How foreign participation in the Colombian local public debt market has influenced domestic financial conditions

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Abstract

Since 2014, the Colombian local public bond market has experienced a substantial increase in the participation of foreign investors due to a reduction of the tax rates on foreign portfolio investment returns and the increased weight of Colombia in the JP Morgan GBI-GD. Some evidence suggests that the resulting inflows have reduced bond and loan interest rates and raised loan supply. There is also evidence of an increased sensitivity of local public bond yields to CDS and EMBI, although the influence of external financial conditions on domestic lending rates has remained subdued. Finally, no evidence is found of a shift in the transmission of domestic monetary policy shocks to public bond and lending interest rates after the increase in foreign participation in the local bond market.

JEL classification: E52, E58, G11, G19.

Keywords: monetary policy, interest rates and transmission mechanism, portfolio choice and investment decisions, portfolio inflows.

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1. Introduction

In recent years, foreign investors have increased their participation in local financial markets of emerging economies. Low interest rates in advanced economies have induced investors to search for yield in emerging market economies (EMEs). Consequently, the latter have received significant financial flows during the last decade and foreigners now represent an important part of their public debt market,[2] allowing EMEs' external and fiscal deficits to be funded in domestic currency. However, these changes might have also altered their domestic financial conditions and monetary policy transmission.

Colombia is a case in point. The participation of global investors in the local public debt market has significantly risen over the last five years (Graph 1). The factors behind this trend include a robust macroeconomic policy framework, the reduction and simplification of the withholding tax on foreign portfolio investment earnings,[3] the significant increase of Colombia's weight in the JPMorgan GBI index,[4] and increasing global interest in EMEs.

In March 2014, JP Morgan announced that Colombia's weight in the GBI-EM Global Diversified (GBI-GD) index would be increased from 3.9% to 8%, by the end of September 2014. Given the estimated size of funds that followed the index in 2014, USD 218 billion, expected inflows for Colombia were USD 9 billion, which was close to the actual amount received during 2014.[5] This was also the year with the highest public bond portfolio inflows ever (Graph 2). This shows that most foreign investors in the Colombian public bond market at that time followed the index very closely. Today, the central bank estimates that 80% of the investors with a significant presence in Colombia use this index as a benchmark.[6]

[2] Between Q1 2010 and Q2 2019, foreign participation in the local currency government debt market, measured as their share of the outstanding, increased significantly in Peru (17% to 54%), Colombia (4% to 26%), Mexico (14% to 30%), Thailand (4% to 18%), Russia (2% to 29%) (Arslanalp and Tsuda (2014)). For more details see www.imf.org/en/Publications/WP/Issues/2016/12/31/Tracking-Global-Demand-for-Emerging-Market-Sovereign-Debt-41399.

[3] In 2012, it was reduced from 33% to 14%, and in 2018 to 5%.

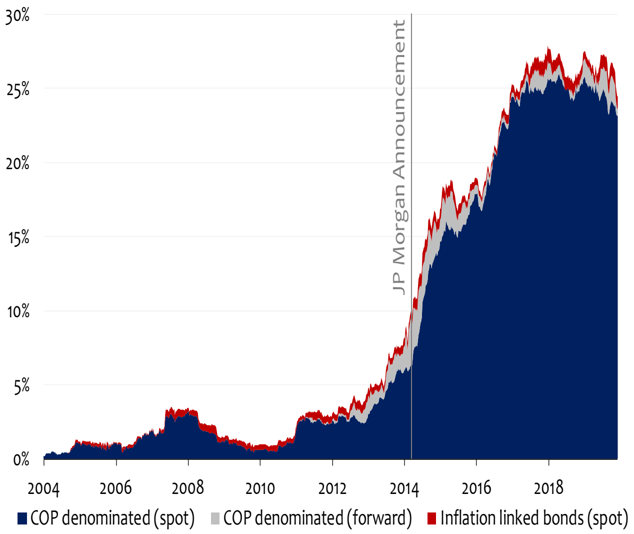
[4] A benchmark that tracks local currency bonds issued by EME governments.

[5] For more details see https://publicaciones.banrepcultural.org/index.php/emisor/article/view/7888/8268 (in Spanish). Between 18 March and 1 October 2014, foreign inflows into TES (local public bonds) were $7 billion, from 18 March to 31 December 2014 they were $8.6 billion.

