

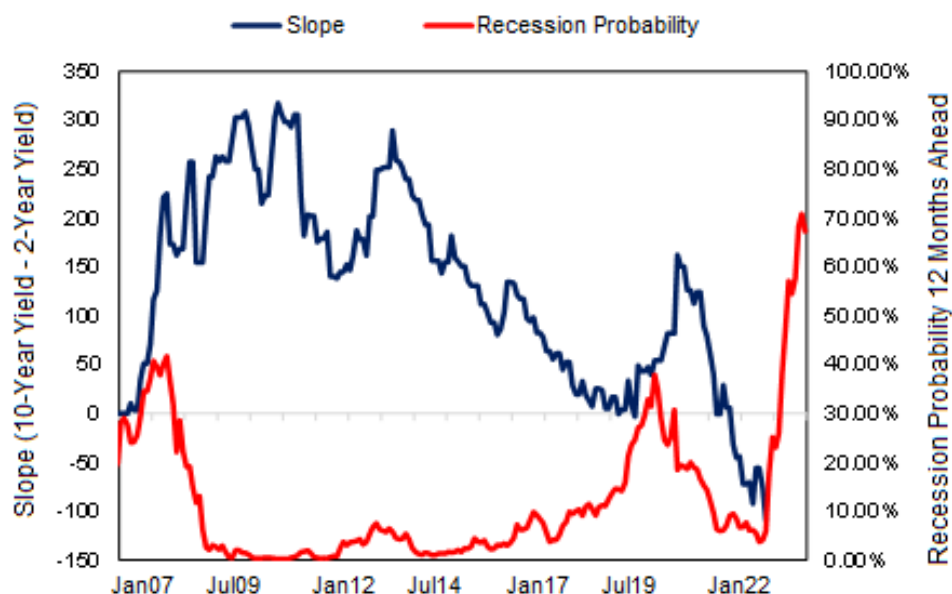
Box 1: Factors that may influence the Resistance to Inversion of the Yield Curve in Colombia

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Introduction

Recent analyses in the U.S. suggest that the cycle of increases in its benchmark interest rate was accompanied by the inversion of its yield curve and an increase in the probability of recession (Graph B1.1). The yield curve is understood to be inverted when long-term (10-year) bond rates are lower than short-term (2-year) rates. This behavior has been documented, and its predictive power to anticipate economic slowdown or recession events has been studied¹.

Graph B1.1. Probability of Recession in the U.S. and Slope of the Yield Curve



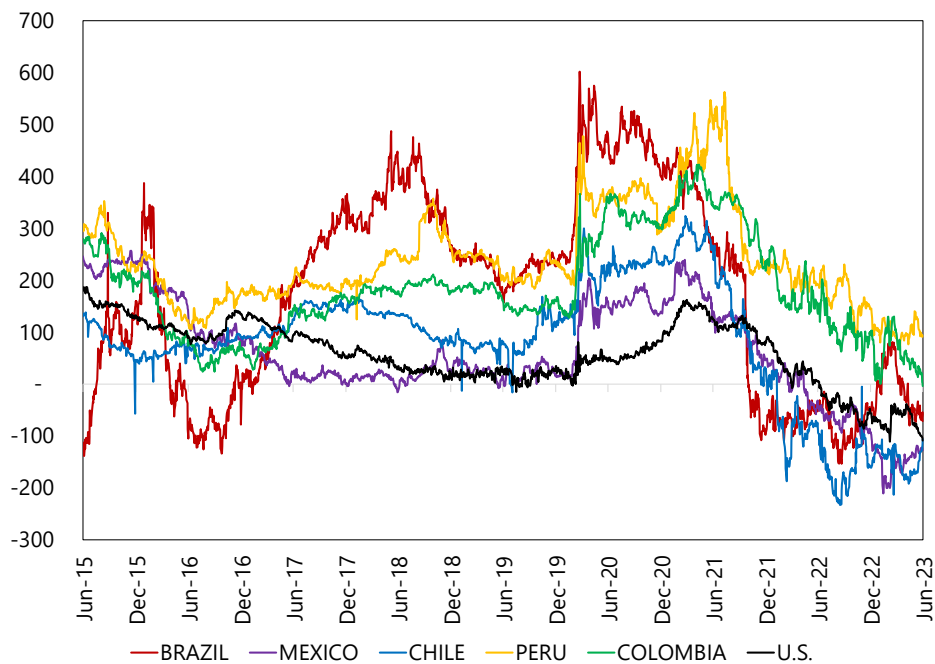
Source: Federal Reserve, National Bureau of Economic Research and *Banrep*.

The behavior of the yield curve slope for Latin American countries exhibits that the only slopes that are not inverted are those of Colombia and Perú (Graph B1. 2). The slope of the local currency nominal bond yield curve is inverted for most countries in the region in mid-2022 and on 30 June

¹ Some related works are Reuben A. Kessel, 1965; Campbell R. Harvey 1989; Arturo Estrella and Frederic S. Mishkin, 1998 and Glenn D. Rudebusch and John C. Williams, 2009.

2023 stood at -72 bps, -128 bps, and -60 bps, in Brazil, Mexico, and Chile, respectively. Meanwhile, the slopes of Colombia and Perú were close to historic lows.

Graph B1. 2. Yield Curve Slope in Latin American Countries and the U.S.



Source: Bloomberg and *Banrep*.

