Portfolio inflows to emerging markets: The role of monetary policy and inflation*

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Abstract

Portfolio investment allows for international risk sharing but can also transmit and amplify domestic and external shocks. In this paper, we investigate the impact of changes in domestic and US policy interest rates on portfolio inflows in an emerging market economy. Using a structural VAR model and monthly data on a large set of macroeconomic variables over the period 2011-2023, we find a positive and statistically significant response of portfolio inflows in government securities and corporate bonds to an increase in both domestic and US policy rates. Portfolio inflows in the stock market are more sensitive to changes in the inflation rate and are insensitive to changes in the US policy rate. These results are robust to the inclusion of local and global risk factors, and to the alternative measures of monetary policy rates. Overall, the results are consistent with the predictions of the interest rate channel and reveal that local and US inflation are also key drivers of portfolio inflows in emerging markets.

JEL codes: F31, F32, F33, F36

Key words: portfolio inflows, emerging market economies, monetary policy, inflation, SVAR models, interest rate channel

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1. Introduction

Portfolio investment allows for international risk sharing but can also transmit and amplify domestic and external shocks (Blanchard et al., 2016, Bruno and Shin, 2015; Caballero and Simsek, 2020; Devereux and Yu, 2020; Gourinchas et al., 2024). In emerging market economies, portfolio flows are an important source of funding for both private and public agents. These investment flows are determined by both external and internal factors that fall under the so-called common (Push) and country-specific (Pull) factors (Gosh et al. 2014, Sarno et al., 2016; Koepke, 2019). Within these determinants, both domestic and foreign interest rates are of particular interest. In emerging economies, increases in domestic policy rates usually lead to surges in portfolio investments (i.e., stocks and bonds) and, in some cases to a rebalancing of portfolio flows (IMF, 2016; Ahmel and Zlate, 2014; Kim, 2014; Erduman and Kaya, 2016). The dynamics of portfolio flows has been also associated with global risk factors such as the VIX and less with domestic factors (Forbes and Warnock, 2012). After the global financial crisis of 2007-2009, the low level of the interest rates in the US and in other central economies have been an important driver of international portfolio flows to emerging economies (Rey, 2016; Koepke, 2018; Miranda-Agripino and Rey, 2020; Cahri et al., 2021; Ciminelli et al., 2022).

In this paper, we answer the following questions: Do domestic and US monetary policy affect the behavior of portfolio inflows in an emerging market economy? If they do, are the effects of domestic and US monetary policy the same depending on the type of instrument? And finally, given that the relative return that the foreign investors consider is the real return in both countries, does the inflation rate affect portfolio inflows and how? To answer these questions, we employ a structural VAR model and monthly data on portfolio inflows of non-residents in Colombia and differentiate between fixed income instruments (Colombian Government Securities (TES) and corporate bonds) and variable income instruments (shares) during the period 2011-2023. The period of study covers local and US monetary policy cycles, the Covid-19 pandemic, and the recent surge in global inflation[1]. Our empirical framework controls for a large set of macroeconomic variables, including global and local risk metrics that enhance identification. Unlike most of the

[1] We do not analyze portfolio outflows of residents because there is no availability of data at the instrument level from the Balance of Payments. Our period of analysis starts in 2011 because the availability of data disaggregated by instrument.

empirical evidence, where gross portfolio flows from both residents and non-residents are used to gauge portfolio flows, we focus on inflows from non-residents and distinguish by instruments issued in the local market (i.e., TES, corporate bonds, and equities).

We focus on studying the effects of domestic and US monetary policy shocks on the dynamics of non-resident portfolio inflows, which respond to the predictions of the so-called interest rate channel (Ciminelli et al., 2022). Under this approach, an exogenous monetary contraction that increases domestic interest rate affects portfolio inflows of non-residents in the following way: on one side, local bonds become more attractive to foreign investors because they offer higher interest rates and therefore, foreign investors are likely to purchase more of these bonds. On the other side, in the stock market occurs the opposite, in the face of an increase in domestic interest rates, they become less attractive because the monetary contraction is expected to have a negative impact on the real activity and therefore on the prospects of dividends. In this case, portfolio inflows would fall. The opposite effects are expected in the case of increases in the domestic rate of inflation or the foreign interest rate. These effects are documented in Fratzscher (2012); Broner et al., (2013); Ananchotikul and Zhang, (2014); Koepke, (2014); Nier et al., (2014); Bruno and Shin, (2015); Ledóchowski and Żuk (2022), among others.

The identification of the monetary policy shocks posits one important challenge. As portfolio flows depend on the relative real return on assets, in our analysis we incorporate the endogenous dynamics of the nominal interest rate and the inflation rate. However, in the empirical evidence it is common to find the so-called *Price Puzzle*. That is, contrary to the expected by the theory, in response to an increase in the nominal interest rate, the inflation rate also increases (instead of falling) (Hanson, 2004). In the literature, this is explained by the fact that the monetary authority reacts with lags or with moderated policy rate increases to inflation that mitigate it but not completely offset it. Therefore, it is necessary to identify how much of the variation in the inflation rate is due to the changes in the nominal policy rate. To do this, some alternatives have been suggested in the literature such as the use of asset prices as proxy of inflation expectations to which the monetary authority reacts or to employ surveys of professional forecasters. In our analysis, we include the Colombian Stock Index (COLCAP) as a measure of asset prices.

Nevertheless, the literature has documented that these variables do not account completely for the puzzle (as we observe in the case of Colombia) and suggests some econometric approaches to

solve it. The two more important approaches are, first, the structural vector autoregressive (SVAR) with sign restrictions, (Uhlig, 2005), in which the sign of the relationship between the inflation rate and the nominal interest rate is fixed as negative. Second, SVARs with short-run or long-run restrictions, that determine some relationships between the economic variables of the VAR and that are not restrictive with respect to the sign of the relationship between the interest rate and the inflation rate, and instead allow the system to estimate it. In our analysis, we employ the second avenue and estimate a structural autoregressive SVAR model with long-run restrictions (Chari et al., 2008). As mentioned before, the latter approach has the advantage over the first that it does not impose the sign of the relationship of the inflation rate and the interest rate but allows the SVAR to estimate it making the result more robust.

We find three main results. First, a positive and statistically significant response of portfolio inflows of government securities (TES) to a contractionary monetary policy that increases the domestic monetary policy rate. We identify that an increase in the interbank interest rate (TIB), used as a proxy for the domestic monetary policy interest rate, of 25 bps is associated with an increase in portfolio inflows in TES of approximately USD 287 million monthly. This finding is robust to the use of an alternative monetary policy measure (i.e., Central Banks' REPOS rate).

Second, we observe that an increase in the US interest rate (proxied by the Federal Funds Rate) is associated with a decline of portfolio inflows in the TES market of government bonds one month after the shock. As a robustness check, we employ the US shadow rate (Wu and Xia, 2016) and find the same effect over portfolio inflows but two months after the shock. Furthermore, we find that an increase in the inflation rate is associated with a decline in portfolio inflows in the TES market, which is expected as its real return is reduced. These results confirm that portfolio inflows by non-residents in the government securities market respond to changes in domestic and US policy rates in the direction predicted by the interest rate channel. Moreover, our findings suggest that a shock to US inflation is associated with outflows of TES. The latter is an interesting finding considering the recent increase in the inflation rate in the US economy, which put forward the importance of spillovers of US inflation rate to emerging market economies (Arteta et al., 2022).