[6] Based on communications with the main investors.

Offshore investors' stock in local sovereign bonds as percentage of outstanding

Graph 1

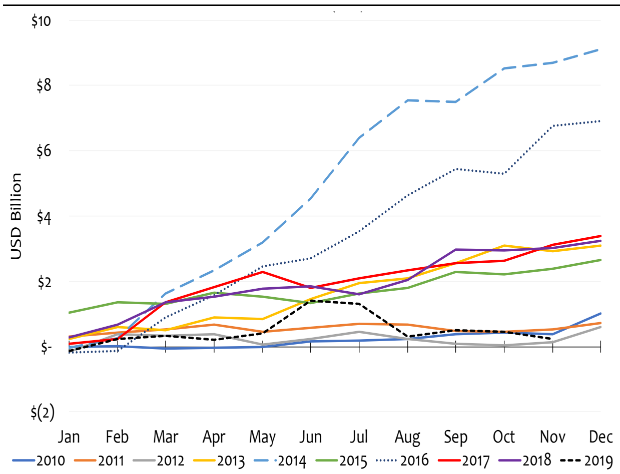


Source: Central Bank of Colombia.

Non-resident net purchases in sovereign local bonds

Accumulated yearly sum

Graph 2

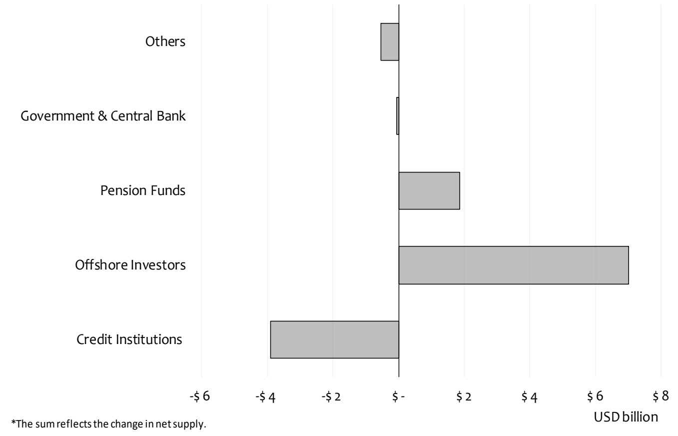


Sources: Central Bank of Colombia

Foreign investors bought Colombian sovereign bonds in local currency (TES) from banks (Graph 3). The reduction of TES in the hands of banks increased their liquidity and translated into an increased credit supply (Graph 4). From March to December 2014, the 10-year government bond yield declined from 7.22% to 6.54%, and the spread between commercial, consumer and mortgage loan rates and the central bank policy interest rate fell as well (Graph 5).

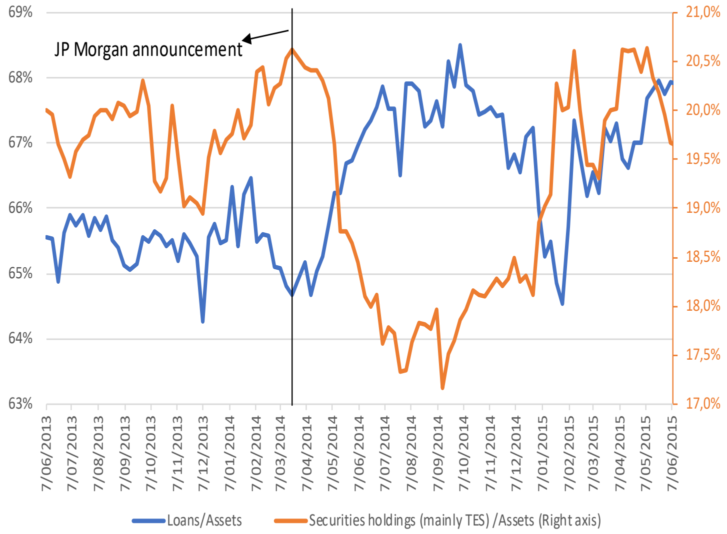
Net sovereign bond purchases in 2014 by type of investor

Between 18 March (before JP Morgan announcement) and 1 October (after the 2014 change was in place) Graph 3