Therefore, this document seeks to identify the factors that explain why Colombia's slope has not inverted and is far from the behavior of most of its peers in the region. Thus, this Box is divided into five sections, including this introduction. The second section presents and analyzes some factors that may influence the yield curve behavior according to analysts and related literature. The third part provides the conceptual framework that guides the analysis. The fourth section reports the results of the empirical exercise. Finally, the last section presents the main conclusions.

Market Feedback and Literature Review

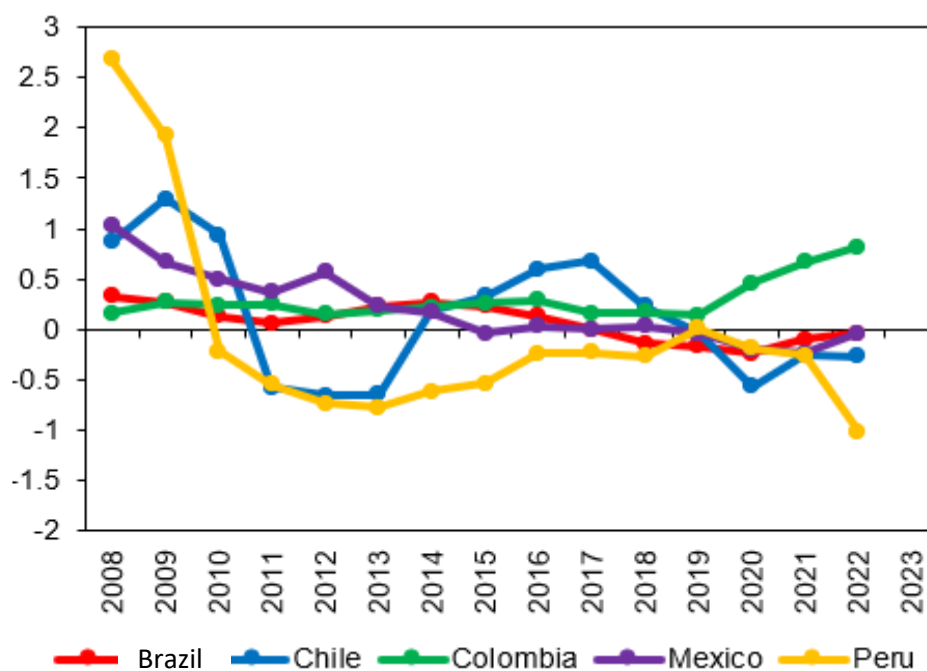
Based on the information obtained from some market agents, the differential behavior of Colombia's curve compared to some countries in the region and the fact that the slope does not reach negative figures can be explained by the following arguments: *i)* the higher credit risk and an increase in fiscal and political risk; *ii)* the significant offer of long-term securities by the Colombian Ministry of Finance and Public Credit (MHCP in Spanish); and *iii)* market microstructure.

Regarding the first argument, the literature points out that the monetary policy expectations channel (linked to economic growth expectations) is not the only channel that can explain the shape of the yield curve. Changes in the slope could also be due to market participants' attitudes

toward risk, and these flows could also help to understand the dynamics of real activity (Benzoni, Chyruk, and Kelley 2018). In this sense, variables such as credit risk, liquidity risk, and geopolitical risk, among other variables, would be decisive in analyzing the slope of yield curves.

In turn, the increased supply of long-term securities by the MHCP could affect the yield curve's slope by pressuring long-term premiums up. Various authors have found that the debt term is associated with increases in yields and the long-term premium due to a higher relative supply of securities in one curve segment (Chadha et al. (2013); Gagnon et al (2010); Greenwood & Vayanos (2010b) and D'Amico et al (2012)). In Colombia, although no literature supports the previous fact, there is an increase in the term of its debt through the placement of long-term securities, which could put upward pressure on the rates of the long end of the curve and its term premium (Graph B1. 3).

Graph B1. 3. Annual Change in the Average Life of the Debt Stock (Years).



Source: Bloomberg and *Banrep*.

The annual change in the average life corresponds to the difference between the average life of the debt stock for a given year and the same value of the previous year for each country in the sample. The average life is understood as the average time it takes to repay the outstanding principal of a bond.

In addition, the composition by type of investors could have implications on the shape of the term structure of the yield curve. In particular, under the preferred habitat theory² (Modigliani and Sutch, 1966), the concentration of participants in some segments of the curve could generate

² This theory states that risk-averse agents can better manage risk by positioning themselves on the yield curve end where the life of their assets coincides with the life of their liabilities.