Third, we document that changes in the domestic or US monetary policy rates have no significant effect on portfolio inflows in the Colombian stock market. We observe that portfolio inflows in the stock market increase with surges in the domestic inflation rate, suggesting a rebalancing of

the portfolio between stocks and bonds in favor of stocks. Besides, an increase in the domestic inflation rate causes a fall in the domestic real interest rate and an increase in the price of the stocks inducing an increase in these portfolio inflows. Finally, in the corporate bonds market, an increase of 25 bp in the TIB is associated with a fall in portfolio inflows of around 12 USD million monthly. Albeit the effect is very short-lived, this result suggests a rebalancing of foreigners' portfolio (between corporate bonds for TES) in the face of changes in interest rate prospects; possibly due to the greater response of TES to changes in interest rates compared to the one of corporate bonds that can be associated with the role of severing risk (Du and Schreger, 2016). We also find that the US interest rate has a negative and significant effect on portfolio inflows in the corporate bonds market, in line with the dynamics observed in the TES market. With respect to the US inflation rate, it causes an increase in corporate bonds flows as expected.

Overall, our findings suggest that portfolio inflows in the government securities and corporate bonds markets respond to changes in domestic and US policy rates, in line with the predictions of the interest rate channel (Ciminelli et al., 2022). They also respond to changes in the domestic rate of inflation in the expected direction and to the US inflation rate. As these flows accounts for around 84 percent of portfolio inflows by non-residents, we can argue that monetary policy actions have an important incidence on the behavior of portfolio inflows in Colombia.

Our findings have some policy implications. First, the higher effect of the US policy rates on portfolio inflows can be related to the search for yield, as many advanced economies have increased their demand for emerging markets assets given the low level of interest rates in their economies after the Global Financial Crises of 2007-09 (Borio et al., 2016). This has been particularly important in the case of institutional investors (i.e., pension funds and insurance companies) (IMF, 2016). Hence, the recent normalization of the interest rates in the United States, after the huge monetary expansion during the Covid-19 pandemic, represents a chief challenge for monetary authorities in emerging market economies that have been facing capital outflows (CGFS, 2021).

Second, one implication of the response of the portfolio flows to the interest rates differentials is that, during a credit boom, the credit channel of the monetary policy is disrupted. In this case, when the domestic policy rate increases, the portfolio inflows (and the loan inflows) cause an increase in the supply of credit, due to the carry trade strategies that are triggered, contrary to the

goals of the monetary authority that aims to subdue the credit in times of credit booms (as documented by Fabiani et al., 2022). The latter implies the need for the use of macroprudential policies to enhance the role of monetary policy and facilitate financial stability (IMF, 2022; Morales et al., 2022).

Contribution to the literature. We contribute to several strands of the international finance literature. Despite the increasing attention on portfolio inflows by both academics and policy makers, empirical evidence remains scarce, relying mostly on cross-country data, that might misguide the individual effects of each specific country, and without distinguishing among the different types of instruments (Ahmed and Zlate, 2014; Fratzscher, 2012; IMF, 2016; Erduman and Kaya, 2016; Sarno, and Ulloa, 2016). We extend these studies by providing novel evidence on the impact of changes in local and US monetary policy rates and inflation on portfolio inflows (fixed and variable income instruments) in Colombia during the period 2011-2023. Our empirical strategy based on a SVAR model with long-run restrictions (Chari et al., 2008) allows for an accurate identification of the impact of monetary policy on portfolio flows. Moreover, we control for traditional *pull* and *push* factors such as the US industrial production index, the VIX (global risk), the local asset prices, the domestic fiscal balance, the rate of real exchange rate depreciation, among others global and domestic factors.

Our results also build on previous evidence that suggests that changes in US monetary policy rates influence portfolio flows in emerging economies (Chen et al., 2014; Bruno and Shin, 2015; Fratzscher et al., 2014; Gilchrist et al., 2019; Ledóchowski and Żuk, 2022). We employ a novel approach for the Colombian case including the role of both monetary policy rates and inflation during the 2011-2023 period. We extend the identification by using alternative measures of monetary policy including shadow rates (Wu and Xia, 2016), and distinguishing the effects across fixed and variable income instruments allowing to test for the interest rate channel (Ciminelli et al., 2022).

There is also evidence suggesting that foreign monetary policy has an important influence on bank lending in the corporate sector through cross-border bank credit flows (Dias et al., 2020; Sarmiento, 2022) and that capital flows affect credit growth in emerging market economies (Baskaya et al., 2017; Cantú et al., 2022). We contribute to this branch of literature by showing that portfolio

inflows also react to changes in both domestic and foreign monetary policy. In this sense, banks have incentives to sell local bonds to foreign investors to increase lending (Williams, 2018), a potential externality of domestic monetary policy.

The remaining of the paper has four sections including this introduction. Section 2 describes the data and empirical strategy. Section 3 presents the results. Section 4 concludes.

2. Data

Since September 1999, the Colombian economy operates under an inflation-targeting with floating exchange rate regime that allows for FX interventions (see Toro et al., 2023; Parra-Polania et al., 2024). In general, portfolio and loan flows could enter and leave the country without restrictions during the evaluated period. **Figure 1** depicts the monthly evolution of non-resident portfolio inflows by instrument issued in Colombia (in millions of USD) during the 2011m1-2023m2 period. We observe that most of the inflows are concentrated in the TES market, followed by the stocks market and the corporate bonds market. On average, the inflows in TES represented 84 percent, during the analyzed period, those of shares 13 percent and those of corporate bonds 3 percent of the total inflows of non-residents. We observe that increases in domestic interest rates (i.e., the interbank market rate -TIB) are associated with increases in portfolio inflows of TES by non-residents, and that an increase in the US policy rate (i.e., Federal Funds Rate -FFR-) coincides with reductions of them, in line with the predictions of the interest rate channel. On average, the gap between the domestic and US policy rates was 408 basis points during the evaluated period.

During the period, some exogenous shocks in the local and global market conditions have influenced the behavior of non-resident portfolio inflows. In 2011, Colombia recovery the investment grade, increasing portfolio inflows in the TES market. Then, between March and December of 2013, emerging markets faced high volatility in exchange rates, capital outflows and liquidity constraints associated with the US fed tapering (Sarmiento, 2022). The significant increase in the TES inflows during the second quarter of 2014 stands out. In March of 2014, JP Morgan decided to increase the weights of Government Colombian bonds in its GBI indices. Additionally, JP Morgan announced that the weighting of the bonds of countries like Turkey,

Russia, Thailand, Indonesia, and Hungary would decrease. These JP Morgan decisions increased the demand for TES by non-residents from Colombian banks giving place to an increase in domestic loans (Williams, 2018; Carranza and Moreno, 2020). The second shock was in the first quarter of 2019. We observe a portfolio rebalancing that can be related with the reduction of the withholding tax for foreign investors in TES from 14 percent to 5 percent approved in a tax reform in Colombia held in December 2018. Finally, the graph shows a strong fall in portfolio inflows associated with the Covid-19 pandemic that reached 768 USD million in March 2020, consistent with the retrenchment in portfolio flows across the emerging economies (BIS, 2021).

Table 1 describes the data we used in our estimations. We use monthly portfolio inflows of non-residents for the period January 2011 to February 2023. The portfolio inflows are divided into locally issued instruments, including public debt securities (TES), shares, and corporate bonds registered at the Balance of Payments of the *Banco de la República*.

The portfolio inflows are expressed in USD million. The mean inflows during the period were around USD 310 million in TES (with a minimum of USD -1086.2 million and a maximum of USD 2534.6 million), USD 64 million in shares (with a minimum of USD -368.7 million and a maximum of USD 667.1 million), and USD 9 million in corporate bonds (with a minimum of USD -70.9 million and a maximum of USD 254.7 million). We use the monthly change in the annual effective interbank interest rate (TIB) as proxy for the domestic policy interest rate whose monthly variation was -0.01 percent on average during the period, as an alternative policy rate we use the monthly variation in annual policy rate REPO which average variation was like the one of the TIB. Inflation is the annual end-of-period inflation rate that exhibits a mean of 3.76 percent a year. The US annual inflation rate was on average 1.73 per cent. The capitalization index of the Colombian stock market (COLCAP) is the end of the month value of the index from the Colombian stock market. Fiscal balance is the nominal fiscal balance of the Colombian central government deflated by the domestic consumer price index (CPI), accumulated over 12 months form the Ministry of Finance and Public Credit, which was negative in average over the sample period. Real depreciation rate is the annual change in the Real Exchange Rate Index (ITCR) from *Banco de la República*, with an average increase of 3.95 percent. We use the 10-year TES interest rate from Bloomberg as a measure of the long-term domestic interest rates.