Source: Central Bank of Colombia

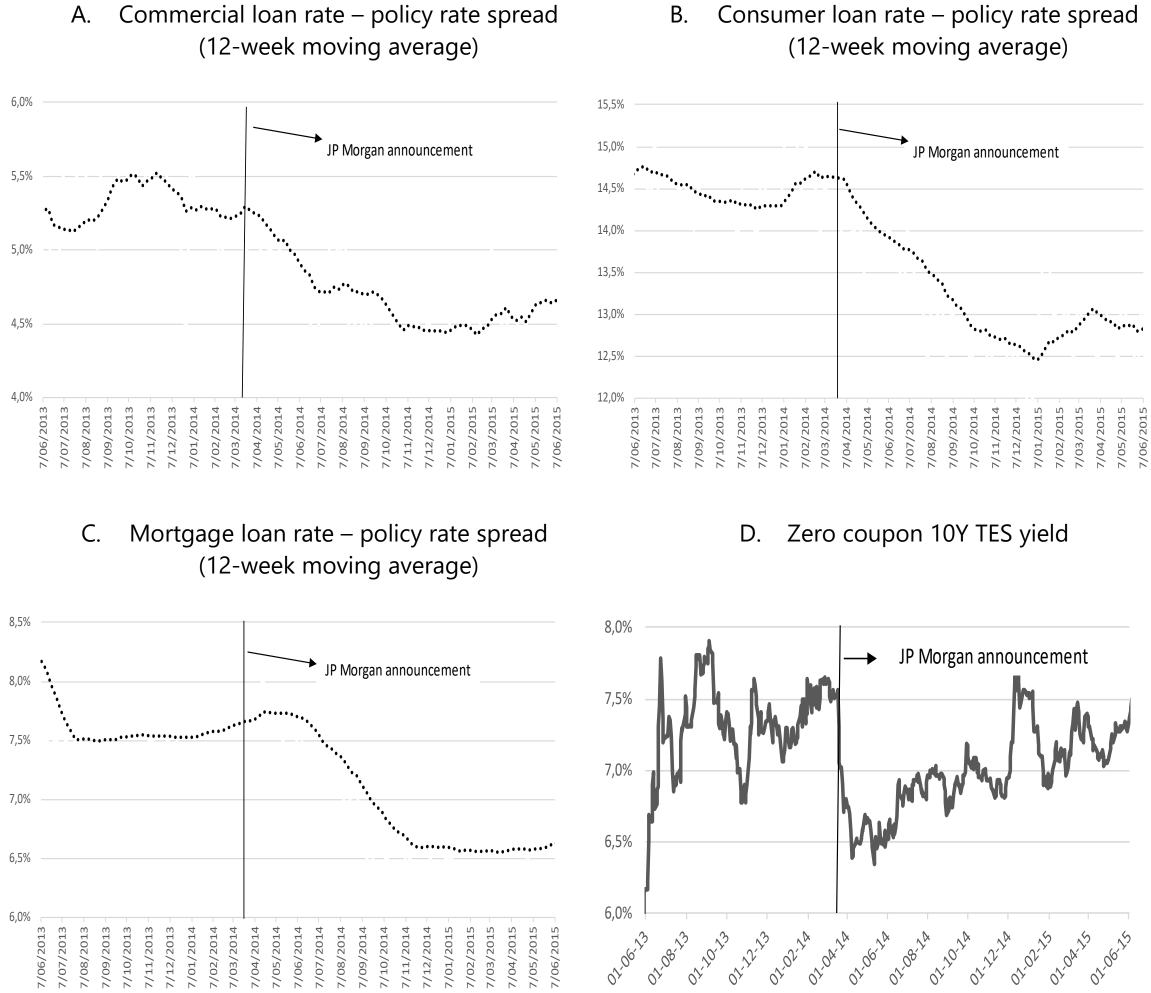
Assets of credit establishments Graph 4



Source: Central Bank of Colombia

Selected interest rates before and after the JP Morgan announcement

Graph 5



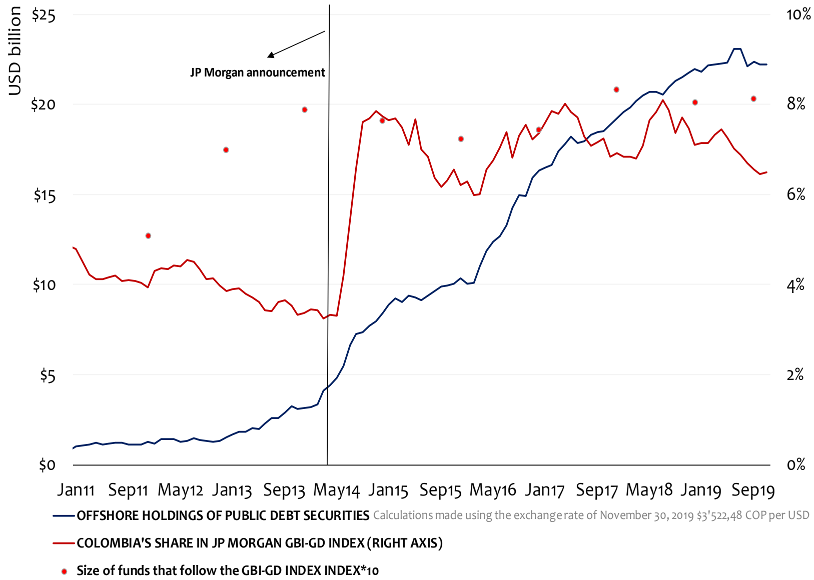
Source: Central Bank of Colombia

Even though since 2015 Colombia's weight in the JP Morgan index has experienced changes, foreigners' holdings of TES have continued to increase in the last couple of years (Graph 6). This occurred because some investors in Colombia have not followed the JP Morgan index and because the funds that use the index have grown in size. According to JP Morgan, in 2019 funds benchmarked to the GBI family stood at USD 228 billion, of which USD 203 billion was linked to the GBI-GD. Another interesting fact is that, from 2011 to 2013, there was no positive relationship between Colombia's weight in the GBI-GD and foreigners' holdings of TES, probably again because as the country's weight went down, the size of the funds that followed the index increased.[7]

[7] In December 2011, the value of funds that followed the index was USD 127 billion, which would have implied foreigners' TES holdings of USD 5 billion. However, actual holdings were USD 2.3 billion