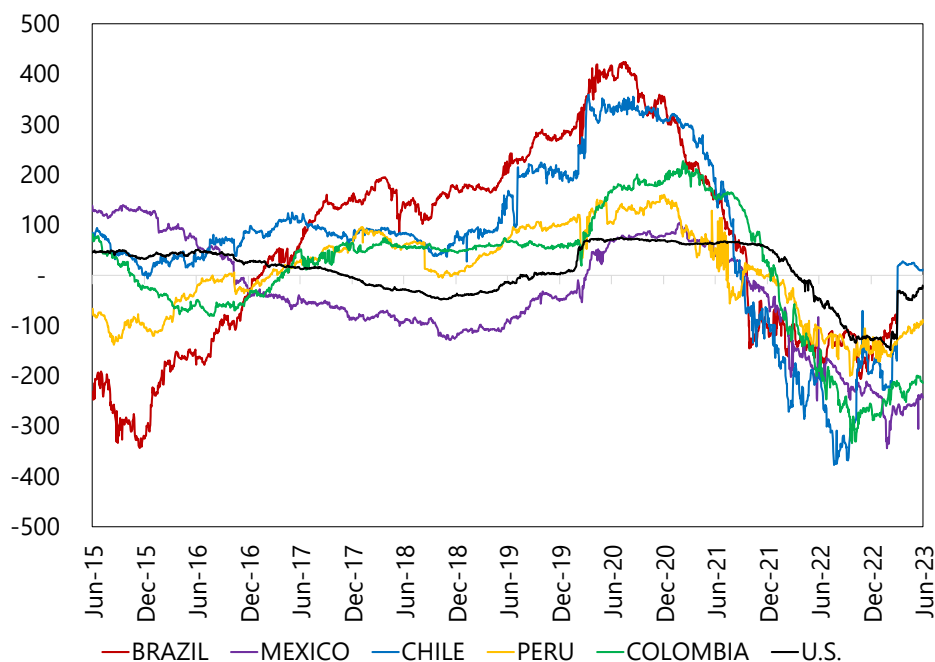
imbalances between supply and demand, resulting in liquidity premiums. Thus, the largest concentration of commercial banks at the short end of the curve (46% of total securities in this term) and the high participation of foreign investors and FPCs in the long end (26% and 33%, respectively), would influence the shape of the yield structure and would be supporting the existence of liquidity premiums at different maturities.

Conceptual Framework: Yield Curve Decomposition

The Adrian, Crump, and Moench (ACM-2013) methodology is used, which breaks down the rate of a bond into two factors: the risk-free rate (associated with monetary policy rate expectations) and the term premium (associated with risk premiums). Thus, the slope of the nominal bond rate is equal to the slope of the risk-free rate and the slope of the term premium.

Applying the ACM methodology (2013), it is found that the risk-free rate slope is inverted and is in line with the behavior of the countries in the region (Graph B1. 4). The inversion of this yield curve is in line with the expectations of monetary policy rate reductions and a slowdown in economic growth.

Graph B1. 4. Risk-Free Rate Slope.



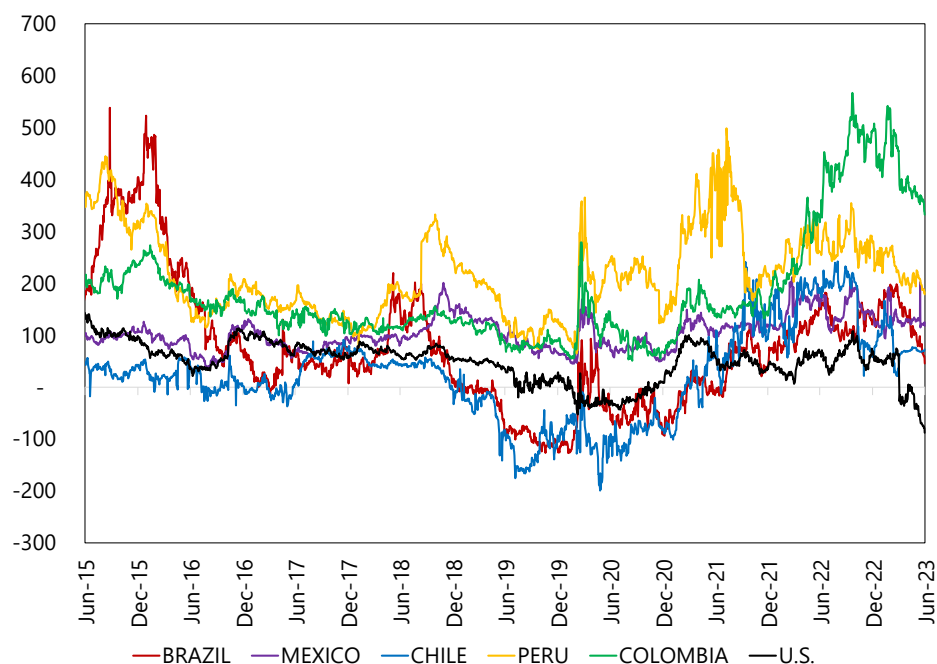
Source: Bloomberg and *Banrep*.

They are obtained as the difference between the estimated 10-year and 2-year risk-free spot rates using the ACM (2013) methodology.

On the other hand, the slopes of the term premium of the countries in the region show divergent behaviors; in Colombia, this variable shows significant growth during 2022 (Graph B1. 5). This

result suggests that the non-inversion of the yield curve can be attributed to a high level of the term premium for the 10-year term. In view of this behavior, it is important to determine the factors that explain the evolution of term premiums.

Graph B1. 5. Term Premium Slope.



Source: Bloomberg and *Banrep*.

They are obtained as the difference between the estimated 10-year and 2-year term premiums using the ACM (2003) methodology.

Empirical Approach: Some Determinants of the Term Premium

Considering the above, an econometric exercise is presented to study the relationships between some macroeconomic and financial variables and the 10-year term premium.³ (Table B1. 1). The results suggest that the term premium is explained by an inflation risk premium, the fiscal deficit, risk appetite in emerging countries, a liquidity premium and, to a lesser extent, the socio-political risk factor. In addition, the large supply of long-term securities by the MHCP, measured through the average life of the debt, is not significant, and there is no statistical evidence to support that this variable has increased the term premium in this end of the curve (Table B1. 2).

³ The analysis does not change using the term premium slope.

