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Abstract

Portfolio flows are an important source of funding for both private and public agents in emerging market economies. In this paper, we study the influence of changes in domestic and US monetary policy rates on portfolio inflows in an emerging market economy and discriminate among fixed income instruments (government securities and corporate bonds) and variable income instruments (stocks). We employ monthly data on portfolio inflows of non-residents in Colombia during the period 2011-2020 and identify the monetary policy shocks using a SVAR model with long-run restrictions. We find a positive and statistically significant response of portfolio inflows in government securities and corporate bonds to changes in both domestic and US monetary policy rates. Portfolio inflows in the stock market react more to changes in the inflation rate and do not react to changes in monetary policy rates. Our findings are consistent with the predictions of the interest rate channel and remark the predominant role of inflation in driving portfolio inflows. The results suggest that domestic and US monetary policy actions have an important effect on the behavior of portfolio inflows in emerging economies.

JEL codes: F31, F32, F33, F36

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

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Política monetaria y flujos de portafolio en una economía de mercado emergente

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Resumen

Los flujos de portafolio son una fuente importante de financiamiento para los agentes públicos y privados en las economías emergentes. En este artículo, estudiamos la influencia de los cambios en las tasas de política monetaria doméstica y de los Estados Unidos sobre los flujos de portafolio en una economía emergente, discriminando entre instrumentos de renta fija (títulos del gobierno y bonos corporativos) e instrumentos de renta variable (acciones). Empleamos datos mensuales sobre flujos de portafolio de no residentes en Colombia durante el período 2011-2020. Los choques de política monetaria se identifican utilizando un modelo SVAR con restricciones de largo plazo. Encontramos una respuesta significativa de los flujos de portafolio en títulos del gobierno y bonos corporativos a los cambios en las tasas de política monetaria tanto domésticas como de los Estados Unidos. Los flujos de portafolio en el mercado de acciones reaccionan más a cambios en la tasa de inflación y no reaccionan a cambios en las tasas de política monetaria. Nuestros hallazgos son consistentes con las predicciones del canal de las tasas de interés y resaltan el papel predominante de la inflación sobre la dinámica de los flujos de portafolio. Los resultados sugieren que las acciones de política monetaria doméstica y de los Estados Unidos tienen un efecto importante sobre el comportamiento de los flujos de portafolio en las economías emergentes.

Códigos JEL: F31, F32, F33, F36

Palabras clave: influjos de portafolio, economías de mercados emergentes, política monetaria, modelos SVAR, canal de tasas de interés.

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1. Introduction

Portfolio flows are an important source of funding for both private and public agents in emerging market economies. Portfolio flows are determined by both external and internal factors that fall under the so-called common (Push) and country-specific (Pull) factors (Sarno et al., 2016; Koepke, 2019). Within these determinants, both domestic and foreign interest rates are of particular interest because of the need for the monetary authorities of specifying its capacity to exert movements on these flows. In emerging economies, increases in domestic policy rates usually lead to increases 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 capital flows to emerging economies (Rey, 2016; Koepke, 2018; Miranda-Agripino and Rey, 2020).

In this paper, we answer the following questions: What is the influence of domestic and US monetary policy on the behavior of portfolio inflows in an emerging market economy? Does the type of instrument (public debt, corporate bonds, or shares) have the same reaction to changes in domestic or US monetary policy? And finally, given that the return that matters for foreign investors is the real return of investments, do the portfolio inflows respond to movements in the inflation rate of the host country? To answer these questions, we analyze 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 2011-2020 covering the first phase of the Covid-19 pandemic[1]. On average, during the period of analysis, the portfolio inflows in TES represented 70.3 percent, those of shares 26.8 percent and those of corporate bonds 2.9 percent of the total inflows of non-residents. Unlike most of the 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

[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.

studying the effects of domestic and US monetary policy shocks on the dynamics of non-resident portfolio inflows, which tend to respond to the predictions of the so-called interest rate channel. Under this approach, and holding both global and local risk constant, the negative shock to domestic monetary policy nominal interest rate (analogous to an increase in the foreign monetary policy rate) decreases the relative return on investment in emerging economies, as well as arbitrage opportunities for foreign investors, encouraging the exit of positions in these markets (Fratzscher, 2012; Broner et al., 2013; Ananchotikul and Zhang, 2014; Koepke, 2014; Nier et al. 2014; Bruno and Shin, 2015, Fabiani et al., 2021).