of TES, most of which were in the hands of foreign banks (Graph 7). This shows that the funds did not follow the index passively at that time, or that the index that was effectively followed was adjusted to exclude Colombia.

Colombia´s weight in the GBI-GD and foreign participation in the local sovereign bond market

Graph 6



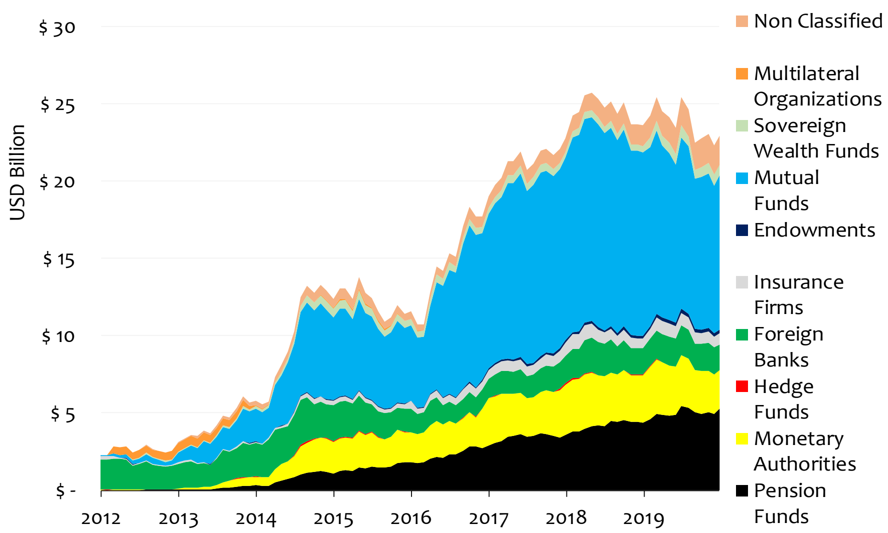
Source: Central Bank of Colombia; JP Morgan.

The type of foreign investor in the local public debt market (Graph 7) has also changed in recent years. In 2012, international banks were the main investors. While they have maintained a stable level of investments, mutual funds, pension funds and monetary authorities have increased their holdings considerably.

This paper addresses three questions. First, what were the effects of the increased foreign participation in the domestic sovereign bond market on credit markets and local public bond and lending interest rates? Second, has the higher participation of foreigners in the local public bond market changed the transmission of external financial conditions into the Colombian economy? And third, has the higher participation of foreigners in the local public bond market changed the transmission of domestic monetary policy shocks?