Table B1. 1. Macroeconomic and Financial Variables Studied

Variable	Description
Inflation risk premium	Standard deviation of one-year inflation expectations taken from <i>Banrep's</i> monthly expectations survey. Studies such as Ceballos, Naudon & Romero (2016) use this variable to measure inflation risk premium.
Fiscal deficit	Fiscal deficit on GDP.
Current account deficit	Current account deficit on GDP.
U.S. term premium (US_TP)	Term premium estimated for the U.S. using ACM methodology (2013).
Risk appetite indicator	Measured using the emerging markets risk appetite variable calculated by JP Morgan.
Liquidity premium	Measured by the Bid-Ask Spread of peso-denominated sovereign bonds in Colombia.
Average life of the debt (Average life)	The annual change in average life corresponds to the difference between the average life of the debt stock for a given year and the same value of the previous year for each country in the sample. The average life is understood as the average time it takes to repay the outstanding principal of a bond.
Socio-political risk (EOF_ISP)	Measured as the percentage of responses associated with the socio-political factor to the question of what are the most relevant factors when making investment decisions. This is one of the questions of the Financial Opinion Survey (EOF in Spanish).

Source: Bloomberg and *Banrep*.

Table B1. 2. Results of the regression between the 10-year term premium and economic and financial variables using FMOLS.

	Coefficient	Standard error	Statistic t	Prob
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Inflation risk premium	2.128	0.285	7.459	1.5e-11 ***
Fiscal Deficit	0.001	0.000	4.341	2.9e-05 ***
Current account deficit	0.054	0.036	1.500	0.136
U.S. term premium	0.122	0.076	1.612	0.109
Risk appetite indicator	-0.002	0.001	-2.927	0.004 **
Liquidity premium	0.001	0.000	2.746	0.007 **
Average life of debt	0.028	0.025	1.132	0.260
Socio-political risk	0.019	0.005	3.696	0.0003***

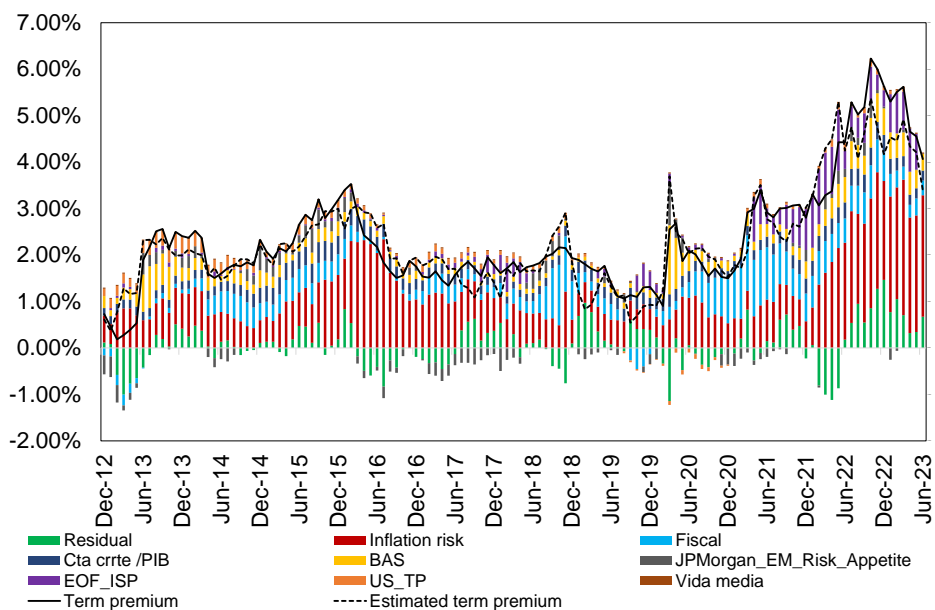
Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '' 1

R-squared: 0.799 N: 126

Source: Banrep.

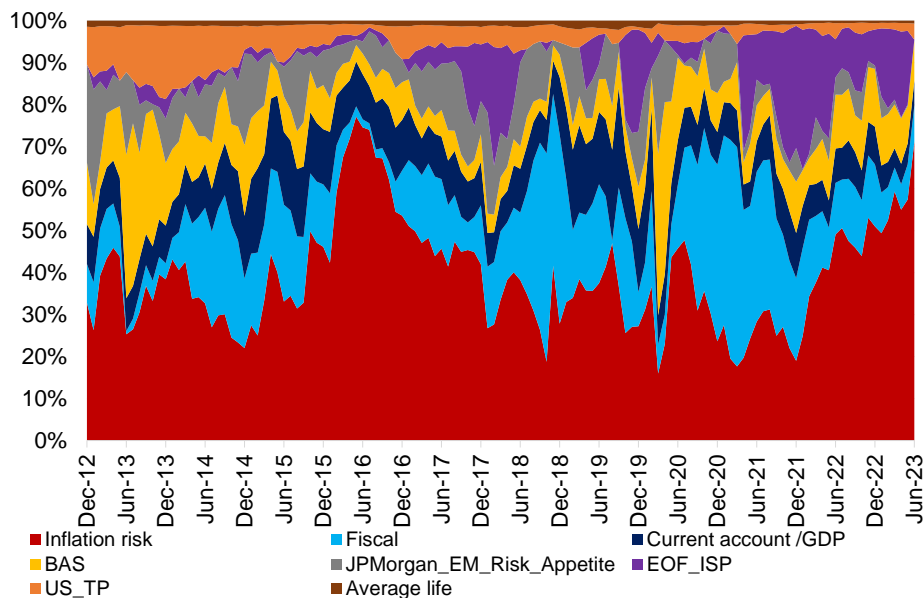
The results suggest that the factors that most affect the dynamics of term premiums are inflation risk premiums, the fiscal deficit, and the liquidity premium (Graph B1. 6). In addition, the results indicate that the increase observed during 2022 in the term premium can largely be explained by a significant increase in the inflation risk premium, followed by an increase in what could be associated with a socio-political risk premium (Graph B1. 7).

