistic function of order 1 that has an *S* shape:

$$g(q_{it}; \gamma, c) = \frac{1}{1+\exp[-\gamma(q_{it}-c)]}, \gamma > 0 \quad (2)$$

q_{it} is the observable threshold variable (gross government debt to GDP). The γ parameter determines the smoothness (the speed of the transition from one regime to the other), and c is the location parameter, which shows the inflection point of the transition[12]. Results in Table 5 report the estimated coefficients in regime 1 and regime 2 ($\hat{\beta}_1$and $\hat{\beta}_1 + \hat{\beta}_2$). In the estimation, we use the CDS spread of our 12 EME sample and the same covariates that we use in the linear baseline model. We set gross government debt to GDP as the threshold variable. Our estimates suggest amplification effects that operate in regime 2 ($|\hat{\beta}_1' + \hat{\beta}_2'| > |\hat{\beta}_1'|$) through a stronger influence on CDS of all the included covariates, with the exception of US financial conditions. In other words, when the gross debt to GDP is higher than the threshold value ($\hat{c} = 70.85$), the weight of these fundamentals increases in the EME CDS model, so the shocks to fundamentals have larger effects on sovereign risk pricing.

[10] The FE model displays similar results if the estimation sample is reduced to December 2019. Dummy variables for the commodity price shock in 2014/2015 and for the Covid-19 health crisis were not significant in country-specific regressions.

[11] A similar approach applied to Italy, Spain and Portugal during the debt crisis can be found in Delatte et al (2014).

[12] The estimation of the PSTR includes several stages. First, a null hypothesis of linearity is tested against the alternative hypothesis of a threshold specification against a baseline linear model. If the linear specification is rejected, the estimation of the parameters of the PSTR model requires eliminating the individual effects, μ_i, by removing individual-specific means and then applying non-linear least squares (see Gonzalez et al (2005) and Delatte et al (2014)).

Panel smooth threshold regression (PSTR) for selected EME CDS

Dependent variable: CDS for selected EMEs Threshold variable: Debt to GDP (–1) Table 5

Variable	β_1 (linear)	β_2 (non-linear)
Gross Government Debt to GDP	0.80 ***	0.99 ***
	[0.22]	[0.34]
Commodities terms of trade cycle	–0.02 ***	–0.02 ***
	[0.00]	[0.00]
US Financial conditions	14.48 **	–47.28
	[7.20]	[31.82]
EM CDS Index	0.78 ***	1.59 ***
	[0.03]	[0.12]
Constant	158.65 **	
	[65.63]	
γ	1.88	
	[5.95]	
c (threshold)	70.85 ***	
	[5.57]	
R-squared: 0.69		
Observations: 1560		

Notes: Effects specification: Cross-section fixed (dummy variables). Standard errors are corrected for heteroskedasticity. Sample: January 2010 to October 2020. (*): significant at the 10% level; (**): significant at the 5% level and (***): significant at the 1% level.

Source: Authors' calculations.

Panel quantile regression. To characterise the distribution of CDS we rely on the quantile regression proposed by Koenker and Bassett (1978). Particularly, we followed the approach proposed by Eguren-Martin et al (2020) in a panel data context. We specify our PQR model for the conditional quantiles of EME CDS as follows:

$$Q_{CDS_{i,t}}(\tau|X_{i,t}) = \alpha(\tau) + \sum_{j=1}^{k} \beta_j(\tau)\, X_{it} + \epsilon_i \quad (3)$$

$CDS_{i,t}$ are the five-year CDS spread for country i, X_{it} is the set of covariates, and ϵ_i is a country-specific fixed effect. Function Q computes quantiles τ of the distribution of $CDS_{i,t}$ given $X_{i,t}$. We estimate equation (3) in our panel of 12 EMEs from January 2010 to October 2020. Graph 8 shows the quantile process estimates in our EM CDS model.[13] Our results show that for the upper quantiles of the CDS distribution the effect of gross government debt is higher. The parameter for the commodities' terms of trade is not significantly different from zero for the lower deciles of the distribution, but the estimate turns negative in the middle of the distribution before it stabilises. Regarding external financial conditions (the broad US financial conditions and the country specific CDS index), we find greater responsiveness in higher deciles of the CDS distribution (see Graph 8).

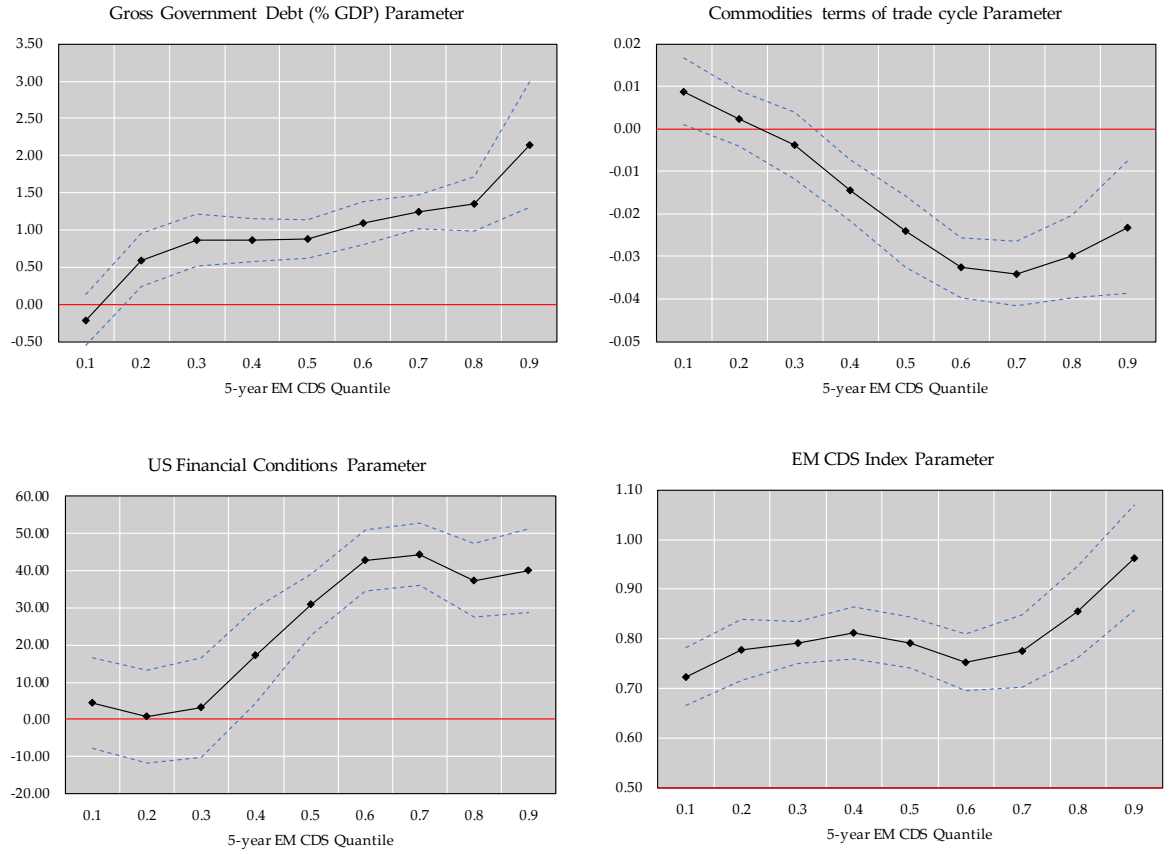
In sum, our results show that there is a positive relation between sovereign risk pricing and the level of government debt to GDP. Furthermore, there is evidence that higher levels of government debt could trigger non-linear behaviour and that

[13] Detailed results for the PQR estimation are presented in Appendix E.

countries in the higher deciles of the CDS distribution could experience a higher responsiveness of CDS to government debt. Moreover, we find that financial conditions play an important role in the determination of CDS and that high levels of government debt and tighter external financial conditions significantly increase EM sovereign risk prices.

Quantile estimates for EME CDS panel

Graph 8



Source: Authors' calculations. Note: Bootstrap Standard Errors (90% confidence intervals).