The identification of the monetary policy shocks posits one important challenge. As portfolio flows depend on the real return on assets (represented by the real interest rate), in our analysis we incorporate the endogenous dynamic of the nominal interest rate and the rate of inflation. However, the latter carries an identification challenge related to the so-called *Price Puzzle*. That is, in response to an increase in the nominal interest rate, the inflation rate also increases, contrary to the expected by the theory. In the literature, this is explained by the fact that there are lags or moderated policy rate increases in reaction to inflation rate that mitigate inflation 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 use 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 and suggests some econometric approaches to solve it. The two more important approaches are, first, the structural VARs 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, structural VARs 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, allowing the system to estimate them. In our analysis, we employ the second avenue and estimate a structural autoregressive SVAR model with long-run restrictions. We also control for other *pull* and *push* factors including the foreign industrial production index, the VIX, the local asset prices, the domestic fiscal balance, the rate of real exchange rate depreciation, among others.

We find three main results. First, we find a positive and statistically significant response of portfolio inflows of government securities (TES) to changes in 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 261 million. 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 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 of portfolio inflows in the TES market, which is expected as the 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 line with the predictions of the interest rate channel.

Third, we identify that changes in none, the domestic or US monetary policy rates have a significant effect on portfolio inflows in the Colombian stock market. We observe that in turn, the portfolio inflows in the stock market react more to the dynamic of the inflation rate, suggesting a rebalancing of the portfolio between stocks and bonds in favor of stocks. Furthermore, we find that the corporate bonds market is affected by changes in the domestic monetary policy rate; an increase of 25 bp in the TIB is associated with a fall in portfolio inflows of around 13.3 USD. 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. 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.

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. They also respond to changes in the rate of inflation in the expected direction. As these flows accounts for around 73 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. These 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 (as documented by Fabiani et al., 2021). 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. This implies the need of the use of macroprudential policies to enhance the contractionary role of monetary policy and facilitate financial stability (IMF, 2022; Lemus et al., 2022).

Our results extend the evidence on the interest rate channel in explaining the behavior of portfolio flows in emerging market economies (Fratzscher, 2012; Broner et al., 2013; Ananchotikul and Zhang, 2014; Koepke, 2014; Nier et al. 2014; Kim 2014; Bruno and Shin, 2015, among others). 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) 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. Our results also build on previous evidence that suggest that changes in US monetary policy rates influence portfolio flows in emerging economies (Chen et al., 2014; Bruno and Shin, 2015; Fratzscher et al., 2018; Gilchrist et al., 2019).

This paper is composed by five sections including this introduction. Section 2 provides the background. Section 3 presents the empirical strategy and the data. Section 4 discusses the results. Section 5 concludes.