We include the annual change in the VIX as an indicator of global risk, that corresponds to the monthly CBOE volatility index, not seasonally adjusted from FRED. D(LIPI_US) is the annual growth of the US production index with base 2021=100. We use the Shadow Federal Fund Rate by Wu and Xia (2016) as an alternative measure of the US Federal Fund Rate.

As explained in the next section, we include a set of dummy variables to control for external and regulatory shocks that affected the dynamic of portfolio flow i) JPM, that is equal to 1 from March 2014 to the end of the sample ii) DIDIV, that is equal to 1 from December 2018 onwards, to model the effect of the regulatory change on the dividend tax policy, and iii) Covid-19, which is equal 1 from March to December 2020 and 0 for the rest of the period.

3. Empirical strategy

A key challenge in the identification of the effects of changes in interest rates on capital inflows is to solve for the traditional *prize puzzle* stated by the monetary literature (Hanson, 2004). To do so, our empirical strategy for the study is that of a structural vector autoregressive SVAR with long run restrictions (Blanchard and Quah, 1989). This consists of jointly analyzing a system of time series variables to establish the impact of changes in the domestic policy interest rate (TIB) on portfolio inflows. Some long-term economic restrictions are imposed on the system to obtain a correct identification of domestic monetary policy shocks[2]. A similar methodology was used by Culha (2006) for the case of Turkey and Kim (2014) for the case of Korea, among others[3].

In a first step, a reduced form VAR-X is estimated as:

$$Y_t = A_1 Y_{t-1} + ... + A_p Y_{t-p} + B_0 X_t + \cdots + B_q X_{t-q} + FD_t + e_t = A(L)Y_{t-1} + B(L)X_t + FD_t + e_t \quad (1)$$

[2] Several methodologies have been proposed for the identification of monetary policy shocks and the goal is to avoid the so-called price puzzle described in the introduction. Among these methodologies, the most used are the VAR with short- and long-term restrictions or the VAR with sign restrictions. However, the former has the advantage over the latter that the sign of the relationship between inflation and the interest rate is not imposed, but rather is allowed to be estimated by the system.

3 We extend those studies by analyzing the effects of changes in US monetary policy rates and domestic inflation on the behavior of portfolio inflows in an emerging market economy.

where Y_t is a $lx1$ vector of endogenous variables (pull factors); (*A(L)* and *B(L)* are polynomials, of degree p and q, respectively, in the usual lag operator L. D_t represents intervention effects (JP Morgan, Tax policy and Covid-19). $X_{t\ is}$ a $mx1$ vector of exogenous variables (push factors). Finally, e_t is a $lx1$ vector of reduced form non-orthogonal residuals, $E(e_t) = 0, E(e_t e_t') = \Sigma$.

The endogenous variables are the annual inflation rate (inf_t), the monthly change of the domestic policy interest rate (ΔTIB_t), the monthly change of the TES interest rate to 10 years (ΔR_t^{TES10}), the annual change of the stock price index ($\Delta L\ COLCAP_t$), ($FiscalBal_t$), the real annual depreciation of the exchange rate ($Depr_t$) and the respective portfolio inflow $Flujo_t^j$. The exogenous variables include the monthly change of the Federal Funds Rate (ΔFFR_t), annual change of the log (ΔVIX_t), annual change in the log of the US Industrial Production Index (ΔIPI_t) and annual US inflation rate (Inf_USA). The vector of determinist variables includes: i) the JP Morgan episode (JPM_t) dummy that equals to 1 from March 2014 to the end of the sample, ii) the modification of the tax in dividends on profits from shares in oct 2018 is included as a dummy variable equal to 1 from December 2018 onwards ($DIDIV_t$), and iii) a Covid-19 dummy that equals 1 from March 2020 onwards.[4]

Reduced form residuals and elements of e_t are a linear combination of unobserved structural shocks.

$$e_t = G\varepsilon_t$$

Where G is a lxl matrix, ε_t is a $lx1$ vector of structural shocks, $E(\varepsilon_t) = 0, E(\varepsilon_t \varepsilon_t') = 1$

[4] We use the CUSUM criterion to evaluate the stability of the VARs and find that all the equations of the VAR models are stable. In order to check the joint homoskedasticity of the VAR residuals, we calculated the White's heteroscedasticity criteria (not including cross terms) and the respective P-values of the VAR models range between 0.6 and 0.8, supporting, in all cases, the null hypothesis of homoscedasticity. Not all the residuals of the VARs are normal (structural factorization), which show excess kurtosis, which could be corrected with transformations of the variable, but this would complicate the interpretation of results, which is why we do not follow that path. As an alternative, the impulse-responses and their confidence intervals were calculated by bootstrapping in blocks of 6 consecutive residuals. Regarding non-autocorrelation: residual autocorrelation is present at lags two and above in some of the models. Having determined the number of lags in the VARs, it is usual to try to improve residual autocorrelation effect by including dichotomous variables in the time periods where extreme residuals are present. Proceeding in this way reduces the autocorrelation somewhat, but the increase in the number of coefficients to be estimated reduces the degrees of freedom excessively, and these results are not presented here.

In the second step, we use the residuals of the reduced form to estimate the structural shocks, the SVAR:

If we ignore the writing of the effects of exogenous and deterministic variables and write the VAR as:

$$Y_t - A_1 Y_{t-1} - \ldots - A_p Y_{t-p} = e_t = \bar{A}(L) Y_t \qquad (2)$$

Since we are employing a stationary model, we can re-write (2) as:

$$Y_t = (\bar{A}(L))^{-1} G \varepsilon_t = C(L) \varepsilon_t \qquad (3)$$

Equation (3) contains the vector moving average representation of the VAR models in the absence of exogenous variables.[5]

Long-term effects are considered as the cumulative effects over time, that is:

$$\begin{bmatrix} Inf_t \\ \Delta TIB_t \\ \Delta R_t^{TES10} \\ \Delta Colcap_t \\ FiscalBal_t \\ Depr_t \\ Flow_t^j \end{bmatrix} = \begin{bmatrix} C^{11}(1) & \cdots & C^{17}(1) \\ \vdots & \ddots & \vdots \\ C^{71}(1) & \cdots & C^{77}(1) \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{i} \\ . \\ . \\ . \\ \varepsilon_t^{f} \end{bmatrix} \qquad (4)$$

The long-run restrictions strategy described above, proposed by Blanchard and Quah (1989), imply the following restrictions on the VAR system:

$C^{12}(1) = C^{13}(1) = \cdots = C^{56}(1) = 0$, that is, $C^{ij}(1) = \sum_{h=0}^{\infty} C_h^{ij} = 0$ for the $j > i$

[5] The inclusion of exogenous variables does not alter the identification restrictions of the shocks.

where the sums of the elements on or below the main diagonal are estimated without restriction and those above the main diagonal are restricted to be zero, the estimation algorithm is the one proposed by Rubio-Ramírez, Waggoner and Zha (2010), more details in Kilian and Lütkepohl (2017).

In our model, we identify the long-term effects of structural shocks by using the following restrictions, which are standard in the literature:

1. The domestic real interest rate (separated between the domestic nominal interest rate (TIB) and the inflation rate), affects all the domestic variables of the system in the long run, but the TIB is only affected in the long term by its own disturbance and by inflation, consistent with the predictions of the Fisher equation on the relationship between interest rates and inflation in the long run.
2. The system is restricted in such a way that the long-term interest rate (ΔR_t^{TES10}) is affected by its own shock, by that of the policy rate and by the one of inflation, but not for the other variables.
3. Inflation is only affected by itself in the long run.
4. The stock price index is affected in the long run only by the real interest rate shock (nominal interest rate and inflation) and by its own shock.
5. The fiscal deficit is affected in the long run only by its own shock and by the real interest rate (through its relation to public debt) and the price of stocks shock (since stocks are substitutes for bonds from which the government is financed).
6. The current account (proxied by the real depreciation rate) is affected in the long term by the real interest rate (through the external debt that depends on the external interest rate). Similarly, the foreign interest rate plus a country risk premium is equal to the domestic interest rate, by the price of shares, the fiscal balance and by its own shock.
7. The effect of portfolio flows on the real depreciation of the exchange rate is considered transitory.
8. The shocks of all the variables affect portfolio flows in the long run.