Graph B1. 6. Determinants of the 10-Year Term Premium.



Source: Banrep.

Graph B1. 7. Contribution of explanatory variables to the 10-year term premium flows.



Source: Banrep.

Conclusions

After reviewing the literature, contrasting the opinions of some market analysts, and applying some econometric exercises, it is found that the non-inversion of Colombia's yield curve can be explained by the term premium component. In particular, by breaking down the slope of the zero-coupon rates of TES in pesos in Colombia, the risk-free component shows a negative slope, which is aligned with the region's performance and the expectations of lower monetary policy rates and lower economic growth.

In addition, there is evidence of a possible link between the 10-year term premium and the inflation risk premium, the fiscal deficit, risk appetite in emerging countries, a liquidity premium and, to a lesser extent, a socio-political risk factor. Finally, the increase in the term premium in the recent period could be associated with an increase in an inflation risk premium and a greater perception of socio-political uncertainty.

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Box 2: Central Bank Asset Purchases in Response to the Covid-19 Crisis

Julián Camilo Mateus Gamboa

This Box summarizes the main findings on central banks' experience with asset purchases in response to the Covid-19 pandemic, emphasizing the Colombian case. The Bank for International Settlements (BIS) recently published a [report](#)⁴ in which the Committee on the Global Financial System (CGFS) examined the experience of central banks in several emerging and developed economies, identifying those who conducted asset purchases in response to a crisis for the first time during the Covid-19 pandemic and those who expanded or reintroduced asset purchase programs. *Banrep* participated in this report by sharing its experience during the pandemic.

Main Findings

In response to the Covid-19 pandemic, a large number of central banks in developed and emerging economies decided to undertake asset purchase programs. Most of these programs were mainly aimed at addressing functioning of financial markets, thus ensuring an appropriate transmission of monetary policy. In the case of developed economies, given the restriction of the central banks of several of these economies to continue cutting their interest rates⁵, the purchase program was also aimed at reducing long-term rates when short-term rates could no longer be lowered.

Given the impact of these programs, the BIS finds that during the first weeks of the pandemic, the provision of liquidity was essential for the proper functioning of the markets. In developed economies, a lower risk premium was subsequently evidenced in the debt market due to central banks' absorption of duration risk. In other words, central bank purchases reduced the private sector's exposure to duration risk (price sensitivity of a security to changes in interest rates) since these transactions involved the exchange of assets with low duration (such as Central Bank Reserves) for assets with higher duration in the private sector's portfolio (such as long-term bonds). Similarly, if the risk premium is broken down into credit risk, liquidity risk, and duration risk, central bank purchases could also put downward pressure on this premium by reducing private exposure to credit and liquidity risks. In contrast, in the case of emerging economies, the impact on the level of rates was more limited given the greater sensitivity of these economies to global financial market conditions.

The BIS found that the possible side or unwanted effects of these purchase programs were very limited. On the one hand, with the pandemic having a global joint expansionary monetary policy response, very few countries were affected by the adoption of these programs in other parts of

⁴ Central bank asset purchases in response to the Covid-19 crisis. Produced by CGFS and directed by Margarita Delgado (Banco de España) and Toni Gravelle (Bank of Canada).

⁵ This restriction is known as *zero lower bound* and refers to the restriction of central banks to continue accentuating an expansionary policy when their benchmark rate is near zero.

the world⁶. On the other hand, the rapid completion of these programs, given the economic reopening and strong inflationary pressures, may have limited the possible negative impact that these programs could have had if they had been in place for a longer period, as was the case for advanced economies after the 2008 financial crisis.

In summary, the main objective of central banks in implementing asset purchase programs was to support the correct functioning of the market and, thus, ensure the correct transmission of monetary policy. Regarding the impact of these programs, most consider that they contributed to the improvement of liquidity and public debt market prices. The following is a summary of the experiences of central banks in the region and other emerging economies in accordance with their statements in the BIS document (*Table 8*).

⁶ For example, during the 2008 financial crisis, the fact that most developed economies' central banks reduced their interest rates to historic lows encouraged portfolio investment flows to emerging economies since the latter still offered attractive interest rates, unlike their developed peers. This generated excessive leverage in several of these economies, making them vulnerable to potential episodes of sudden capital outflows.