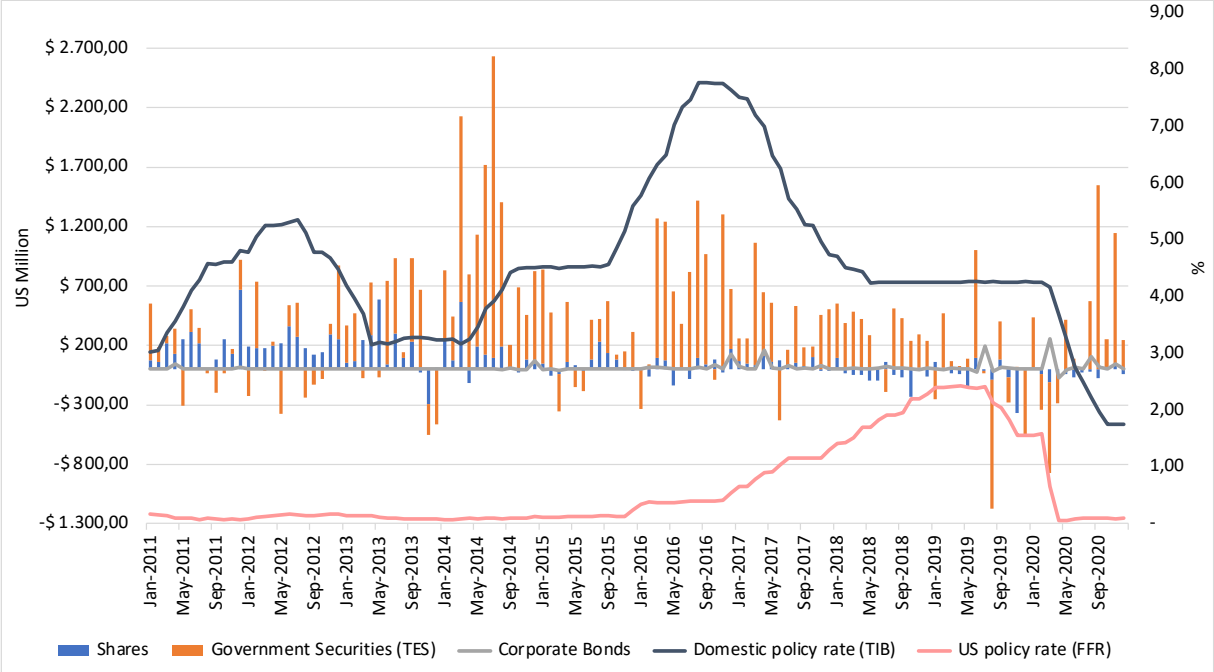
2. Background

Since September 1999, the Colombian economy operates under inflation-targeting with a floating exchange rate regime that allows for FX interventions. In general, portfolio and loan flows can 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 2011-2020 period. We observe that most of the inflows are concentrated in the TES market, followed by the stocks market and the bonds market. On average, during the analyzed period, the inflows in TES represented 70.3 percent, those of shares 26.8 percent and those of corporate bonds 2.9 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 393 basis points during the evaluated period.

Changes in local and global market conditions also influence the behavior of non-resident portfolio inflows. The significant increase in the TES inflows during the second quarter of 2014 stands out, due to the increase in the weighting of Colombian securities within the JP Morgan GBI indices. In March 2014, JP Morgan announced that Colombia's TES weight in the GBI-EM-GD index would be increased from 3.9 percent to 8.0 percent, by the end of September 2014. Additionally, JP Morgan announced that because of the increased weighting of the TES of Colombia in their index, other countries will decrease their weight in the indices, such as Turkey, Russia, Thailand, Indonesia, and Hungary. The JP Morgan shock increased the availability of foreign funding for financial intermediaries, leading to higher credit growth (Williams, 2018; Carranza and Moreno, 2020). During 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 of December 2018. Finally, the strong fall in portfolio inflows associated with the Covid-19 pandemic reached 768 USD million in March 2020, consistent with the retrenchment in portfolio flows across the emerging economies.

Figure 1. Evolution of non-resident portfolio inflows by instrument in Colombia (2011-2020)



Notes: This figure shows the evolution of monthly non-resident inflows in Colombia by instrument (Government Securities, Corporate Bonds and Shares) along with the domestic policy rate (TIB) and US policy rate (FFR) during 2011-2020. The domestic monetary policy rate is the interbank rate of the uncollateralized interbank market in Colombia (TIB) and the US policy rate is the Federal Funds Rate (FFR). 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.

3. Empirical strategy

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, the expected response of the behavior of the inflows in the face of domestic monetary policy shocks suggests that when there is an increase in the TIB, an increase in the inflows of portfolio of the TES market would be

expected as well as in the corporate bond market, since these are more attractive relative to international bonds (Fratzscher, 2012; Broner et al., 2013; Ananchotikul and Zhang, 2014; Koepke, 2014; Nier et al. 2014; Bruno and Shin, 2015). In tender with the domestic nominal interest rate effect in the bonds market it is expected that an increase in the local rate of inflation causes a fall in these portfolio 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[2]. 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). 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).

To establish the potential impacts of interest rates on bond and equity inflows, we also control for the impact of other variables that may affect non-residents' portfolio flows. Among the exogenous external variables that we consider are the VIX, which is an index that captures global risk, and the US industrial production index. Among the domestic variables, which we consider endogenous, we include the Colombian stock price index, COLCAP, the cumulative real primary fiscal balance, the inflation rate, the 10-year TES interest rate and the real depreciation of the exchange rate of Colombia. It is worth mentioning that all the variables are in annual variations during the analysis period between January 2011 and December 2020 (apart from interest rates that are in monthly variations). We also include three dichotomous variables. The first captures the increase in the weighting of Colombian government securities that JP Morgan made in two of its emerging economy indices as of March 2014. The second captures the dividend policy that refers to the increase in the income tax on dividends that went from 5 percent to 7.5 percent as of December 2018. The third captures the beginning of the period of the Covid-19 pandemic as of March 2020.