The structure used is represented as:

$$\begin{bmatrix} Inf_t \\ \Delta TIB_t \\ \Delta R_t^{TES10} \\ \Delta Colcap_t \\ FiscalBal_t \\ Depr_t \\ Flow_t \end{bmatrix} = \begin{bmatrix} C^{11}(1) & 0 & \cdots & 0 \\ C^{21}(1) & C^{22}(1) & \dots & 0 \\ & & & 0 \\ \vdots & \vdots & \ddots & \vdots \\ C^{71}(1) & C^{72}(1) & & C^{77}(1) \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{i} \\ \cdot \\ \cdot \\ \cdot \\ \\ \varepsilon_t^{f} \end{bmatrix} \quad (5)$$

4. Results

This section presents the results of the SVAR model. The results are divided between the impulse-response analysis and the prize puzzle analysis. We also present alternative exercises to check the robustness of our results.

4.1. Impulse-Response Analysis

Our goal is to understand the influence of domestic and US monetary policy on portfolio inflows (liabilities). To do this, we use the overnight interbank interest rate (TIB) as a measure of the domestic policy interest rate (i_t) and the overnight federal funds rate (FFR) of the Federal Reserve of the United States, Fed, as the international interest rate (i_t^*). Colombia is considered a small and open economy, meaning that it has no influence on the Fed's interest rate, although the latter does affect portfolio flows to Colombia. According to the interest rate channel, an increase in the domestic monetary policy rate (analogous to a reduction in the international interest rate) leads to higher portfolio inflows in the bonds market, since fixed-income domestic instruments are more attractive relative to international fixed-income instruments (Fratzscher, 2012; Broner et al., 2013; Ananchotikul and Zhang, 2014; Koepke, 2014; Nier et al. 2014; Bruno and Shin, 2015). Conversely, it is expected that an increase in the local rate of inflation causes a fall in these portfolio inflows because the real interest rate falls. With respect to the foreign interest rate, it is expected that when it increases there will be a substitution effect between domestic and international bonds in favor of the international ones; that is, inflows from the bond market by

non-residents would be expected to fall (Milesi-Ferreti and Tille, 2011; Rey, 2013). Similarly, when the US inflation rate increases, it is expected a rise in bond inflows because of the fall in real interest rate of the US.

We find a positive and statistically significant response of TES portfolio inflows to changes in the domestic monetary policy rate. In the baseline model, we identify that an increase in the TIB (used as a proxy for the domestic monetary policy interest rate) of 25 bps is associated with an increase in inflows of portfolio in TES by non-residents of approximately USD 287 million (**Figure 2**). Interestingly, we observe that an increase in the FFR (used as a proxy for the US monetary policy interest rate) is associated with a decline in portfolio inflows in TES by non-residents one month after the shock. We also find that an increase in the inflation rate is associated with a decline in portfolio inflows of TES market while an increase in the US interest rate is associated to an increase in TES inflows by non-residents. These results are consistent with the interest rate channel of portfolio inflows.

We perform two robustness exercises. In the first, **Figure 3** presents a similar exercise to the previous one but using the *Banco de la República* expansion REPOS rate as the monetary policy rate instead of the TIB. We find that the results are robust to this specification and that, in this case, a shock of 25 bps in the BR REPOS rate is associated with an increase in inflows of USD 134 million in TES by foreign investors in the first month. Results on the shocks to domestic inflation rate and US monetary policy rate show a negative relation with the portfolio inflows of TES and have similar magnitudes than the ones in **Figure 2**, confirming our previous findings. However, in this case the direction of the response of TES inflows to US inflation rate is in line with the expected by theory, there is an increase in TES inflows in the second month.

In the second robustness exercise, **Figure 4** shows the impulse-responses of portfolio inflows of TES to monetary policy shocks and inflation shocks using the United States shadow rate (Wu and Xia, 2016) instead of the FFR nominal interest rate. We observe that an increase in the US shadow rate is associated with a fall in inflows in the TES market two months after the shock. In the case of the shock to the TIB, the estimates confirm the results obtained in the baseline model. The results suggest that an increase of 25 bps in the TIB is associated with an increase in inflows in TES of around USD 271 million in the first month. These results confirm that portfolio inflows by non-residents in the TES market respond to changes in domestic and foreign policy rates, in line

with the predictions of the interest rate channel. Finally, an increase in the domestic rate of inflation is associated with a fall in portfolio inflows as in the baseline model an increase in the US inflation rate with an increase in TES inflows.

Regarding the stock market, it is possible that there is a compensation effect between fixed-income bonds and shares, as highlighted by Kim (2014) for the case of Korea. In particular, the increase in the domestic interest rate is expected to lead to a fall in share prices (since output is expected to slow down in the future) and therefore, there will be a fall in inflows in the stock market by non-residents[6]. At the same time, an increase in the foreign interest rate would be associated with an increase in portfolio inflows of Colombian shares by non-residents since a fall in the price of shares in advanced economies is expected to occur (Kim, 2014; Çulha, 2006).

We find that none, the changes in the TIB or the foreign interest rate seem to have a significant effect on portfolio flows in the stock market (**Figure 5**), however, the portfolio inflows in the stock market react to the inflation rate which is a component of the real interest rate. As expected, when the inflation rate increases the real interest rate falls, giving place to an increase in the asset prices that causes increases in these portfolio inflows and a re-composition of assets between bonds and shares. If the share of the stock market is very low in the international markets, it is expected that the reactions of these inflows to nominal interest rates might not be as important as in the case of the government bonds market.

Finally, we observe that portfolio inflows in the corporate bonds market are affected by changes in the domestic monetary policy rate. The results show that an increase of 25 bp in the TIB is associated with a fall in portfolio inflows of around USD 12 million, although the effect is very short lasting (**Figure 6**). In this case, the results may suggest a rebalancing of foreigners' portfolio (between corporate bonds for TES) in the face of changes in domestic interest rate prospects, due possibly to the greater response of TES to changes in domestic interest rates compared to the response of corporate bonds. Moreover, we find that the US interest rate has a negative relationship with portfolio flows for corporate bonds, in line with the dynamics observed in the TES market

[6] We do not consider the effect of the interest rates on net outflows by residents because the data is not available by type of instrument (bonds or shares).

and with the predictions of the interest rate channel but it is volatile. The reaction to inflation rates in this market is also volatile.

4.2. On the Price Puzzle, Portfolio Flows and Monetary Policy

As mentioned in section 1, one of the main challenges for establishing the impact of the interest rate on the capital inflows is to solve the price puzzle of monetary policy. According to the puzzle the relationship between the local monetary policy interest rate and the inflation rate is positive. When this occurs, the effect of the monetary policy on the inflation rate and output is not well identified as discussed by Rudebush (1998). The prize puzzle can be solved by including oil prices or commodities prices in the VAR system, and the generally accepted interpretation is that, lacking these inflation-sensitive prices, a standard VAR misses important information that is available to policy makers. Something similar is argued about some forward-looking variables. Many standard VARs, as well as the ones we estimated in the first step in our econometric analyses, persist in displaying such prize puzzles even though some of these variables are included in the VARs. To solve this problem and to correctly identify the monetary policy shock, represented by the different proxies of local interest rates, the literature has proposed the use of Structural VARs either with sign restrictions (Uhlig, 2005) or with short-run and long-run restrictions in the SVAR to identify the structural shocks from the reduced form shocks (Chari et al 2008).