Table 1. Experience of some Central Banks

Country	Eligible securities	Target	Amount
Colombia	<ul style="list-style-type: none"> - Sovereign bonds (TES): Along the curve - Private debt: They are only issued by financial institutions with a rating above A and a maturity of less than three years. 	To support the proper functioning of the market in order to correct liquidity shortages and improve proper price formation.	<ul style="list-style-type: none"> - Sovereign bonds: COP 2.8 trillion (0.3% of GDP) - Private debt: COP 8.7 trillion (0.8% of GDP)
Chile	<ul style="list-style-type: none"> - Bank bonds of all participants in the open market operations system - Bonds issued by BCCh 	To improve liquidity in local currency	<ul style="list-style-type: none"> - Bank bonds: US\$4 billion (1.6% of GDP) - BCCh bonds: US\$815 million (0.3% of GDP)
Brazil	Sovereign bonds (purchase and sale auctions made by the National Treasury), of which 77% corresponded to long-term inflation-tied securities.	<ul style="list-style-type: none"> - To support liquidity in the secondary market - To provide reference prices in times of market stress 	BRL 33.1 billion (US\$6.4 billion)
Mexico	Twist operations: Purchases of sovereign securities over ten years in exchange for short-term securities (less than three years to maturity).	To avoid disruptions in the public debt market by allowing market participants to reduce duration risk while promoting the orderly functioning of the market	Although the program was for MXN 100 billion (US\$4.1 billion, 0.4% of GDP), only MXN 15 billion (US\$0.6 billion, 0.1% of GDP) was awarded, showing that the need to hedge interest rate risk through this mechanism was not as high as expected.

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Hungary	Sovereign bonds and government-backed securities: While initially an attempt was made to limit the purchase of a particular security to 33% of the outstanding balance, it was later decided that it could exceed 50% if required to ensure liquidity and market stability. Regarding the maturity of the securities to be purchased, the Bank focused on long-term securities.		<ul style="list-style-type: none"> - To maintain the efficiency of monetary policy transmission - To maintain the stability of the public debt market - To ensure that interest rates the Bank sets will be reflected in the long end of the curve. 	HUF 3.65 trillion (7.5% of GDP)
India	Sovereign bonds through OMOs (70% of operations focused on the 5 to 10-year term) and twist operations (buying long-term bonds and paying short-term bonds).		<ul style="list-style-type: none"> - Market functioning - Monetary policy transmission 	<ul style="list-style-type: none"> - OMOs: INR 5.9 trillion (US\$80 billion, 3.0% of GDP) - Twist operations: INR 2.4 trillion (US\$33 billion, 1.2% of GDP)
Malaysia	Sovereign bonds: Not more than 10% of the outstanding balance of each security		<ul style="list-style-type: none"> - To provide liquidity - To ensure an orderly functioning of the market 	MYR 9.4 billion (US\$2.1 billion, 0.6% of GDP)
Country	First time?	Impact	End of program	
Colombia	<ul style="list-style-type: none"> - Sovereign bonds: No - Private debt: Yes 	Improved TES secondary market liquidity and public and private debt prices	<ul style="list-style-type: none"> - March and April 2021: Sales for COP 5.9 trillion (0.6%) - Subsequently, the Bank purchased TES for COP 23 trillion (2.1% of GDP) to offset some long-term liquidity needs. 	
Chile	They mention their role in providing liquidity to the PFMs during the three approvals of savings withdrawals. This			

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		prevented emergency sales of the PFMs' portfolio	
Brazil	In May 2020, the BCB was authorized to carry out transactions in the secondary public (local and foreign currency) and private debt markets. However, that authorization was sufficient to help improve liquidity and prices, so the BCB did not see the need to intervene in that market.		
Mexico	Reduced short-term rates, which in turn contributed to looser financial conditions		The Bank had initially announced that its program would end in February 2021. That month, the Bank announced that it would stand ready to conduct such operations as it deemed necessary.
Hungary	Yes. However, even before the crisis, the Bank was already supporting the local debt market through purchases of corporate and mortgage bonds.	<ul style="list-style-type: none"> - The program supported the extension of the maturity profile of sovereign debt and the reduction of the slope of the curve by lowering long-term rates. - The spread between the 10-year bond and its German counterpart also narrowed, reflecting not only global factors but idiosyncratic factors that contributed to the reduction in sovereign bond rates. - Liquidity returned to historical average levels 	In August 2021 the Bank began to reduce the pace of weekly purchases from HUF 60 billion to HUF 50 billion, and subsequently to HUF 40 billion. In December, the Bank announced the final termination of the program

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India	No	<ul style="list-style-type: none"> - Financial stress was reduced and orderly market conditions were ensured. Monetary policy transmission strengthened and credit flow was supported - Interest rates and spreads fell to pre-covid levels - According to an event study, for every 10% of GDP in purchases, rates fall by 80 bps 	<ul style="list-style-type: none"> - In October 2021, the Bank announced the end of its asset purchase program - In order to reduce excess liquidity, the Bank has moved from its overnight window to longer-term reverse repos
Malaysia	No	As evidenced by moderate market flows, purchases provided sufficient liquidity and facilitated an orderly price adjustment	Since the Bank's holdings are negligible compared to the size of the market, no exit plan is required. The Bank simply plans to let the bonds mature and not reinvest them

Colombian Case

During the Covid-19 crisis, *Banrep* implemented several policies focused on protecting the payment system, stabilizing the sovereign and corporate debt markets, supporting the foreign exchange market⁷, and ensuring that credit continued to flow to the economy. One of the first decisions made by *Banrep* at the beginning of the crisis was to reduce its interest rate to all-time lows. With respect to the sovereign and corporate debt markets, given the high turbulence observed at the beginning of the pandemic, the low liquidity, and the distortion of the prices of these assets⁸, *Banrep* decided to: (i) expand the amount, term, institutions (trusts, stockbrokers, investment management companies, and pension fund managers) and collateral types (high-quality corporate debt and debt receivables) eligible to participate in liquidity operations (repo transactions) managed by *Banrep*; and (ii) purchase sovereign and corporate bonds (the latter issued only by financial institutions). *Banrep* also implemented other measures such as reducing the reserve requirement from 11% to 8.0% providing additional liquidity of up to COP 10 trillion.