3.3.3 Some stylised facts of Colombian CDS

To show some stylised facts regarding Colombian CDS we estimate a simple linear model using the same set of covariates as in the previous exercises. We use the following form:

$$CDS_t^{Col} = \alpha_0 + \alpha_1 \left(\frac{D}{Y}\right)_t + \alpha_2 \left(\widetilde{CT}_t\right) + \alpha_3 US_{FCON_t} + \alpha_4 ECDS_t + \varepsilon_t \qquad (4)$$

Where (D/Y) represents the gross debt-to-GDP ratio produced by the IMF, $\widetilde{CT}_t$ is the cyclical component of the commodity terms of trade index, US_FCON_t is the US financial condition index produced by the Chicago Fed, and $ECDS$ is the EME five-year CDS index constructed using the weights of the first principal component taken from the selected countries (excluding Colombia). Table 6 shows the OLS estimates for this specification.[14]

[14] Individual unit root tests are shown in Appendix C.

OLS regression for Colombia

Dependent variable: five-year Colombian CDS — Table 6

Variable	Coefficient
Gross government debt to GDP	1.42 ***
	[0.14]
Commodities terms of trade cycle	–9.78 ***
	[1.53]
US Financial conditions	30.01 **
	[7.57]
EM CDS Index	0.85 ***
	[0.04]
Constant	20.19
	[10.28]
R-squared: 0.90	
Jarque-Bera (JB) test: 0.44 P-value: 0.79	

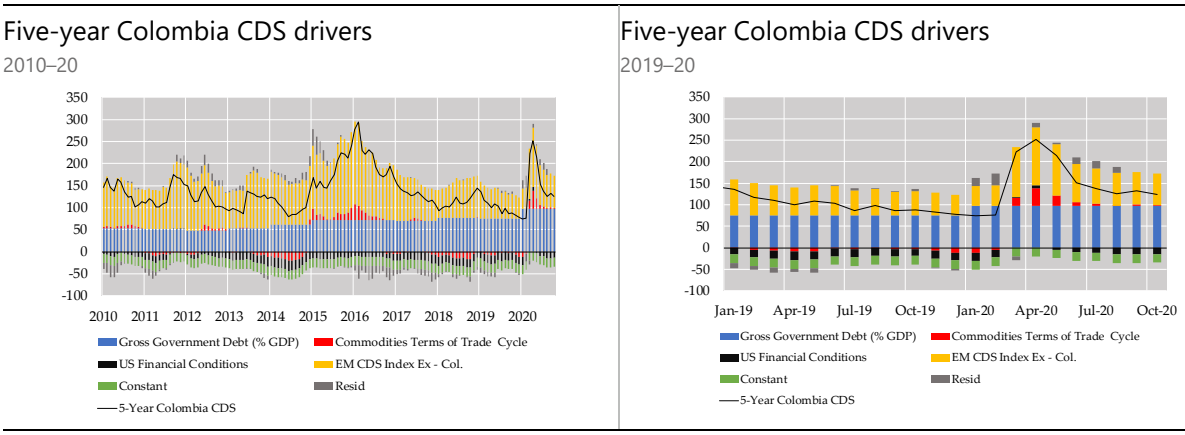
Notes: HAC Standard errors and covariance. Sample: January 2010 to October 2020. (*): significant at the 10% level; (**): significant at the 5% level and (***): significant at the 1% level.

Source: Authors' calculations.

In line with our EM CDS panel estimation, we find a positive relation between gross government debt and Colombian five-year CDS spread. The commodities terms-of-trade cycle shows a negative and significantly higher parameter (in absolute terms) than the one estimated in the EM Panel. US financial conditions and the dynamics of the EM CDS index also affect positively the level of CDS spread. Graph 9 shows the historical contribution of each factor to the dynamics of Colombian five-year CDS. Gross government debt and the EM CDS are the main contributors to the level of CDS. Nonetheless, the variation of CDS seems to be highly related to the dynamics of the rest of the EM CDS included in our index. During the recent stress episode of the Covid-19 shock, the increase in the five-year CDS was driven by the deterioration of EM CDS, a worsening of commodities terms of trade and a temporarily tightening in US financial conditions. These results further support the importance of gross government debt levels and external financial conditions in the determination of CDS.

Five-year Colombia CDS drivers using equation 3

Graph 9



Source: Authors' calculations.

3.4 Public debt dynamics and monetary policy

Up to this point we have provided evidence that:

1. The fiscal response to the Covid-19 shock, coupled with the deteriorating trend of public finances, has taken the level of public debt in Colombia above prudent debt limits.
2. Public sector debt levels measured as a debt-to-GDP ratio are positively correlated with risk premia in EME economies.
3. Debt-to-GDP ratios may be related to risk premia in a non-linear way, with risk premia becoming increasingly sensitive to debt and other determinants as debt levels rise.
4. Financial conditions in advanced economies are related to risk premia, and when they tighten, risk premia rise (also in a possibly non-linear fashion).
5. Public debt levels, international financial conditions, and commodity cycles explain almost all the variation of Colombian risk premia as measured by five-year CDS on public debt.

We now use the COFFEE model (see Appendix F for a brief description) and illustrate how increasing debt levels may constrain monetary policy. To this end we filter the data through the model, recover shocks in 2020 and construct a baseline scenario that resembles a macroeconomic adjustment like the one that the central bank's staff forecasts in its Monetary Policy Report. In this scenario we allow for a fiscal adjustment similar in magnitude to the one in the MTFF through non-distortionary taxes in 2022. We also set fiscal variables to follow a path over time like the one projected in the MTFF. This baseline scenario exhibits a relatively smooth recovery after the Covid-19 shock in which debt levels fall slowly towards 60% and risk premia also fall over time, GDP growth rates rise above their long-term growth rate of 3.3%, and interest rates normalise from below, while the currency appreciates in 2022. Absorption grows faster than GDP and consequently the trade balance widens over time.

Based on this benchmark and the findings of the previous section, we study the implications of two aspects of fiscal policy for the macroeconomy and monetary policy, namely (i) the effects of an insufficient fiscal adjustment on risk premia and (ii) the impact of delaying a fiscal adjustment. We then discuss the consequences that changes in the currency composition of public debt may have on monetary policy.

In Section 3.3 we stated that both the sovereign risk premium and its sensitivity to external financing shocks would be important factors to determine how increased fiscal deficit and public debt ratios would affect monetary policy. To illustrate their effect, we construct an alternative scenario in which we do not allow for a fiscal reform to happen before 2030. In this scenario debt grows over time. Given the results of Section 3.3, a shock that produces a jump in the debt level would be associated with larger risk premia, with values reached in the simulation akin to a non-linear response. To reflect this in the model, we introduce shocks and changes to the curve that capture the availability of external financing and its cost (a curve that relates risk premia to debt levels, see (Schmidt-Grohe and Uribe (2003)). More specifically, the shocks temporarily shift up this curve (to reflect the availability of external financing) and make it permanently steeper. In this way we make risk premia more sensitive to debt levels while making them vary in a non-linear form. The size of the shocks in this scenario is chosen to resemble the behaviour of risk premia in some downgrade

events (Hungary 2011, Russia 2015 and Brazil 2015) in which countries lost their investment grade credit rating. In these events, risk premia tends to rise fast prior to the downgrade and about a year later it exhibits a correction. When debt levels remain high after the events and the investment grade rating is not regained, risk premia also remains higher than in comparable countries.

Graph 10 compares the baseline scenario, which has a fiscal reform in 2022, with the alternative scenario where there is no reform before 2030. In the absence of a reform, public debt levels would go from 71% of GDP in 2021 to about 85% of GDP in 2030. Consequently, risk premia would jump in 2022 and while they decline subsequently, they would remain higher than in the past because of greater debt levels and the absence of the expected fiscal reform. Higher risk premia is accompanied by capital net outflows and currency depreciation. The COP depreciates by about 12% in real terms in 2022, nominal depreciation passes through local prices and inflation rises by more than 100 bp above target in 2023. An inflation rate persistently above target requires a monetary policy interest rate path that is about 110 bp higher on average than in the baseline scenario. Higher real interest rates and a greater debt burden[15] result in lower consumption and investment growth rates and lead to a persistently lower output level of about 100 bp. The reduced growth rates of private consumption and investment and the real depreciation of the currency are consistent with the fall in the trade balance deficit. Generally speaking, through their impact on risk premia, deteriorating public finances can significantly worsen the trade-offs of monetary policy. The persistence of the changes in risk premia determines the impact on the exchange rate and its expectation, and, thereby, the degree of constraint on monetary policy.[16]

Thus far we have illustrated how higher levels of debt can result in persistently higher, and more sensitive risk premia, and how they could affect the macroeconomy and the response of monetary policy. However, we have not considered other dimensions of higher debt that could further affect the economy. For instance, higher debt could be accompanied by the potential loss of credibility in fiscal policy and in the compatibility of both fiscal and monetary policies. In our analysis, there is full credibility and agents perceive the government to have both the willingness and ability to pay. Relaxing these assumptions requires other tools, but one can conjecture that, if they did not hold, monetary policy could face even stronger constraints. Moreover, the use of different fiscal instruments to achieve an adjustment may have diverse consequences for the economy and, thereby, for monetary policy. It may also imply different challenges to central bank communication (eg VAT increases could have short-term effects on inflation that should be explained to minimise their impact on inflation expectations).