[2] 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).

The 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 the portfolio inflows of non-residents. Some long-term economic restrictions are imposed on the system to obtain a correct identification of domestic monetary policy shocks[3]. A similar methodology was used by Culha (2006) for the case of Turkey and Kim (2014) for the case of Korea, among others.

3.1. The Model

To identify the monetary policy shock, we use a structural VAR-X with long-run restrictions. In a first step, a reduced form VAR-X is estimated as:

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

where Y_t is a $lx1$ vector of endogenous variables, (*A(L)* and *B(L)* are polynomials, of degree *p* and *q*, respectively, in the usual lag operator *L*. D_t represents deterministic effects as constants (possible deterministic trends, usually linear) intervention effects such as that of Covid-19 or the other deterministic variables described above. X_t is a $mx1$ vector of exogenous variables. 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 ($\Delta COLCAP_t$), real accumulated fiscal balance as a share of GDP ($FiscalBal_t$), 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). 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

[3] 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.

the tax in dividends on profits from shares in oct 2008 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 to the end of the sample.[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, $E(\varepsilon_t) = 0$, $E(\varepsilon_t \varepsilon_t') = 1$

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:

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

[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.

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:

$$\begin{bmatrix} Inf_t \\ \Delta TIB_t \\ \Delta R_t^{TES10} \\ \Delta Colcap_t \\ FiscalBal_t \\ Depr_t \\ Flow_t^j \end{bmatrix} = \begin{bmatrix} C^{11}(1) & C^{12}(1) & \cdots & C^{17}(1) \\ C^{21}(1) & C^{22}(1) & \cdots & C^{27}(1) \\ \vdots & \vdots & \ddots & \vdots \\ C^{71}(1) & C^{72}(1) & \cdots & C^{77}(1) \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{i} \\ \vdots \\ \varepsilon_t^{f} \end{bmatrix} \quad (4)$$

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

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

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.

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

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, but in the long-term fulfilling the law of a one price, 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:

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

3.2. Data

Table 1 describes the data we employ in our estimations. We use monthly portfolio inflows of non-residents for the period January 2011 to December 2020. 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.*

Table 1. Summary of statistics

Serie \ Statistic	Means	Std	Min	P25	Median	P75	Max
TES Inflows	310.05	512.86	-1086.2	10.27	252.68	509.56	2534.96
Shares Inflows	64.2	150.5	-368.65	-32.33	49.64	126.5	667.06
Corporate Bonds Inflows.	9.65	36.64	-70.85	0	0.01	5.03	254.07
Real exchange rate Depreciation (Depr)	3.95	9.76	-17.05	-2.71	2.42	8.43	40.83
Real Fiscal Balance (FiscalBal)	-297.58	129.7	-817.45	-337.89	-275.51	-228.34	-88.1
Δ(LCOLCAP)	-2.07	14.98	-36.23	-8.55	0.85	9.04	28.84
Inflation rate (inf)	3.76	1.6	1.49	2.91	3.4	4.07	8.97
Δ (TIB)	-0.01	0.2	-0.54	-0.07	0	0.05	0.53
Δ (Policy Rate REPO)	-0.01	0.23	-1	0	0	0	0.75
Δ (Fed Fund Rate)	0	0.16	-1.5	-0.01	0	0.02	0.32
(Wu-Xa S. F. Shadow Rate)	0	0.16	-0.72	-0.07	0	0.1	0.53
Δ (VIX)	2.1	40.15	-87.13	-25.68	1.42	23.23	138.28
Δ (IPI USA)	0.01	0.04	-0.18	-0.01	0.02	0.03	0.05
Δ ($Rate^{TES\ 10years}$)	-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.

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 -1082.6 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. Inflation is the annual end-of-period inflation rate that exhibits a mean of 3.76 percent a year. 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 policy rate.