***Banrep's* purchases were focused on providing sufficient liquidity to the system amid increased uncertainty, supporting the proper functioning of the market, and improving appropriate price formation. It was not one of the objectives of these purchases to directly impact debt security rate levels.** In March and April 2020, *Banrep* purchased COP 8.7 trillion (0.8% of 2019 GDP) in securities issued by financial institutions. Eligible securities had to have a credit rating higher than A and a maturity of less than three years. This was the first time *Banrep* purchased assets of this type as part of its policy of expanding the type of assets and collateral included in its balance sheet.

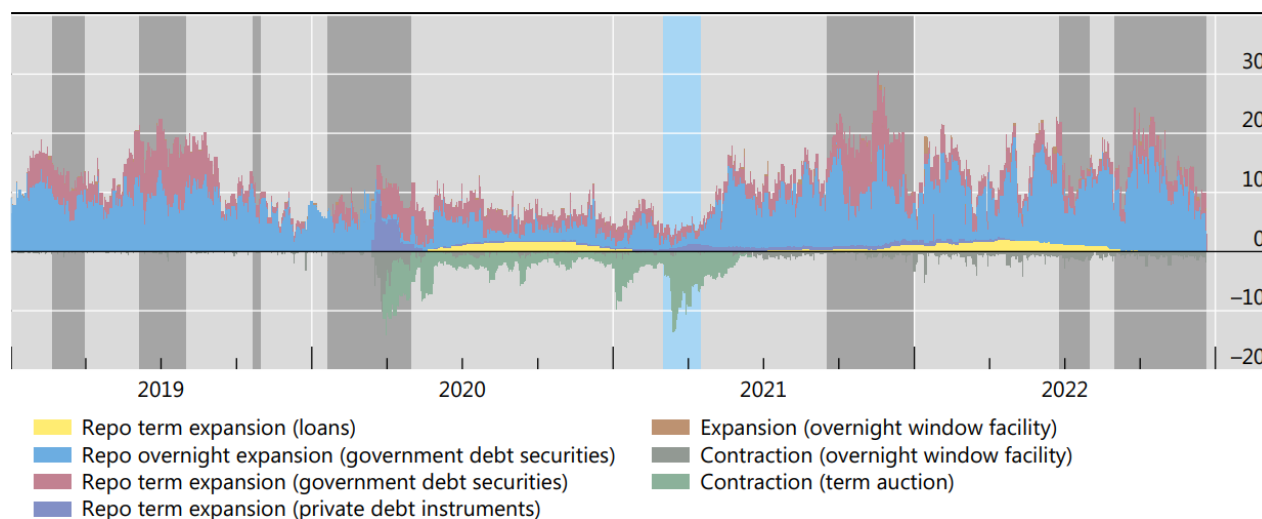
In Colombia, monetary policy operates mainly through transactions with sovereign bonds (TES). These transactions are made at market prices in the secondary market and consider estimates of supply and demand of the monetary base. In this sense, purchases of public debt are a common tool implemented by *Banrep* to provide structural liquidity to the market in order to align the benchmark interbank rate (IBR in Spanish) with the monetary policy rate. During the pandemic, these transactions also helped to support the proper functioning of the market (correcting liquidity shortages and enhancing robust price formation). In order to provide sufficient liquidity in pesos and support market functioning, *Banrep* announced the purchase of up to COP 4 trillion (0.4% of GDP) of TES between March and April 2020. As market conditions recovered quickly, purchases were limited to COP 2.8 trillion (0.3% of GDP). These operations were carried out along the entire TES curve.

⁷ *Banrep* did not intervene in the spot market. However, between March 2020 and March 2021, *Banrep* sold U.S. dollars through non-delivery forward (NDF) contracts in order to offset any potential tightness in the hedging instruments market. In March and April 2020, the Bank also offered 60-day FX swaps to provide short-term liquidity in U.S. dollars.

⁸ In March 2020, the daily average BAS of peso sovereign securities stood at 28.5 bps, well above the average level of 2.1 bps observed during 2019. Likewise, the average daily rate of the 10-year sovereign bond reached a level of over 9.0% during the last days of March 2020, well above the average level observed in 2019 (6.5%).

Following the implementation of several liquidity instruments during the pandemic, in March and April 2021, some liquidity was withdrawn from the system through TES sales (COP 5.9 trillion, 0.6% of GDP). Subsequently, during the same year and 2022, the Bank purchased TES for COP 11 trillion (1.0% of GDP) and COP 12.2 trillion (1.1% of GDP), respectively, as a mechanism to offset some long-term liquidity needs. These transactions were focused on aligning the benchmark interbank rate with the monetary policy rate. Graph B2.1 shows the monetary policy mechanisms implemented by the Bank since May 2019.

Graph B2.1. Balance of *Banrep's* Temporary Liquidity Transactions



Source: *Banrep*.