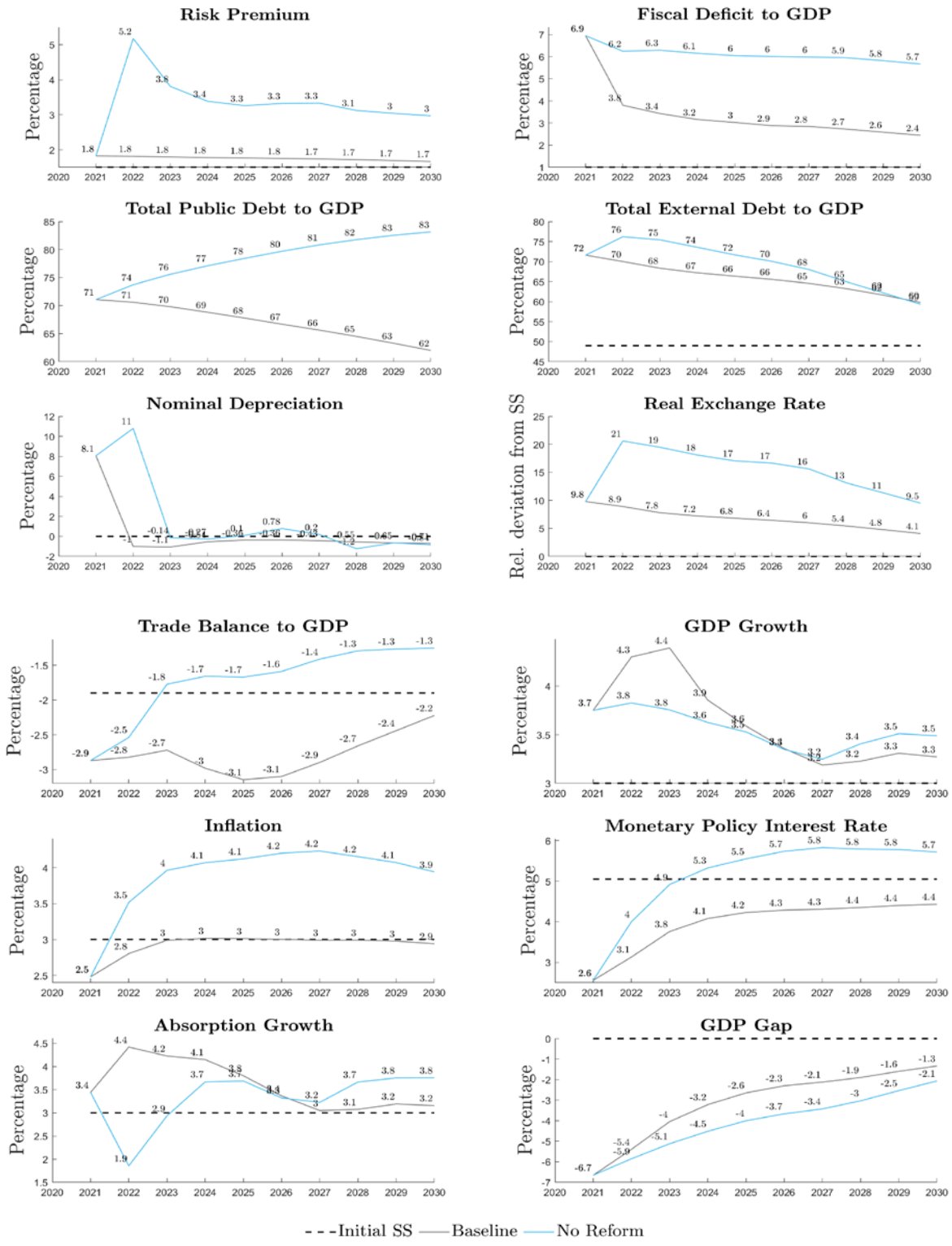
We now illustrate how delaying a fiscal adjustment may imply changes in its size that matter for the performance of the macroeconomy and for monetary policy. For these simulations we compare the magnitude of the adjustment of two tax reforms

[15] Debt burden in 2023 is about 2% of GDP in the baseline scenario while it is almost 4% in the no-reform scenario. On average, between 2023 and 2030, the difference between the debt burden of both scenarios is 1% of GDP per year.

[16] Graph TA.6 in the appendix also presents a scenario in which the required fiscal adjustment occurs in 2023. Even though the reform arrives late with respect to the baseline scenario and therefore risk premia do jump and become more sensitive to debt and external financing shocks, the effect on risk premia is less persistent and therefore the impact on the exchange rate and exchange rate expectations is milder and the constraint on monetary policy is not as strong.

Effect of higher public debt and higher risk premia on monetary policy: no fiscal reform

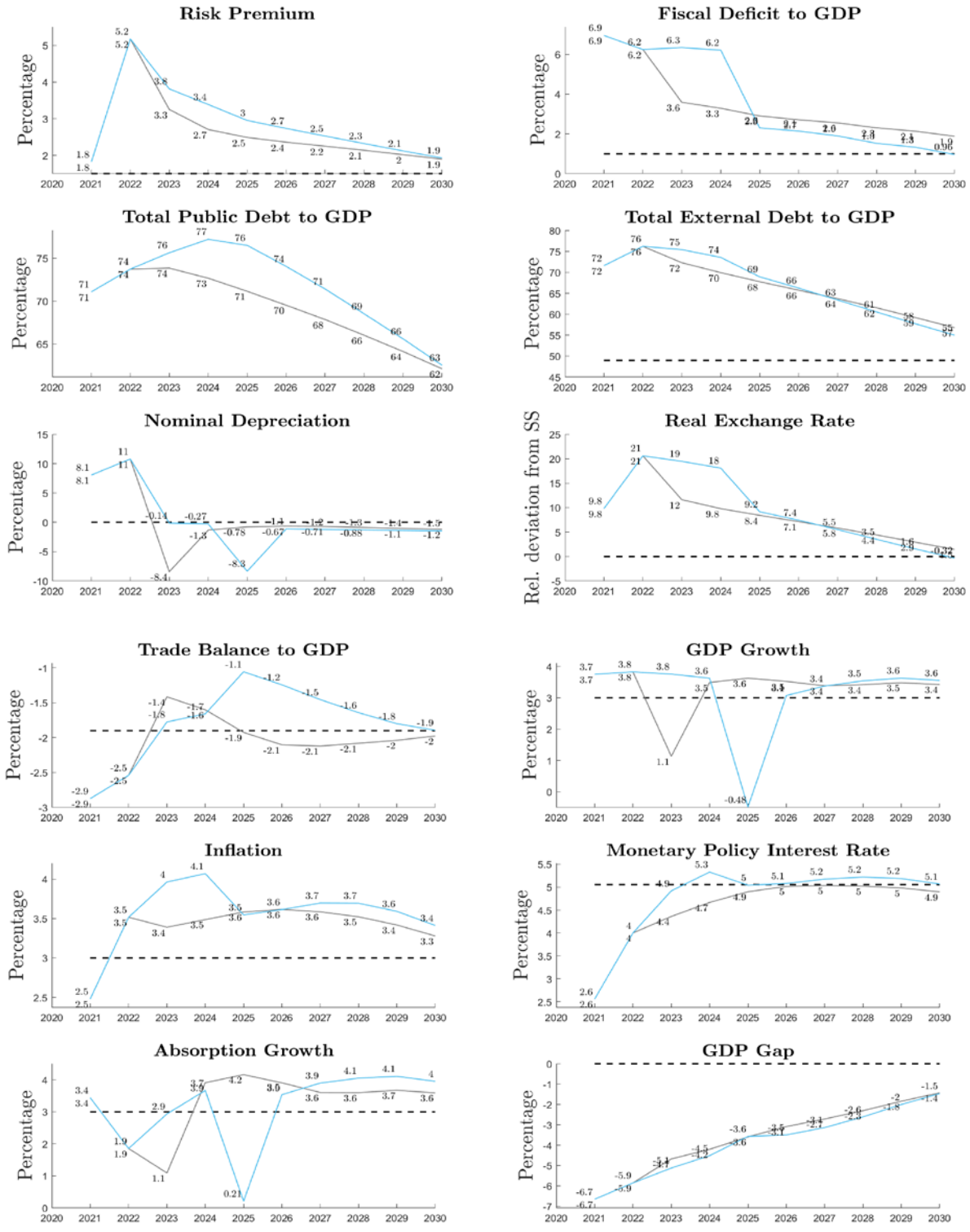
Graph 10



Source: Authors' calculations.