We impose long-run restrictions to the impulse response matrix that relates the reduced form residuals with the structural shocks (see section 3.1) in the SVAR. As we show in **Figure 7**, we solve the puzzle for all the SVARs of the three types of instruments, namely, TES, shares, and corporate bonds. When the TIB is used as measure of the monetary policy rate, an increase in it results in a fall in the inflation rate for the SVAR for all, TES, shares, and corporate bonds, as expected by the theory. That is, monetary policy can control the rate of inflation. The same happens when the proxy of monetary policy rate is the Central Bank REPO rate in the case of the TES[7].

[7] The for the other SVARs the impulse responses for the price puzzle are available upon request. We also performed additional exercises using the Colombian CDS as exogenous variable in the SVAR model and find similar results.

4. Final Remarks

We study the effect of both domestic and US monetary policy rates on portfolio inflows in Colombia, distinguishing between locally issued government bonds (TES), shares and corporate bonds. For identification of the monetary policy shocks, we use a Structural VAR model, SVAR, with long-run restrictions. We also control for traditional *pull* and *push* factors such as the US industrial production index, the VIX (global risk), the local asset prices, the domestic fiscal balance, the rate of real exchange rate depreciation, among others global and domestic factors.

We find that both domestic and US nominal interest rates have a significant impact on portfolio inflows in the government securities market (TES). Remarkedly, the domestic and US inflation rates also explain the behavior of portfolio inflows in TES. Given the high participation of this market in the Colombian portfolio inflows and given that since the Global Financial crises of 2007-2009 the non-residents (specially pension funds and insurance companies) have increased their participation in this market, our findings suggest a very important role of domestic monetary policy on driving portfolio inflows. The results posit that a contractionary domestic monetary policy might offset, at least in part, falls in portfolio inflows caused by increases in the US interest rate and the domestic inflation rate. We also find that neither local nor US monetary policy rates have an impact on portfolio inflows in the stock market, which may be related with the fact that this market is very small in the local portfolio inflows relative to the TES market. However, our model predicts that an increase of the inflation rate causes a decline in the real interest rate and increases asset prices, leading to higher portfolio inflows in shares.

Finally, our findings also suggest a significant impact of the domestic monetary policy on portfolio inflows in the corporate bonds market and reveal a potential compensatory effect between TES and corporate bonds. This market also reacts to the US interest rate and to the domestic rate of inflation. The market that seems to react the most to the domestic monetary policy rate is the TES market.

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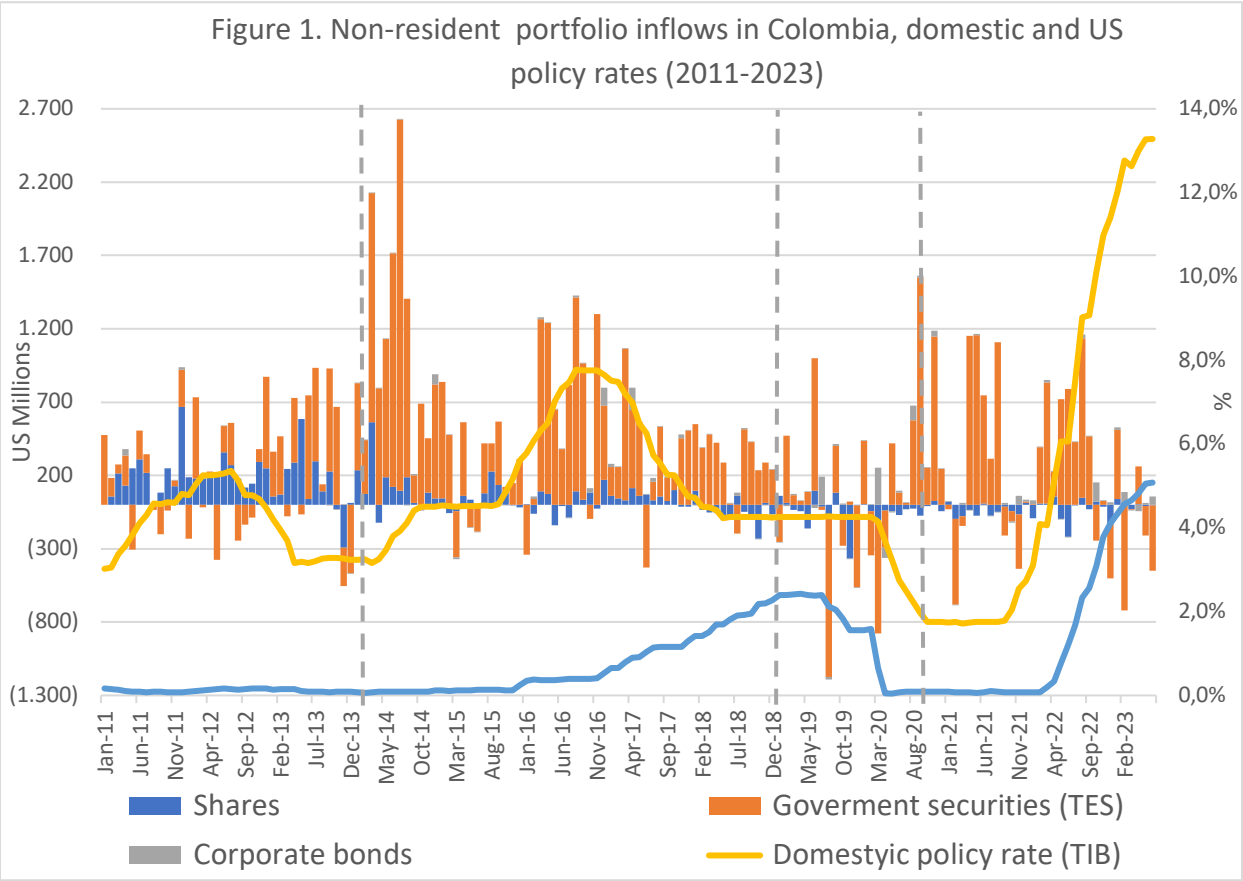
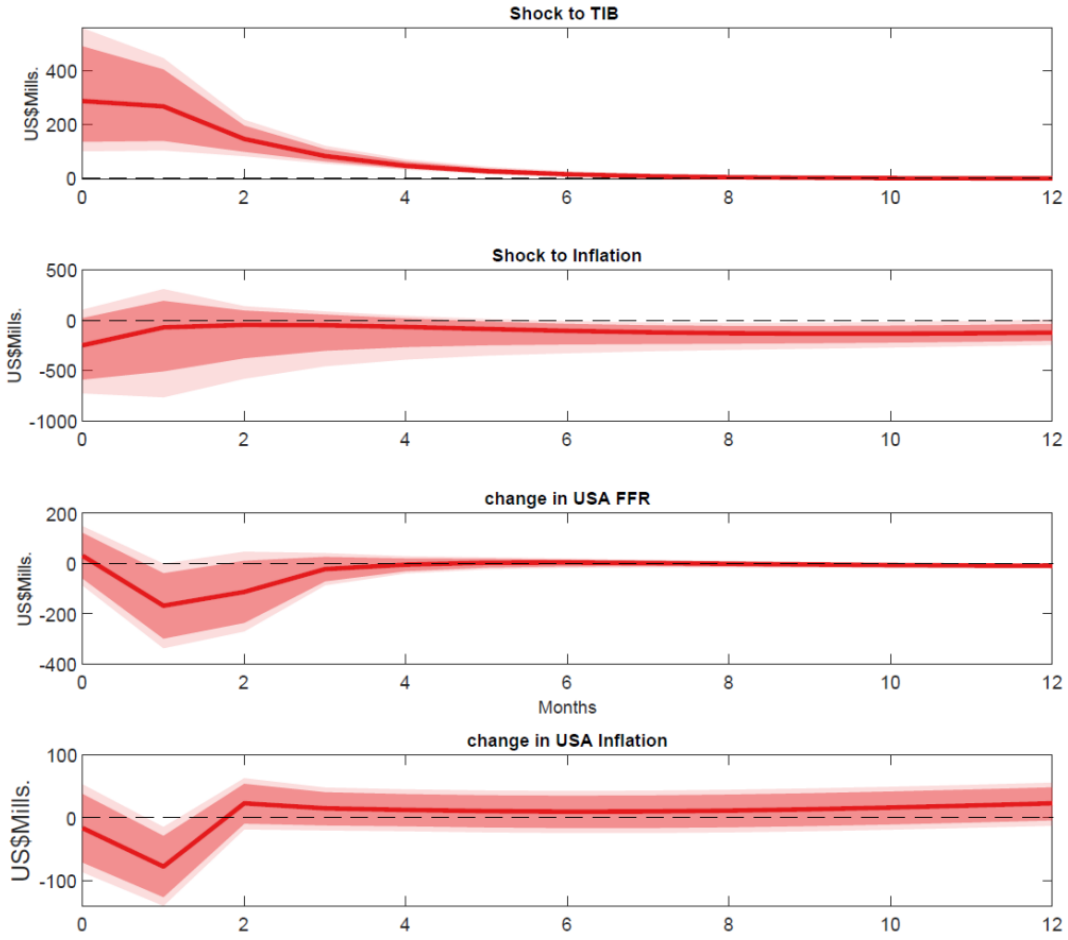