As mentioned in the previous section, we include a set of dummy variables to control for external and regulatory shocks that affected the dynamic of portfolio flows: 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.

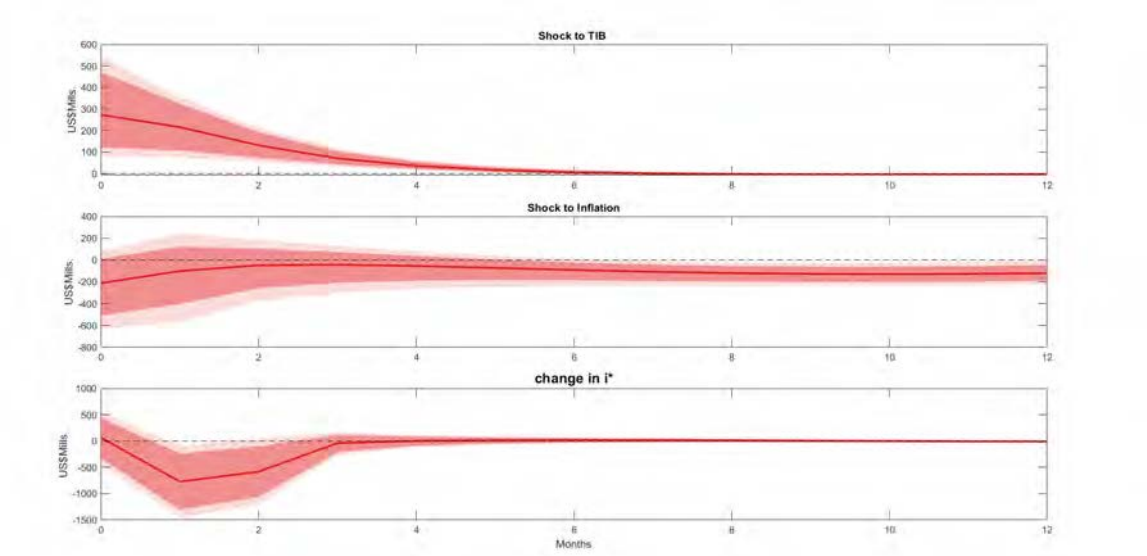
4. Results

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[6]

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 291 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. The latter is important given that what matters for the economic investors is the real return of the bonds. These results are consistent with the interest rate channel of portfolio inflows.

Figure 2. Response of portfolio inflows in TES to monetary policy and inflation shocks