Effects of higher public debt and higher risk premia on monetary policy: effects of a delayed income tax reform

Graph 11



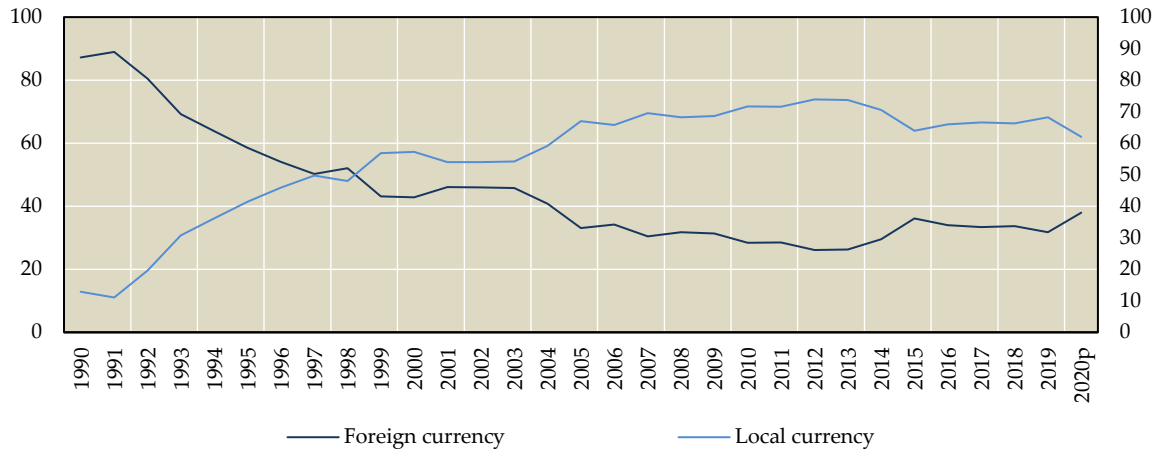
Source: Authors' calculations.

involving changes in distortionary taxes in order to allow for a direct impact on output and expenditures. More specifically, fiscal adjustment is carried out through successive raises in personal income taxes at two different points in time, in 2023 and 2025. As in the previous simulations, both exercises exhibit large increases in risk premia and currency depreciations in 2022, triggering the channels that constrain monetary policy that we have already mentioned. We force the economy to achieve debt levels of around 62% of GDP by 2030 as in the MTFF regardless of the timing of the reform.[17] Putting off the reform in 2023 increases risk premia as the level of public debt rises, but also requires of a larger fiscal adjustment in 2025 to be able to get to the same debt level by 2030. Graph 11 shows that delaying the reform further constrains monetary policy and worsens macroeconomic outcomes. The negative output gap widens, while the reform in 2025 is so large that it is enough to generate a recession on impact. However, because of the increase in risk premia and inflation, the policy interest rate is higher in this scenario until 2030, illustrating the limits that a delayed fiscal reform may impose on a countercyclical response of monetary policy.

Finally, we turn to the currency composition of public debt, another factor that may eventually contribute to constrain monetary policy in the face of increased fiscal deficits and debt. Before the Covid-19 shock, such composition was related to the structure of government revenue sources (oil, tradable and non-tradable sectors). With the need to produce an immediate response to the crisis, the government relied more on external financing and the new debt was tilted toward foreign currency-denominated debt. Graph 12 and Graph TA.7 in the appendix show the evolution over time of the currency composition of public debt. Before the pandemic, around 70% of debt was denominated in local currency. With the pandemic this percentage is projected to fall to around 60%. Even though the fraction of foreign currency remains

Colombian central government gross debt composition

% of total gross debt — Graph 12



Source: Ministry of Finance, Central Bank's estimates.

[17] Since in the class of models we are using there is full credibility, debt is always sustainable, and agents are rational and forward-looking, delaying the reform tends to produce better short-run outcomes. This is unlikely in a stress scenario at debt levels that are higher than prudent limits. To get around this issue, in all simulations we force debt to get to the same level by 2030.

relatively low, and much lower than in the 1990s, a future policy challenge may be to restore the weight of COP-denominated debt to avoid currency mismatches and the associated fragility in the public sector. One way in which debt composition might matter for the conduct of monetary policy and its interaction with fiscal policy has been pointed out by Blanchard (2004). When the initial debt level is high and the proportion of foreign currency-denominated debt is high as well, an inflation targeting central bank that raises the real interest rate in response to an increase in inflation can produce a depreciation that further increases inflation due to the weakening of the government's financial position.

4. Conclusions

The central bank policy response to the Covid-19 shock in Colombia was effective enough to keep the payment system operating, stabilise key financial markets under stress, maintain financial system liquidity and support credit supply, and provide a timely stimulus to economic activity. As part of this wider response, asset purchase programmes were particularly aimed at stabilising financial markets under stress and enhancing overall liquidity in the economy. However, they can hardly be characterised as "quantitative easing" measures, given their relatively small amount (with respect to central bank assets) and their one-time, non-systematic use.

Public debt greatly increased because of the Covid-19 shock, reaching values near estimates of "natural" limits. Further, an empirical exploration of the behaviour of sovereign risk premia (CDS) in EME points to non-linear, augmented responses to changes in fundamentals for high debt-to-GDP ratios and for values of the risk premia in the upper deciles of their distribution. The inclusion of such non-linear behaviour of risk premia in a fiscal DSGE macro model for Colombia suggests an increasing importance of constraints on monetary policy derived from shocks that significantly raise debt ratios. Interest rates are generally higher in these circumstances and it becomes more difficult for the central bank to support the economy in the face of a delayed fiscal adjustment. These constraints mostly arise from the impact that the shocks have on the exchange rate.

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Technical Appendix

Natural debt limit calculations

Following Mendoza and Oviedo (2009), we can calculate the natural debt limit b^* as follows:

$$b^* = \frac{y^{min} - g^{min}}{r - \gamma}$$

where

- y^{min} : minimum level of revenues that the government can obtain in crisis times
- g^{min} : minimum feasible level of public spending should a financing constraint bind
- γ : long-run per-capita growth rate of the economy
- r : real interest rate on public debt
- The interest rate on government debt depends on its debt level $r(b_t) = r^{fr} e^{\omega b_t}$, r^{fr} is the international risk free rate and ω is the sensitivity of the interest rate to changes in the level of public debt