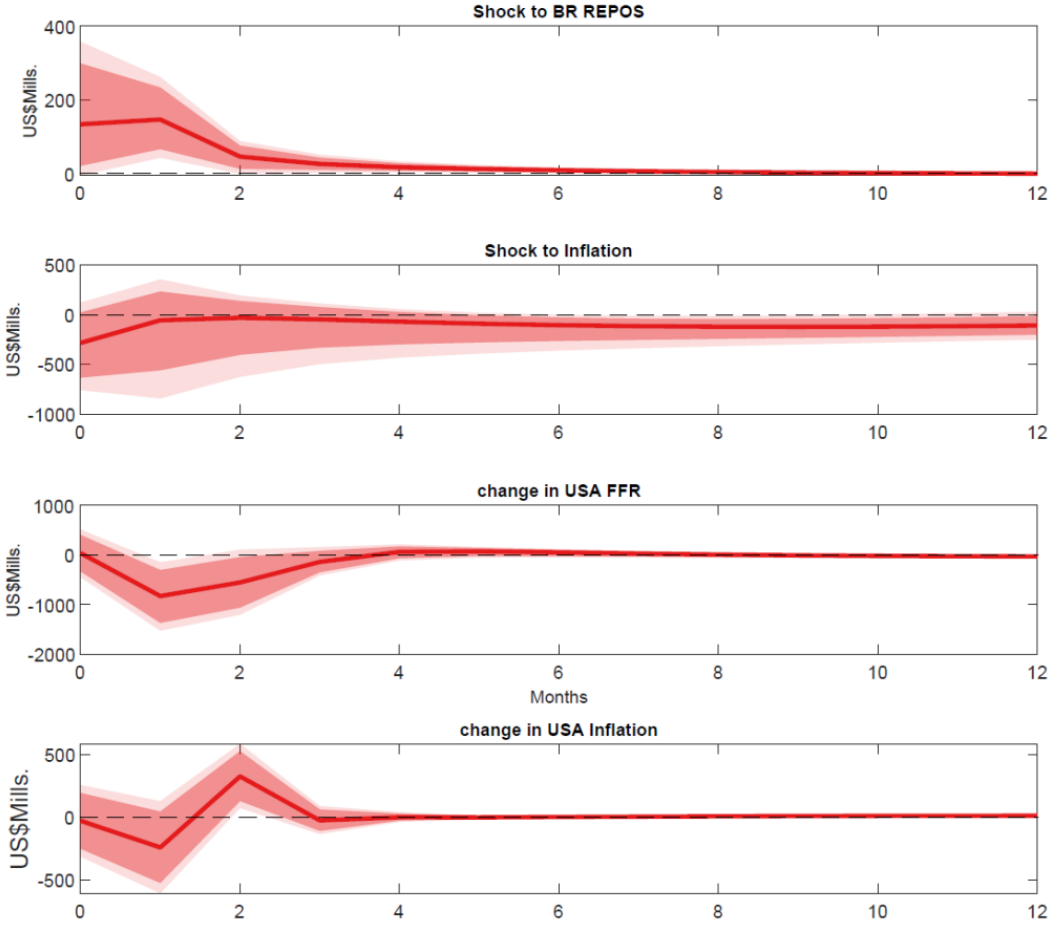
Notes: This figure depicts the evolution of monthly portfolio inflows in Colombia by instrument (Government Securities, Corporate Bonds and Shares) along with the domestic policy rate (TIB) and US policy rate (FFR) during 2011-202 0. Source: Banco de la República and Federal Reserve of the United States. Portfolio flows are taken from regulatory information reported by Portfolio Managers for foreign investors, which is registered in the Balance of Payments. Authors' calculations.

Figure 2. Response of portfolio inflows in TES to monetary policy rates (TIB and FFR) and inflation shocks



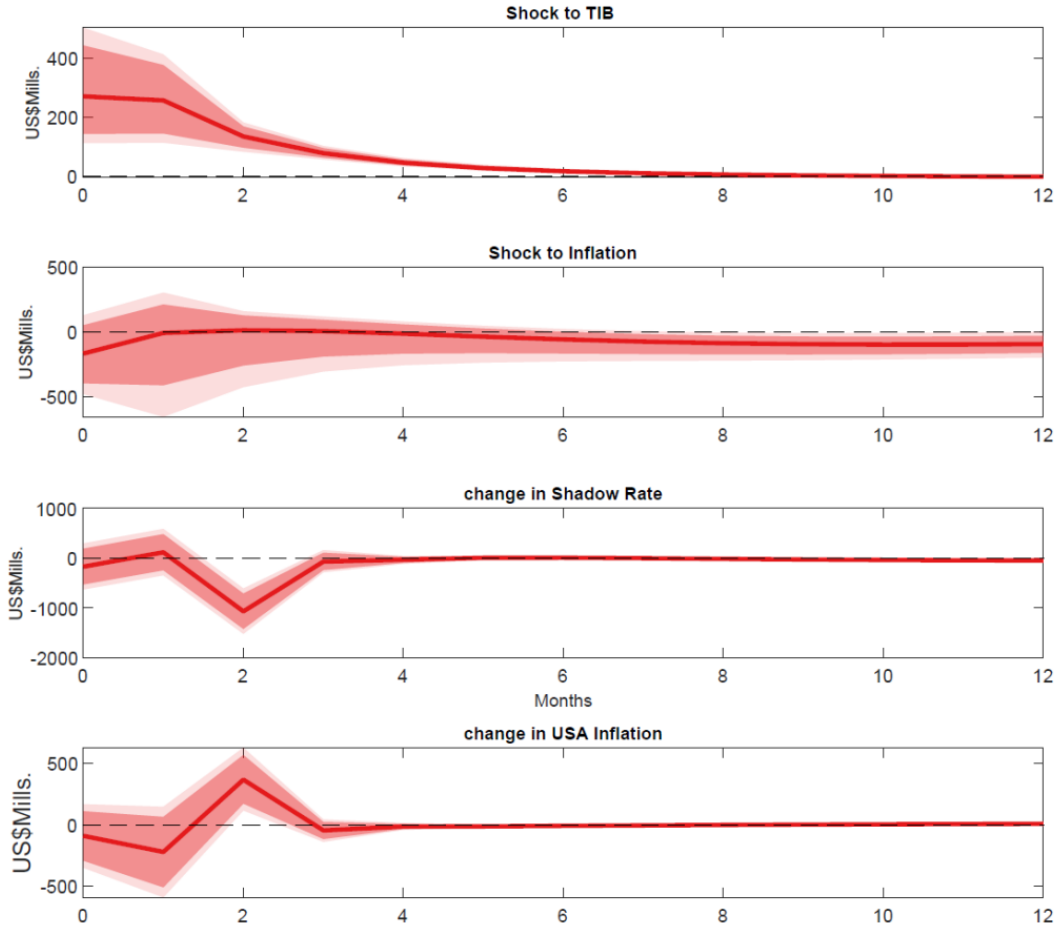
Note: This figure shows the responses of portfolio inflows to monetary policy rates and inflation shocks. The results indicate that an unexpected increase in the domestic monetary policy rate (TIB) of 25 bps is associated with an increase in portfolio inflows in government securities (TES) of around USD 287 million in the first month; Unexpected 25 bps increases in the inflation rate with an outflow of 249; US interestrate 25 bps increase with an decrease of USD 168 millon; US inflation increased 25 bps with an decrease of around USD 78 million.Portfolio inflows are in USD millions. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: Authors' calculations.