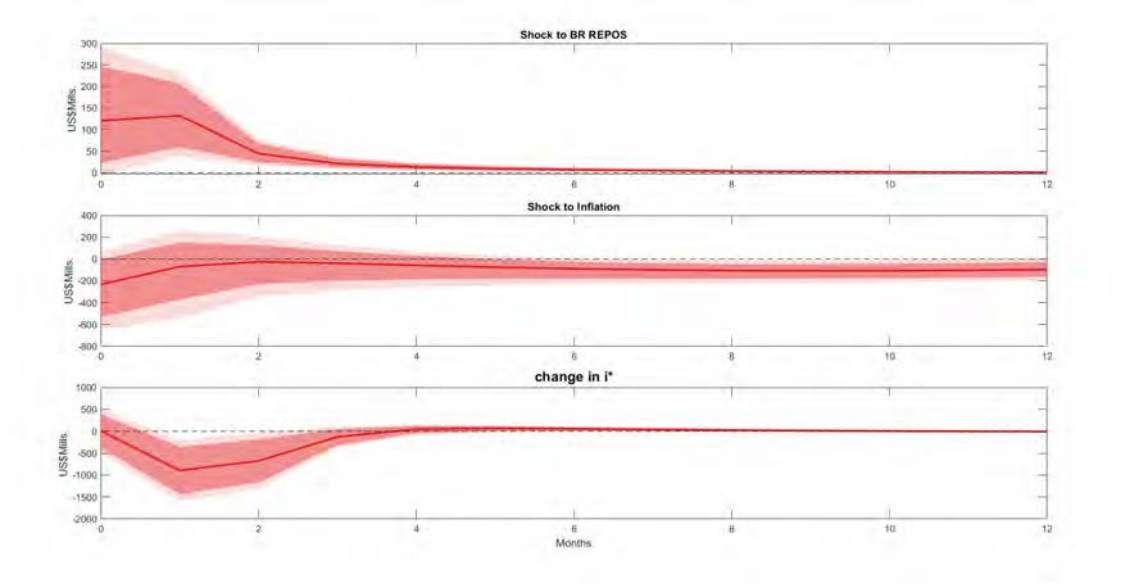


Note: This figure shows the impulse-responses of portfolio inflows to monetary policy shocks interest rate and inflation shocks. The results indicate that an increase in the domestic monetary policy rate (TIB) of 25 bp is associated with an increase in inflows of portfolio of TES by non-residents of approximately USD 291 million. Increases in the inflation rate and the foreign interest rate are associated with a fall in portfolio inflows in the TES market. 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.

[6] The impulse-response correspond to changes in the TIB and inflation rate of 25 bps. The impulse-response of the rate of inflation are cumulative impulse-response to be able to compare the annual inflation rate with the monthly change in TIB. The impulse-response for the foreign interest rate correspond to 100 bps.

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 143.4 million in TES by foreign investors. 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.

Figure 3. Response of portfolio inflows in TES to monetary policy (REPO rate) and inflation shocks

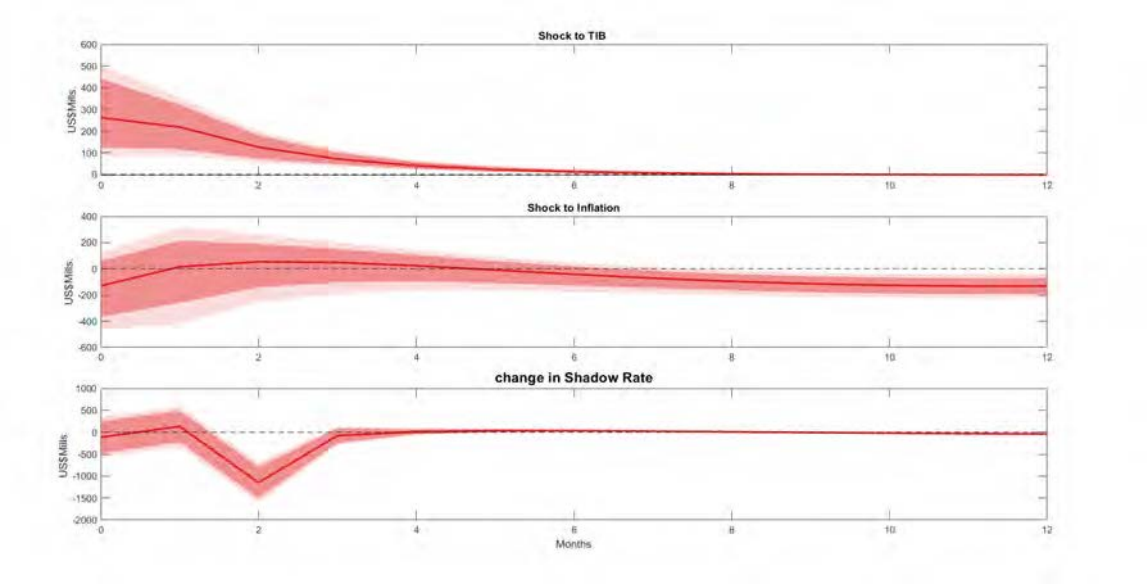


Note: This figure shows the impulse-responses of portfolio inflows to monetary policy shocks and inflation shocks. The results indicate that an increase in the domestic monetary policy rate (REPO rate) of 25 bps is associated with an increase in portfolio inflows in TES by non-residents of USD 143.4 million. Increases in the inflation rate and the US interest rate are associated with a decline in portfolio inflows in the TES market. 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.

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 Fed's 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 16 bps in the TIB is associated with an increase in inflows in TES of around USD 76 million. 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 rate of inflation, is associated with a fall in portfolio inflows as in the baseline model.