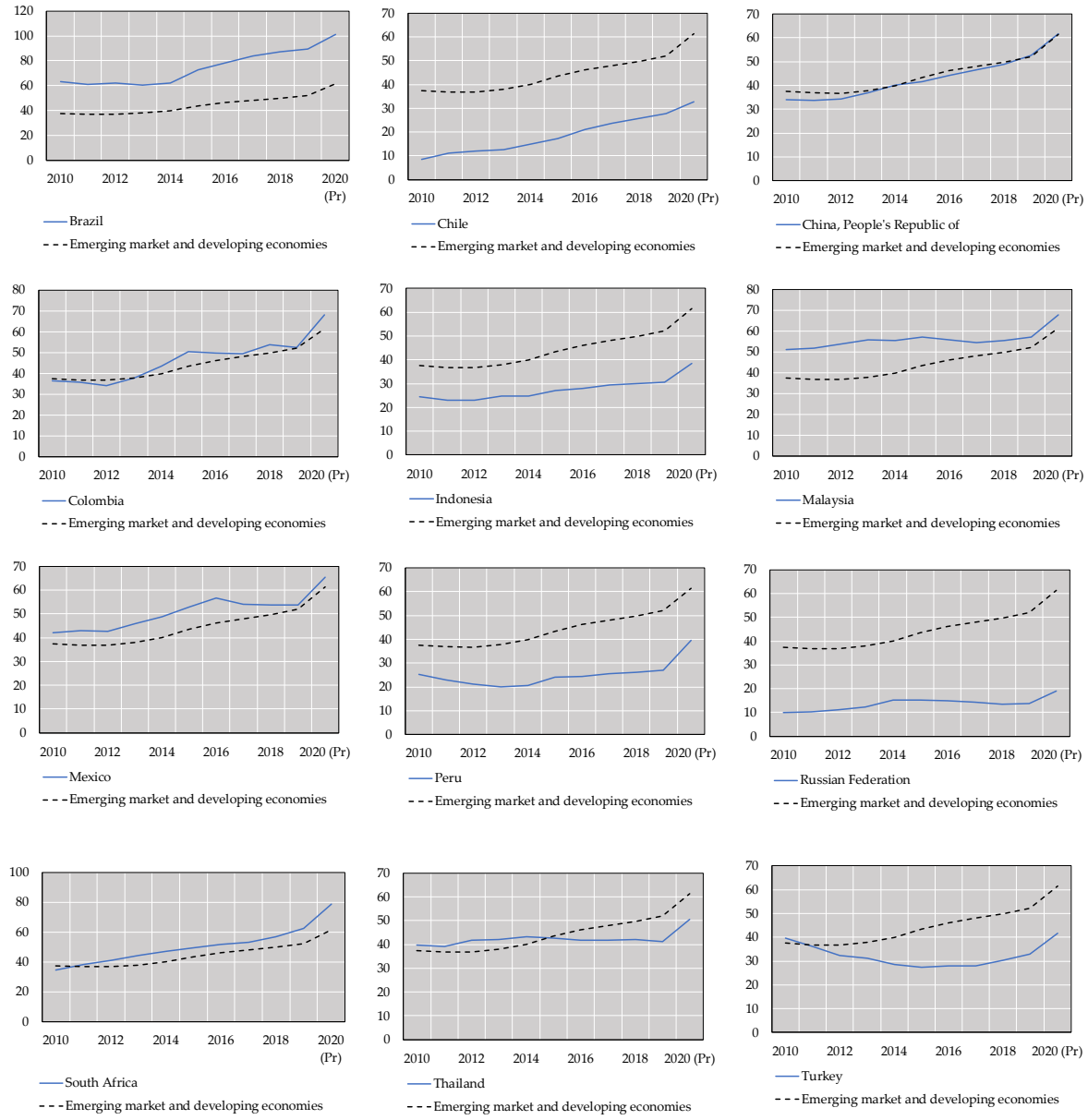
Assumptions for the natural debt limit calculation

- (y^{min}): 14,4% of GDP PIB, which is 2 standard deviations below average revenues between 2010 and 2019 (15,6%).
- (g^{min}): 13,6% of GDP, 85% of primary spending between 2010 and 2019, which amounts to having a degree of flexibility 2,4% of GDP.
- (γ): 3,3%, which is consistent with recent estimates of the rate of population growth rate and a per-capita growth rate of 2,7%.
- (r^{fr}): 0,66%, mean real interest rate on 3-month US Treasury Bills between 1947 and 2019.
- (ω): 0,05, consistent with an external interest rate for Colombia close to 400bp, which is the level reached by five-year CDS during the 2008 Global Financial Crisis.

Selected variables included in the estimations

Gross Government Debt (% GDP) in Selected EME Countries

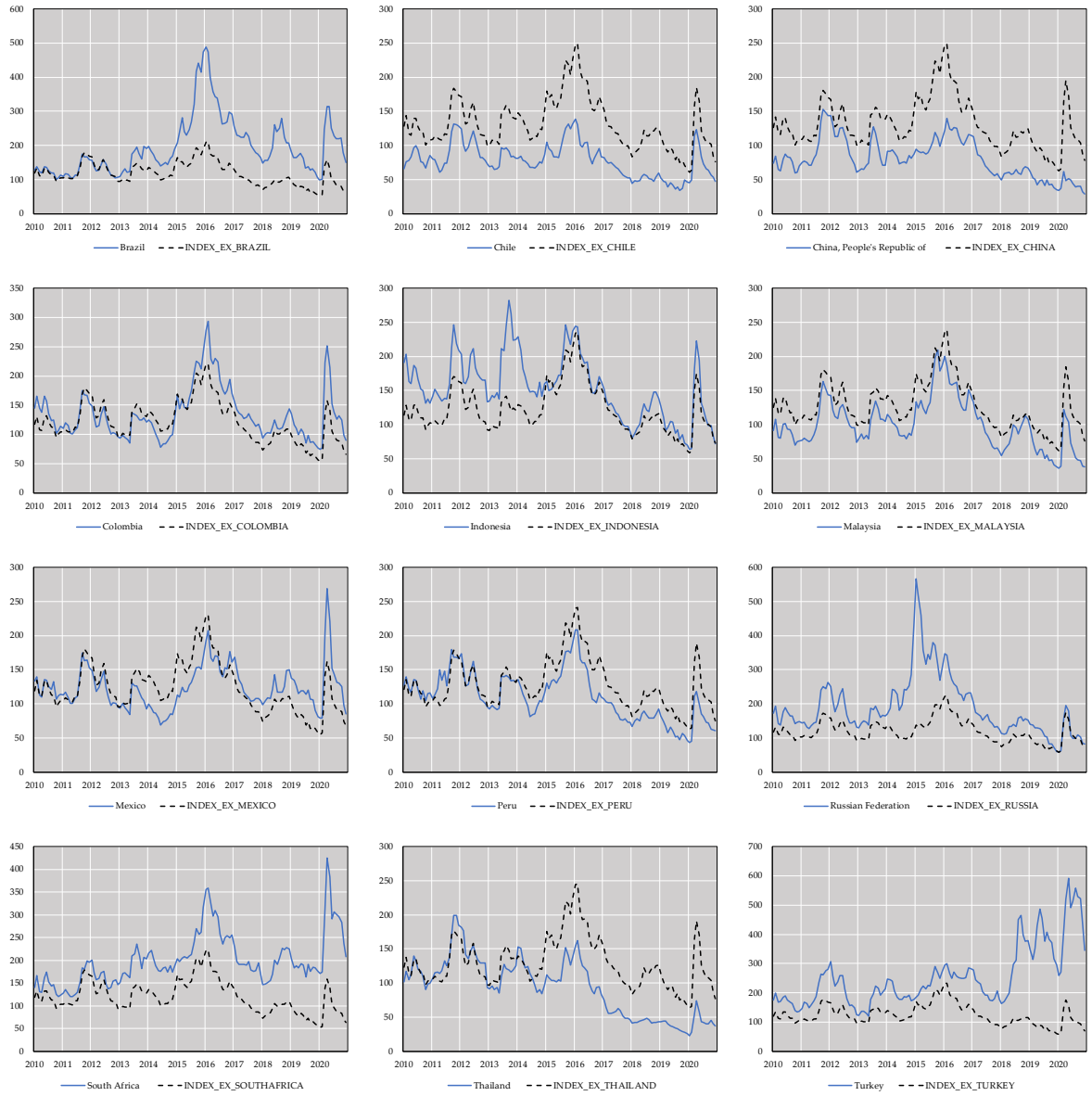
Graph TA.1



Source: IMF – WEO.

Five-year CDS and EME CDS Index (principal component)

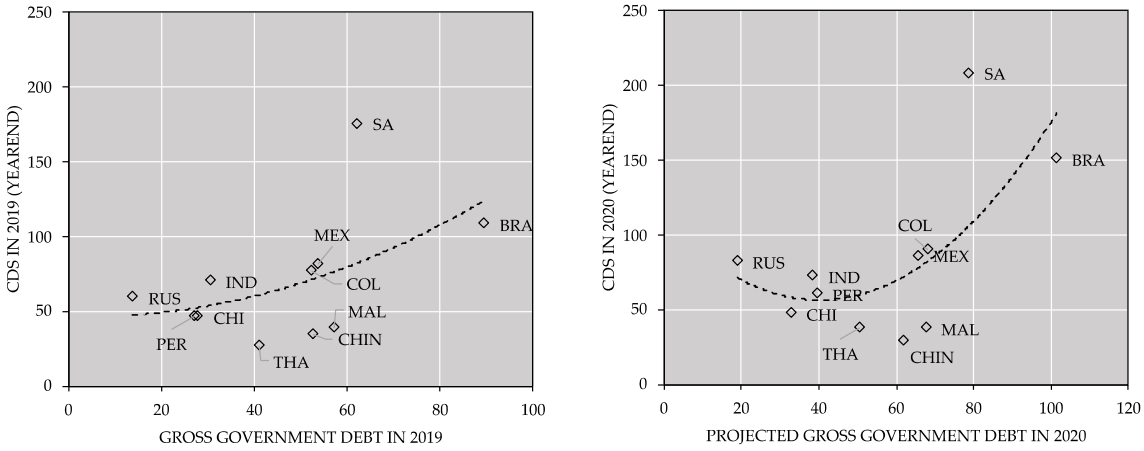
Graph TA.2



Source: Bloomberg and authors' calculations. Notes: The EM CDS index used in the estimations was constructed using the weights of the first principal component using n-i CDS series.