Figure 3. Response of portfolio inflows in TES to monetary policy rates (REPO_rate and FFR) and inflation shocks



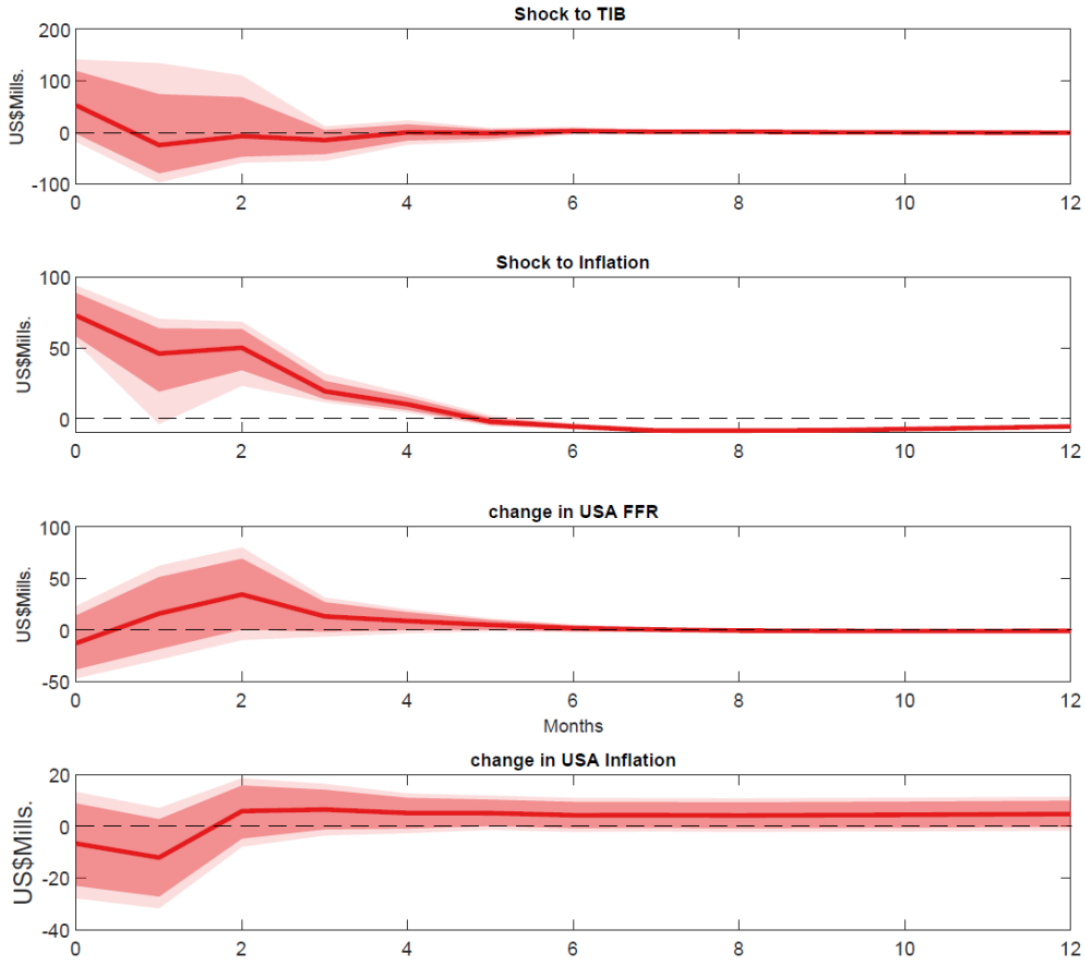
Note: This figure shows the responses of portfolio inflows to monetary policy rates and inflation shocks. The results indicate that an unexpected increase in the domestic monetary policy rate (BR REPOS) of 25 bps is associated with an increase in portfolio inflows in goverment securities (TES) of around USD 134 million in the first month; Unexpected 25 bps increases in the inflation rate with an outflow of 284; US interestrate 25 bps increase with an decrease of USD 826 millon; US inflation increased 25 bps with anincrease of around USD 326 million. Portfolio inflows are in USD millions. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: Authors' calculations.

Figure 4. Response of portfolio inflows in TES to monetary policy (shadow rate) and inflation shocks



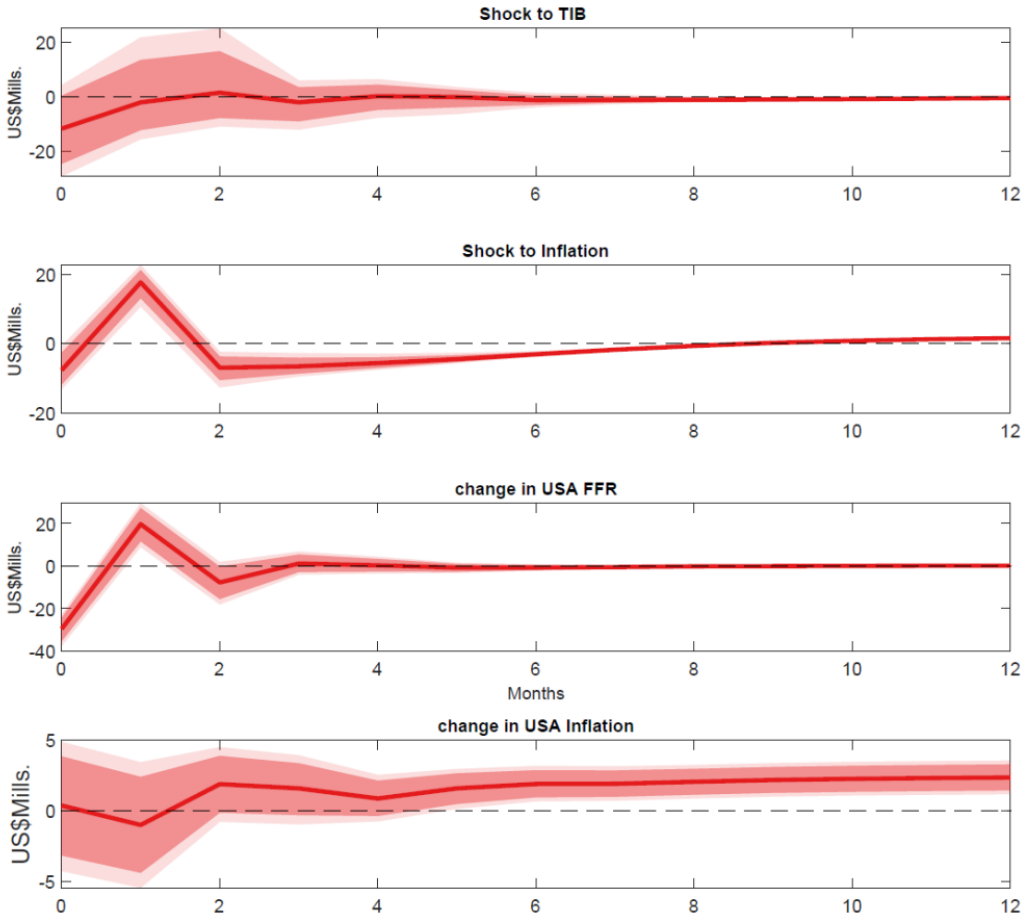
Note: This figure shows the responses of portfolio inflows to monetary policy rates and inflation shocks using the US shadow rate (Wu and Xia,2016) instead of the Federal Funds Rate. The results indicate that a 25 bps increase in the US shadow rate is associated with a fall in portfolio inflows in the TES market of 169 million two months after the shock. Moreover, an increase of 25 bps on the monetary policy rate (TIB) is associated with an increase in portfolio inflows in government securities (TES) of around USD 271 million in the first month; Unexpected increases in the inflation rate with an outflow of 169; US inflation increased with an increase of around USD 369 million. Portfolio inflows are in USD millions. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: Authors' calculations.