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

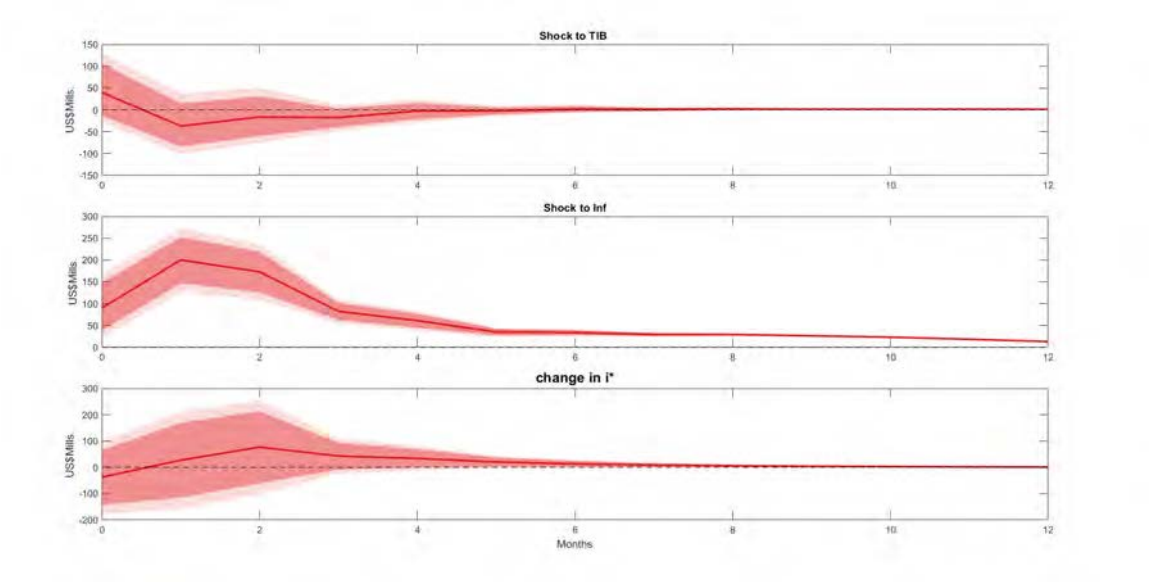


Note: This figure shows the impulse-responses of portfolio inflows to monetary policy interest rates shocks and inflation shocks using the US shadow rate (Wu and Xia, 2016) instead of the Federal Funds Rate. It is observed that an increase in the US shadow rate is associated with a fall in portfolio inflows in the TES market two months after the shock. Moreover, an increase of 16 bps in the TIB is associated with a net inflow of portfolio flows in TES of around USD 76 million, a similar effect to that obtained in the baseline model. 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-run restrictions. Source: Authors' calculations.

Regarding the stock market, we identify that none, the changes in the TIB nor 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 and there is a re-composition of assets between bonds and shares. As long as 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.

Figure 5. Response of portfolio inflows in the stock market to monetary policy and inflation shocks