Gross public debt vs five-year CDS

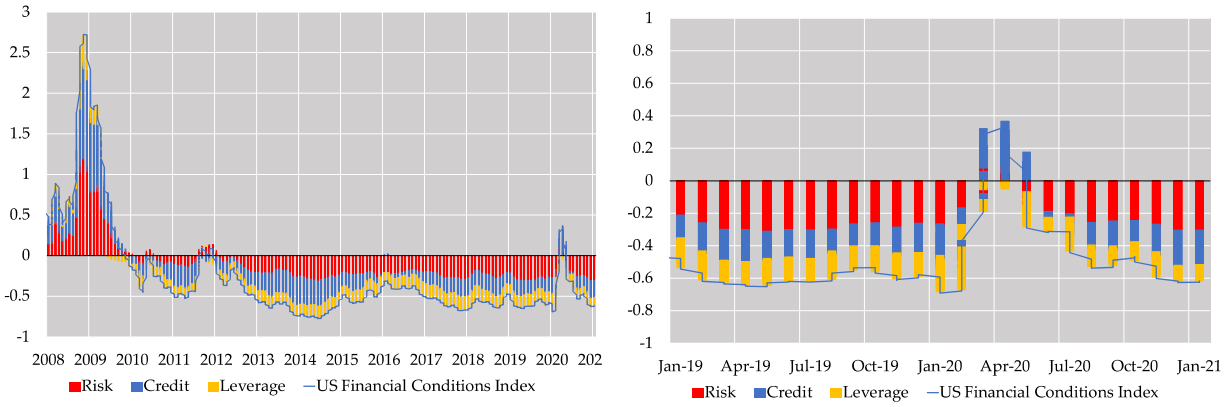
Graph TA.3



Source: IMF-WEO and authors' calculations.

US Financial Conditions Index and its components

Graph TA.4



Source: Chicago Fed. Notes: Weekly data.

Unit root tests for the series used in the selected models

Unit Root Test Results

Table TA.1

	5-YEAR CDS (At Level)												
		BRA	**CHI**	**CHIN**	**COL**	**IND**	**MAL**	**MEX**	**PER**	**RUS**	**SA**	**THA**	**TUR**	**PANEL**
With Constant	t-Statistic	-2.63	-3.36	-2.36	-3.56	-3.28	-2.48	-4.81	-1.89	-2.11	-2.59	-1.17	-2.75	Breitung t-stat
	Prob.	0.09	0.01	0.15	0.01	0.02	0.12	0.00	0.34	0.24	0.10	0.68	0.07	(common unit root process)
		*	**		***	**		***			*		*	-6.28
With Constant & Trend	t-Statistic	-2.65	-4.00	-3.09	-3.55	-3.96	-2.70	-4.84	-3.00	-2.35	-2.85	-2.96	-4.08	Prob.
	Prob.	0.26	0.01	0.11	0.04	0.01	0.24	0.00	0.14	0.40	0.18	0.15	0.01	0.00
			**		**	**		***					***	***
Without Constant & Trend	t-Statistic	-1.04	-0.96	-1.14	-0.96	-1.32	-1.17	-0.84	-1.00	-0.91	-0.26	-0.92	-0.85	
	Prob.	0.27	0.30	0.23	0.30	0.17	0.22	0.35	0.28	0.32	0.59	0.32	0.35	
Evidence		I(0)	I(0)	I(0) KPSS	I(0)	I(0)	I(0) KPSS	I(0)	I(0) KPSS	I(0) KPSS	I(0)	I(0) KPSS	I(0)	
	Commodities Terms of Trade Cycle (At level)												
		BRA	**CHI**	**CHIN**	**COL**	**IND**	**MAL**	**MEX**	**PER**	**RUS**	**SA**	**THA**	**TUR**	**PANEL**
With Constant	t-Statistic	-3.33	-3.42	-4.27	-4.41	-4.81	-2.36	-4.21	-4.06	-4.39	-5.84	-4.21	-4.20	Breitung t-stat
	Prob.	0.02	0.01	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	(common unit root process)
		**	**	***	***	***		***	***	***	***	***	***	-1.38
With Constant & Trend	t-Statistic	-3.32	-3.41	-4.26	-4.39	-4.79	-2.36	-4.19	-4.05	-4.38	-5.81	-4.20	-4.18	Prob.
	Prob.	0.07	0.05	0.01	0.00	0.00	0.40	0.01	0.01	0.00	0.00	0.01	0.01	0.08
		*	*	***	***	***	n0	***	***	***	***	***	***	*
Without Constant & Trend	t-Statistic	-3.35	-3.44	-4.29	-4.43	-4.84	-2.36	-4.23	-4.08	-4.41	-5.86	-4.23	-4.21	
	Prob.	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	
		***	***	***	***	***	**	***	***	***	***	***	***	
Evidence		I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	
	EM CDS Index EX (At Level)												
		BRA	**CHI**	**CHIN**	**COL**	**IND**	**MAL**	**MEX**	**PER**	**RUS**	**SA**	**THA**	**TUR**	**PANEL**
With Constant	t-Statistic	-3.02	-3.10	-3.24	-2.93	-3.08	-2.46	-2.92	-3.26	-3.22	-2.96	-3.22	-3.11	Breitung t-stat
	Prob.	0.04	0.03	0.02	0.04	0.03	0.13	0.05	0.02	0.02	0.04	0.02	0.03	(common unit root process)
		**	**	**	**	**		**	**	**	**	**	**	-8.65
With Constant & Trend	t-Statistic	-3.41	-3.24	-3.35	-3.25	-3.19	-3.40	-3.18	-3.35	-3.39	-3.25	-3.30	-3.30	Prob.
	Prob.	0.05	0.08	0.06	0.08	0.09	0.06	0.09	0.06	0.06	0.08	0.07	0.07	0.00
		*	*	*	*	*	*	*	*	*	*	*	*	***
Without Constant & Trend	t-Statistic	-0.82	-0.78	-0.79	-0.78	-0.76	-0.78	-0.80	-0.77	-0.81	-0.83	-0.78	-0.79	
	Prob.	0.36	0.38	0.37	0.37	0.38	0.38	0.37	0.38	0.36	0.36	0.38	0.37	
Evidence		I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	
	US Financial Conditions (At Level)												
With Constant	t-Statistic	-2.87												
	Prob.	0.05												
		*												
With Constant & Trend	t-Statistic	-3.05												
	Prob.	0.12												
Without Constant & Trend	t-Statistic	-0.32												
	Prob.	0.57												
Evidence		I(0)												

Notes: Individual ADF test results and common unit root tests. We also compute the KPSS test, and the result is shown for some CDS series (when the ADF signalled a unit root process in the series). Sample: January 2010 to October 2020..

Source: Authors' calculations.

Linearity tests for the PSTR Model

Smooth Threshold Linearity Tests

Table TA.2

Linearity Tests Null Hypothesis	F-statistic	d.f.	p-value
H04: b1=b2=b3=b4=0	14.75355	(5, 1538)	0
H03: b1=b2=b3=0	14.75355	(5, 1538)	0
H02: b1=b2=0	14.75355	(5, 1538)	0
H01: b1=0	18.42526	(4, 1539)	0