Figure 5. Response of portfolio inflows in the stock market to monetary policy rates (TIB and FFR) and inflation shocks



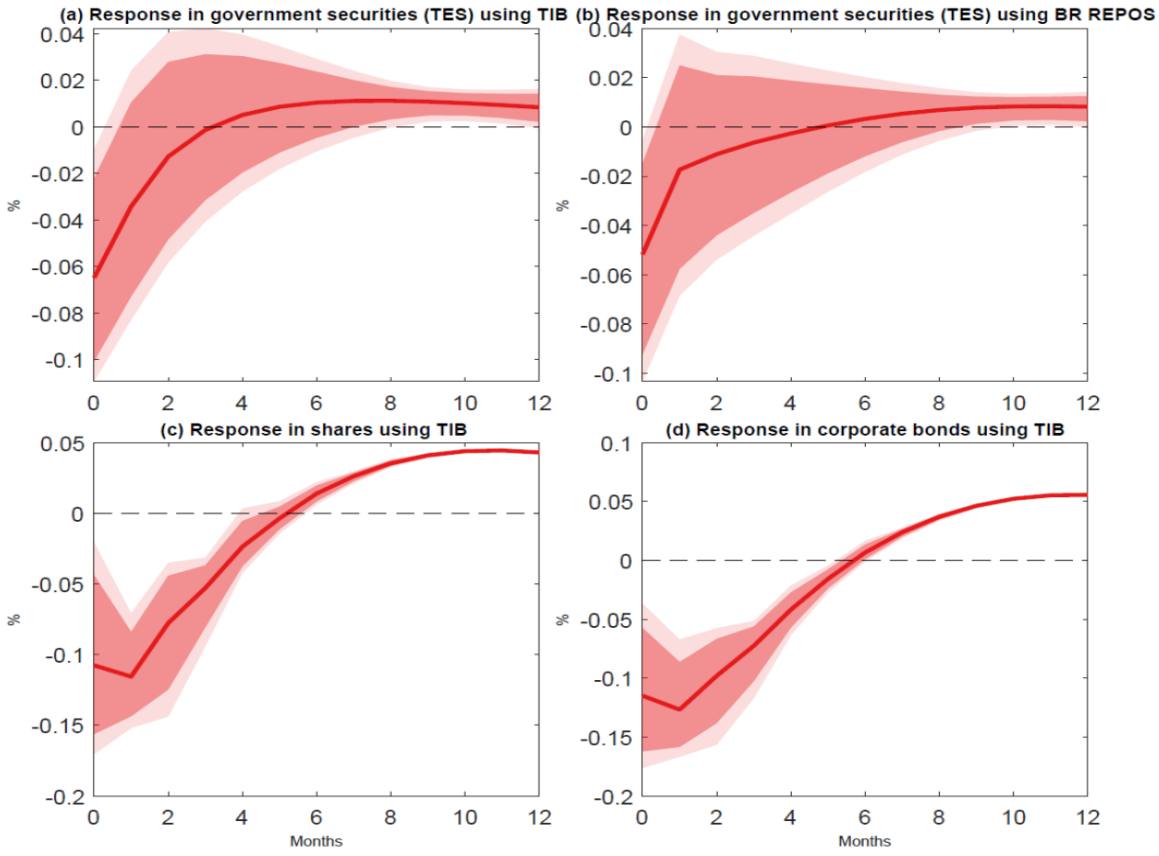
Note: This figure shows the impulse-responses of portfolio inflows to monetary policy rates and inflation shocks. Portfolio inflows in equity markets do not exhibit a statistically significant response to shocks in both domestic and US policy rates but are influenced by the relative real return of assets by the movements in the inflation rate. Portfolio inflows are in USD millions. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: Authors' calculations.

Figure 6. Response of portfolio inflows in the corporate bond market to monetary policy rates (TIB and FFR) and inflation shocks



Note: This figure shows the responses of portfolio inflows to monetary policy rates and inflation shocks. The results indicate that an unexpected increase in the domestic monetary policy rate (TIB) of 25 bps is associated with a decline in portfolio inflows in corporate bonds of around USD 12 million in the first month (i.e., potential substitution between corporate bonds and TES); Unexpected 25 bps increases in the inflation rate with an outflow of 8; US interest rate 25 bps increase with an increase of USD 20 millon; US inflation increased 25 bps with an increase of around USD 2 million. Portfolio inflows are in USD millions. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: Authors' calculations.

Figure 7. Response of inflation to shocks in the domestic monetary policy rate (Price Puzzle)



Notes: This figure presents the response of inflation to shocks in the domestic monetary policy rate to evaluate the Price Puzzle for each of the instrument's SVAR. The values are in percentage. Confidence intervals at 80% and 90% (shaded areas). The impulse-responses are obtained using a structural VAR model with long-term restrictions. Source: authors' calculations.

Table 1. Summary statistics

	Description	Means	Std	Min	P25	Median	P75	Max
TES	Government bonds Inflows millions of US$	310.05	512.86	-1086.2	10.27	252.68	509.56	2534.96
Shares	Shares Inflows millions of US$	64.2	150.5	-368.65	-32.33	49.64	126.5	667.06
Corporate Bonds	Corporate Bonds Inflows millions of US$.	9.65	36.64	-70.85	0	0.01	5.03	254.07
(Depr)	Real annual depreciation of the exchange rate %	3.95	9.76	-17.05	-2.71	2.42	8.43	40.83
(FiscalBal)	Real accumulated fiscal balance as a share of GDP %	-297.58	129.7	-817.45	-337.89	-275.51	-228.34	-88.1
Δ(LCOLCAP)	Annual change in log of stock prices %	-2.07	14.98	-36.23	-8.55	0.85	9.04	28.84
(Inf)	Colombia annual inflation rate %	3.76	1.6	1.49	2.92	3.4	4.06	8.97
(Inf_USA)	US Annual Inflation rate %	1.73	0.89	-0.20	1.22	1.72	2.20	3.87
Δ (TIB)	Monthly change of the domestic interbank interest rate %	-0.01	0.2	-0.54	-0.07	0	0.05	0.53
Δ (Policy Rate REPO)	Monthly change of the domestic policy interest rate %	-0.01	0.23	-1	0	0	0	0.75
Δ (Fed Fund Rate)	Monthly change of the US Federal Funds Rate %	0	0.16	-1.5	-0.01	0	0.02	0.32
(Wu-Xa S. F. Shadow Rate)	US Shadow Rate %	0	0.16	-0.72	-0.07	0	0.1	0.53
Δ (VIX)	Annual change of the log of VIX %	2.1	40.15	-87.13	-25.68	1.42	23.23	138.28
Δ (IPI USA)	Annual change in the log of the Industrial Production Index %	0.01	0.04	-0.18	-0.01	0.02	0.03	0.05
Δ ($Rate^{TES\ 10years}$)	Monthly change of the 10 years TES 10 interest rate %	-0.02	0.34	-0.95	-0.24	-0.04	0.17	1.04

Notes: This table presents summary statistics of the variables employed in the estimations. Portfolio inflows (TES, shares, and corporate bonds) are inflows from non-residents in USD million. Interest rates are monthly changes. The other macroeconomic variables are in annual growth.