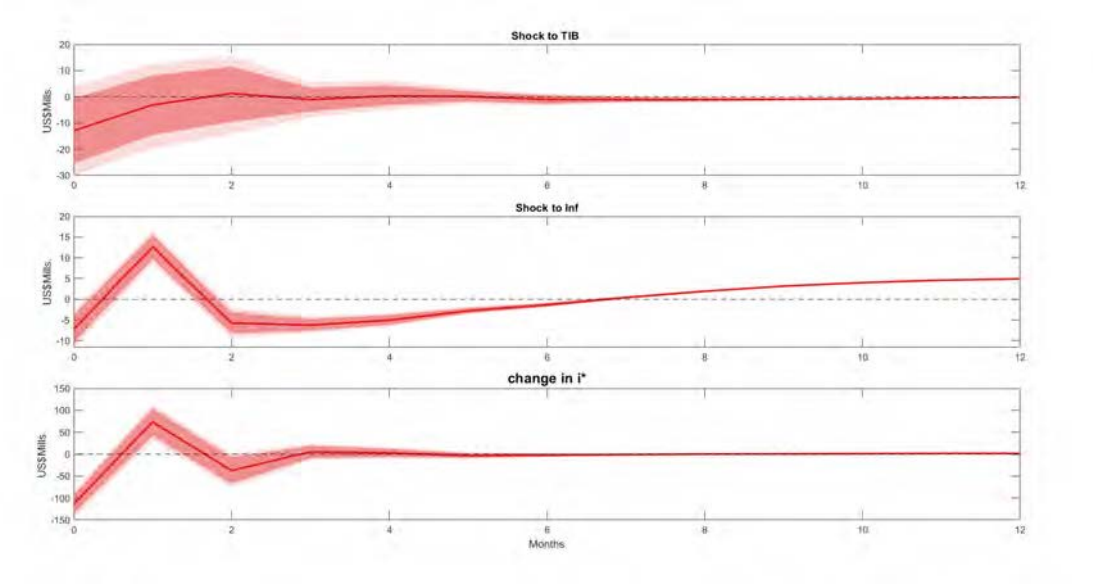


Note: This figure shows the impulse-responses of portfolio flows in the stock market to monetary policy rates and inflation shocks. The results indicate that changes in both domestic and US monetary policy rates do not have a significant effect on portfolio inflows in the stock market, while the inflation rate has a significant effect. 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.

Finally, we observe that portfolio inflows in the corporate bond 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 13.3 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

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

Figure 6. Response of portfolio inflows in the corporate bond market to monetary policy and inflation shocks



Note: This figure shows the impulse-responses of portfolio inflows in the corporate bond market to monetary policy rates and inflation shocks. The results suggest that an increase of 25 bp in the TIB is associated with a fall in portfolio inflows of around USD 13.3 million in the corporate bond market and that this effect is very short-lived. 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.

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

As mentioned in section 1, when analyzing the relationship between the domestic interest rate and the rate of inflation in a standard VAR it is common to find the so-called price puzzle, in which 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

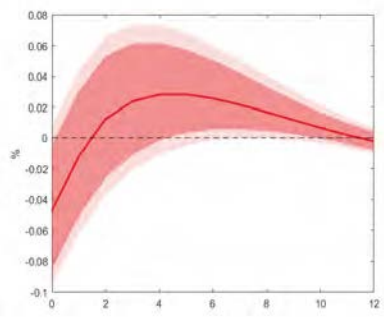
VAR misses important information that is available to policy makers. Something similar is argued about some forward-looking variables. Many standard VARs, as well as the ones we estimated in the first step in our econometric analyses, persist to display such prize puzzle even though some of these variables 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.

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, the 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].

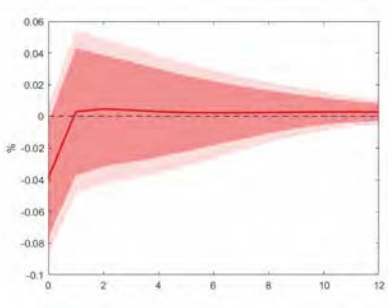
[7] The for the other SVARs the impulse responses for the price puzzle are available upon request. We also performed additional exercises using the Colombian CDS as exogenous variable in the SVAR model and find similar results.

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

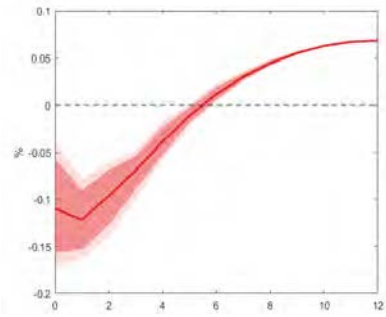
(a) TES using Interbank Rate (TIB)



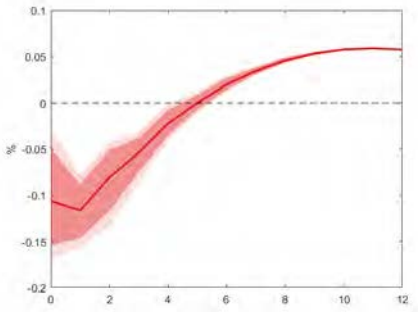
(b) TES using Central Bank Repo Rate (REPOS)



(c) Corporate Bonds using TIB



(d) Shares using TIB



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.

5. Final Remarks

We study the effect of both domestic and US monetary policy rates on portfolio inflows in Colombia, distinguishing into locally issued government bonds (TES), shares and corporate bonds. As the return that matters for foreign investors is the real return, we also analyze the impact of the rate of inflation over these inflows. 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 inflation rate also explains the behavior of portfolio inflows in TES (the other variables were used just as control variables in the model to maintain the focus of the analysis on the interest rates). 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 portfolio inflows. In particular, 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 none, 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 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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