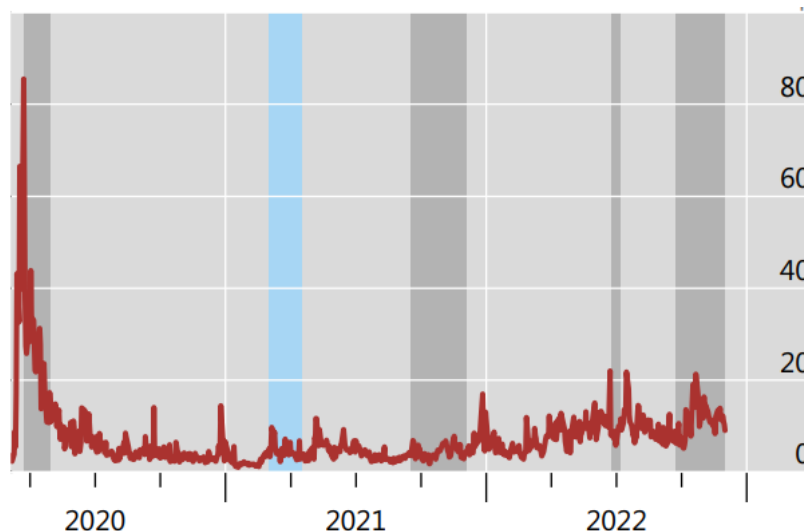
The gray shaded areas indicate the periods in which *Banrep* purchased assets. The blue shaded areas indicate the periods in which *Banrep* sold assets. Figures are in COP trillions.

In line with *Banrep's* interventions in 2020, some important signs of recovery in terms of liquidity conditions (Graph B2.2) and asset prices were observed (Graph B2.3). After the Bid-Ask Spread (BAS) of peso-denominated TES increased from less than 5 bps in February 2020 to levels above 80 bps in March 2020⁹, *Banrep's* intervention may have contributed to the rapid recovery of liquidity conditions during the subsequent months¹⁰. The BAS increased in Colombia in line with what was observed in the region's public debt markets, but corrected rapidly thereafter. Also, following a sharp reduction in the prices of sovereign and corporate debt securities in March 2020, these assets returned to their original price levels in line with the purchases implemented by *Banrep*.

⁹ Alternative liquidity measures of this market (e.g., traded volume and depth) show a similar pattern to the BAS's.

¹⁰ To date, no analysis has been conducted to measure the impact of *Banrep's* purchases on the yields of public and private debt instruments.

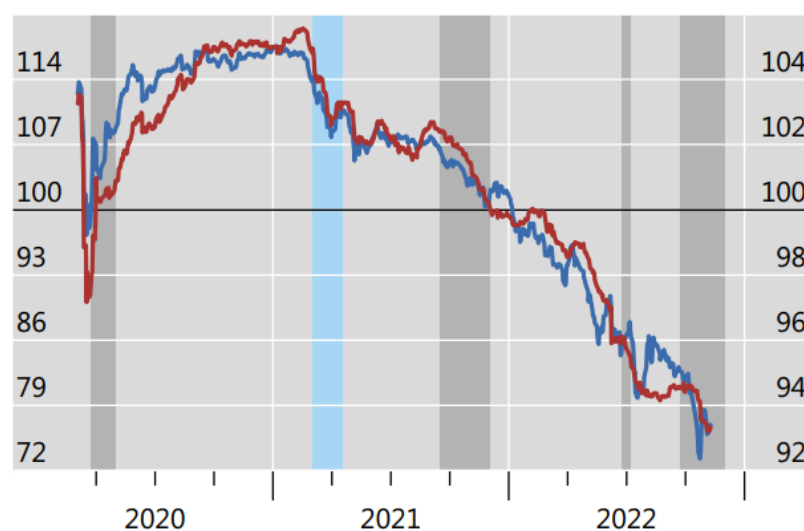
Graph B2.2. BAS of Peso-denominated TES (bps)



Source: *Banrep.*

The gray shaded areas indicate the periods in which *Banrep* purchased assets. The blue shaded areas indicate the periods in which *Banrep* sold assets. Figures are in COP trillions.

Graph B2.3. Colombian Public and Private Debt Price Index



Source: *Banrep.*

The gray shaded areas indicate the periods in which *Banrep* purchased assets. The blue shaded areas indicate the periods in which *Banrep* sold assets. Figures are in COP trillions. Public debt is shown on the blue line (left axis) and private debt is shown on the red line (right axis).

Subsequently, in 2021 and 2022, local financial conditions tightened as a result of the international environment (i.e., global contractionary monetary policy, the war in Ukraine and the Zero-Covid policy in China), as well as on account of some idiosyncratic factors linked to the increase in the monetary policy rate, the loss of investment grade, some episodes of socio-political turmoil in

2021, and uncertainty regarding the parliamentary and presidential elections in 2022. However, liquidity conditions have shown a better response than in March 2020.

***Banrep* has not implemented a quantitative easing program and its purchases in the TES market have sought a level of liquidity that is in line with market requirements.** Any adjustments in the Bank's asset portfolio have been consistent with the goal of keeping the O/N IBR aligned with the monetary policy rate.¹¹.

Regarding purchases of corporate debt securities, *Banrep* has not purchased additional assets of this type since April 2020. This measure was temporary and was notified to the market at the time. However, the Bank can still intervene in the sovereign and corporate debt markets when it deems it appropriate. Additionally, some counterparties accepted for liquidity operations during the Covid-19 crisis remain active despite the end of the emergency market. This is to ensure adequate response in the event that economic conditions change rapidly. For example, trusts, pension fund managers, and open-ended funds remain on the list of authorized counterparties (under certain conditions).

¹¹ In 2021, *Banrep* reduced its balance sheet by selling TES (in order to drain liquidity to align the IBR with the MPR), and also as a result of the transfer of profits to the Colombian Government.