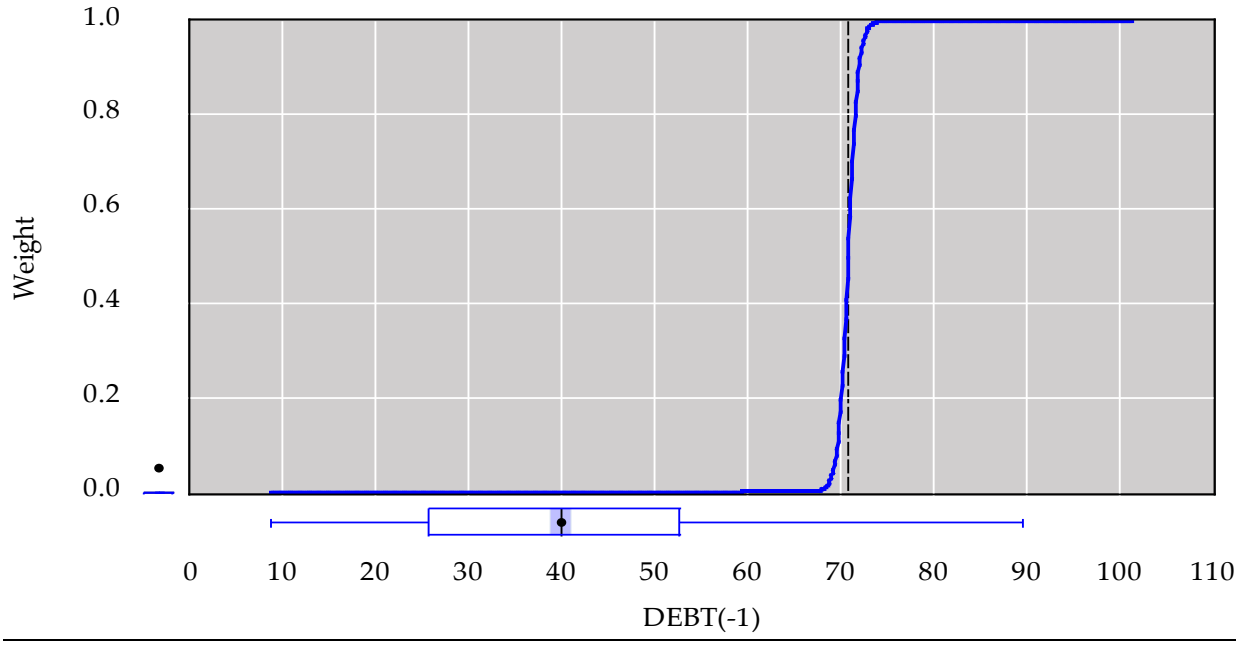
The H0i test uses the i-th order Taylor expansion (bj=0 for all j>i).

Terasvirta Sequential Tests Null Hypothesis	F-statistic	d.f.	p-value
H3: b3=0	NA	(0, 1538)	NA
H2: b2=0 | b3=0	0.109382	(1, 1538)	0.7409
H1: b1=0 | b2=b3=0	18.42526	(4, 1539)	0

Source: Authors' calculations. Notes: Test for non-linearity using the first lag of gross government debt as the threshold variable. Taylor series alternatives: b_0+b_1*[+b_2*s^2+b_3*s^3+b_4*s^4]. All tests are based on the third-order Taylor expansion (b_4=0). The Linear model is rejected at the 5% level using H03. Recommended model: first-order logistic.

Function Graph – Threshold Weighting Function Logistic (c=70.8499)

Graph TA.5



Source: Authors' calculations.

Panel Quantile Regression

Quantile Panel Regression (PSTR) for selected EM CDS – Median

Table TA.2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Gross Government Debt to GDP	0.880	0.15	5.51	0.00
Commodities terms of trade cycle	-0.02	0.50	-4.75	0.00
US Financial conditions	30.82	5.01	6.15	0.00
EM CDS Index	0.79	0.031	25.05	0.00
Constant	279.72	51.94	5.38	0.00
Effects Specification - Cross-section fixed (dummy variables)				
Pseudo R-squared	0.49	Mean dependent var		143.38
Adjusted R-squared	0.48	S.D. dependent var		77.98
S.E. of regression	49.20	Objective		21531.84
Quantile dependent var	127.39	Restr. objective		42314.76
Sparsity	58.42	Quasi-LR statistic		2845.775
Prob(Quasi-LR stat)	0.00			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Gross Government Debt to GDP	0.880	0.15	5.51	0.00
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Sparsity	58.42	Quasi-LR statistic		2845.775
Prob(Quasi-LR stat)	0.00			

Source: Authors' calculations. Notes: Bootstrap Standard Errors and Covariance.

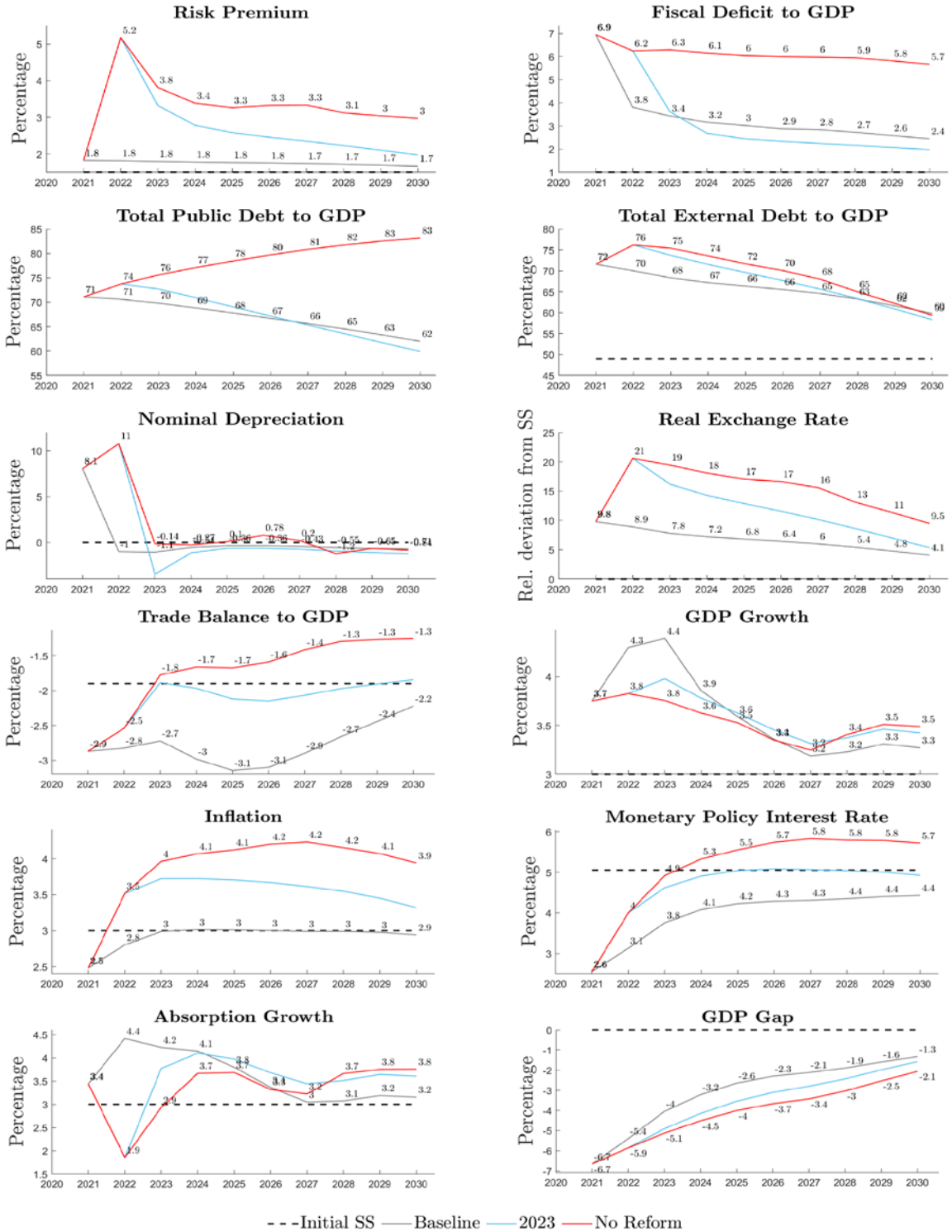
COFFEE DSGE Model: main features

The Colombian Framework for Fiscal Economics and Evaluation –COFFEE– is a model for a small oil-exporting economy that comprises different types of household and firm and incorporates nominal price and wage rigidities (Gonzalez et al (2021)). The model is an overlapping generation DSGE that includes households with and without access to credit and saving instruments. Domestic firms produce a composite good that can be consumed internally, exported, or used by other domestic firms to produce investment goods. Final household consumption and investment goods baskets include both domestic and imported goods. Imports are also intermediate goods in domestic production.

Given the emphasis on analysis of fiscal policy, COFFEE has a comprehensive module that characterises Colombia's fiscal policy. The government receives revenues and dividends from oil production, lump-sum taxes and taxes on consumption goods (domestic and imported), labour income, household wealth, and the profits of firms and capital producers. Government revenue is used for spending on consumption, interest payments, transfers to households, and public capital formation. Fiscal deficits are financed with both domestic and foreign debt. A fiscal rule set for the deficit considers the output and oil price gaps. The central bank sets the nominal interest rate based on a Taylor rule.

Effects of higher public debt and higher risk premia on monetary policy

Effect of higher public debt and risk premia in selected variables — Graph TA6

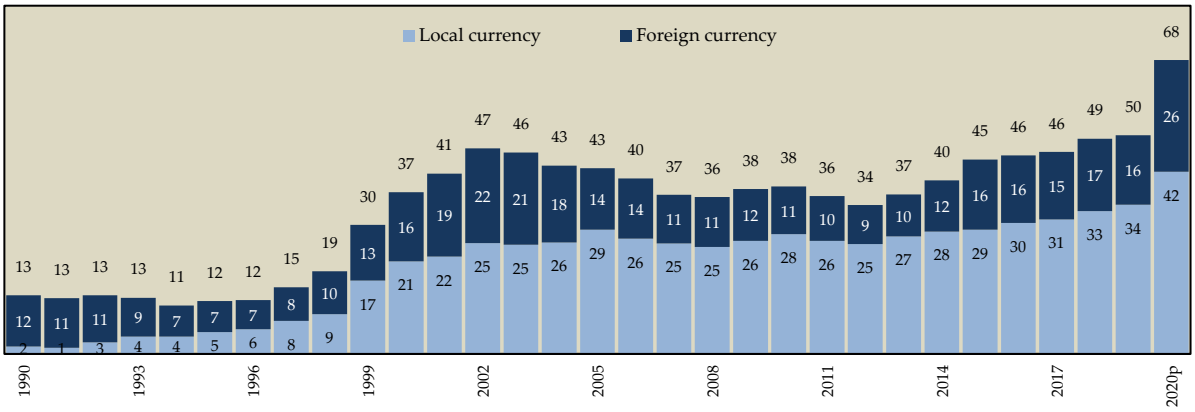


Source: Authors' calculations.

Colombian central government debt by currency

Colombian central government gross debt by currency (% of GDP)

Graph TA.7

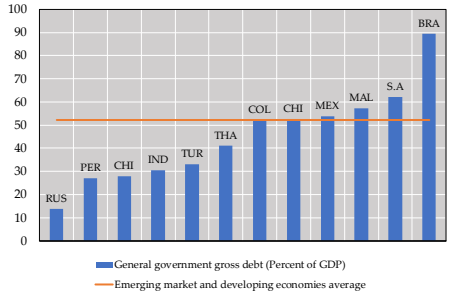


Source: Ministry of Finance, Central Bank's estimates.

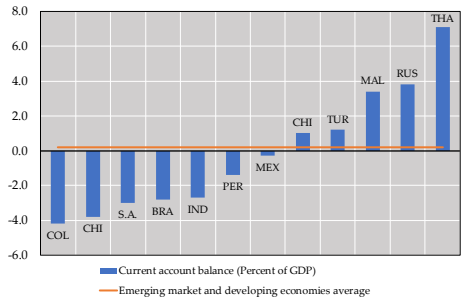
Annex Graphs

A.1

General government debt in selected EME economies



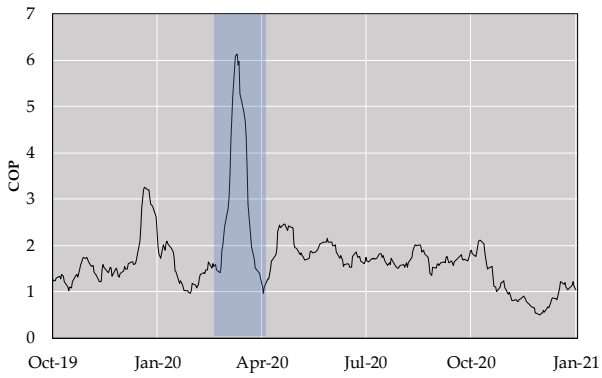
Current account balance in selected EME economies



Source: IMF and authors' calculations. Includes information for Brazil, Chile, China, Colombia, Indonesia, Malaysia, Mexico, Peru, Russia, South Africa, Thailand and Turkey,

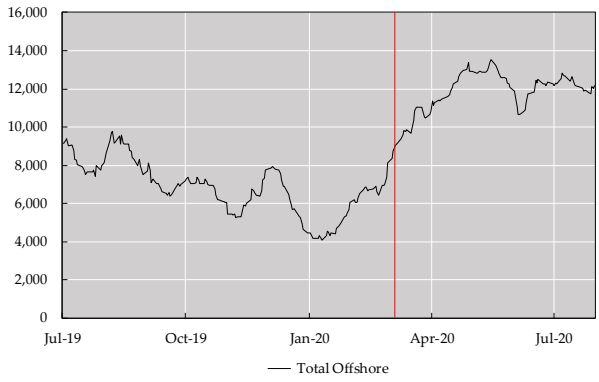
Bid-ask spread USD-COP spot market

10-day moving average December 2019 = 100



Offshore net forward long positions

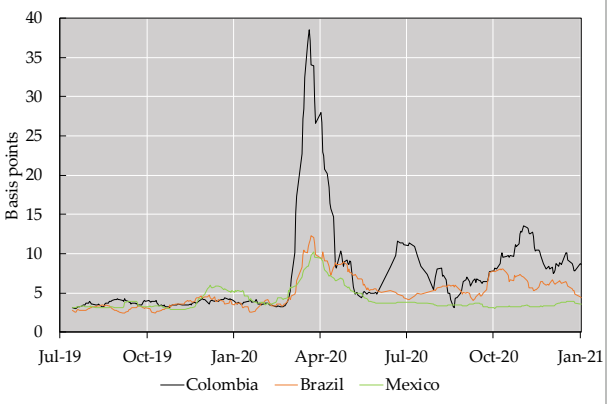
USD millions



Note: net claims of offshore agents on domestic FX intermediaries (FXI) and pension funds.

Bid-ask spread 10-year local currency bonds*

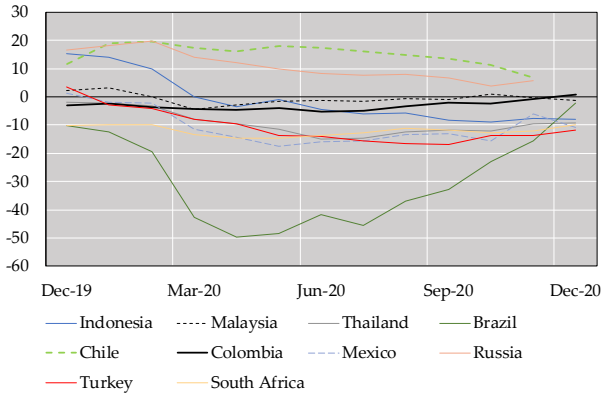
10-day moving average



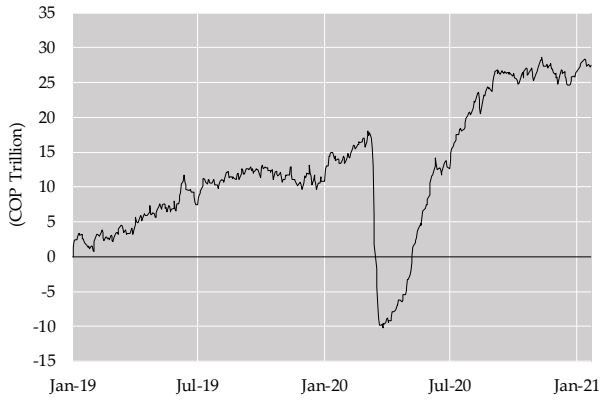
* Bond References: Colombia 2028, Brazil 2029 and Mexico 2029.

Capital inflows to EME economies

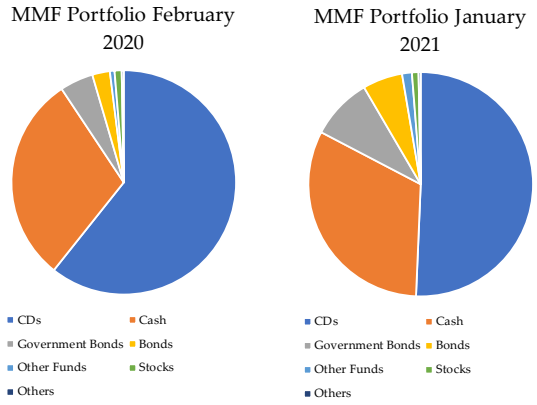
12-month cumulative net portfolio inflows (USD billions)



Money market funds (MMF) cumulative net inflows



Money market funds (MMF) portfolio distribution



Source: Bloomberg, SET-FX, Bank of the Republic, Financial Superintendency, IIF and authors' calculations