Foreign investors holdings of local sovereign bonds by investor type

Graph 7



Source: Central Bank of Colombia

2. Effects of foreign investors on local financial conditions

To study the influence of foreign investors on domestic financial conditions in circumstances resembling the experience of Colombia since 2014, a simple two-period model of a small open economy is developed in which "portfolio balance channels" in the local banking sector and the foreign investment decisions are important. The model is presented in Appendix 1. In particular, the model is used to explore the effects of changes in (i) the size of the foreign portfolios in which local bonds are included; (ii) the taxes on foreign portfolio earnings; and (iii) the external interest rate. The main results of the model may be summarised as follows:

- In the absence of any change in external interest rates, increases in the size of foreign portfolios including domestic public bonds have a downward effect on local bond, loan and deposit interest rates only in the presence of imperfect substitution between foreign and domestic bonds. Close substitution would imply a low or negligible impact in this regard. Intuitively, expanded foreign portfolios entail a smaller share of local bonds, making them more valuable in the eyes of foreign investors.
- Reductions in the tax rate on foreign portfolio earnings have stronger effects on local interest rates when they occur at higher initial tax rate levels. This occurs because a greater drop in local bond interest rates is required to balance external and domestic net returns after a given reduction in the tax rate.
- The effects of tax rate cuts are smaller in the presence of imperfect substitution between foreign and local bonds in the foreign portfolios, or between loan and bonds on the banks' asset side. A tax cut increases the exposure of foreigners to local bonds, increasing the "premium" that they require to accommodate a larger

share of them in their portfolio. This partially offsets the direct effect of the tax rate reduction. Likewise, as foreign investors buy bonds from banks, the latter's exposure to loans (relative to bonds) increases, pushing loan interest rates upwards and partially offsetting the direct negative effect of the tax cut.

- For the same reason, increases in external interest rates have a more subdued effect on domestic interest rates in the presence of imperfect substitution of foreign and local bonds in foreign portfolios, and of bonds and loans in banks' assets.
- Increases in external interest rates have stronger effects on local interest rates when the tax rate on foreign portfolio earnings is higher. Again, this happens because a given rise in external interest rates requires a larger response of the local bond rate to balance net internal and external returns when the tax rate is higher.
- Under imperfect substitution between foreign and local bonds in foreign portfolios, the impact of an increase in external interest rates on domestic rates is smaller, the larger the size of foreign portfolios. Given a fixed supply of local bonds, larger foreign portfolios imply a lower share of domestic bonds in them. An increase in external interest rates induces a reduction in those already low shares and, thus, makes local bonds more valuable to foreign investors. Consequently, the premium that they require to hold local bonds falls, partially offsetting the direct impact of the external interest rate hike.

In addition to the channels posited in the model, external financial conditions may affect local ones in other ways. Monetary policy in advanced economies (AEs) could be transmitted to EMEs through changes in financial conditions.[8] For instance, Takáts and Vela (2014) suggest that market sentiment could work as a transmission mechanism. As the 2013 *taper tantrum* episode showed, actual and perceived changes in AEs monetary policy may alter agents' expectations and have consequences for EMEs. This channel could be amplified by the presence of foreign agents in local markets. Another possible transmission channel is present through variations in cross-border bank flows, since differences in relative monetary policy could affect cross-border claims, which in turn could disturb the credit channel of monetary policy. However, it is not clear if the presence of foreign investors amplifies this transmission channel (Correa et al (2018); Albrizio et al (2019)). [9]

There is evidence that higher foreign participation in the local bond market is associated with lower yields (Peiris (2010); Andritzky (2012); Bernanke et al (2004)). For example, Peiris (2010) finds that for emerging markets a 10-percentage point increase in the share of foreign holdings leads to a 60 bp decrease in sovereign yields. In the same line, Garcia (2019) uses causal inference methods to conclude that Colombian sovereign bond yields in local currency decreased by up to 94 bp after the jump of foreign participation in the TES market brought about by the country's increased weighting in the JP Morgan GBI-EM.

In the case of advanced economies, Warnock and Warnock (2009) study the effects of higher foreign demand for treasuries on yields in the United States. They

[8] For example, Takáts and Vela (2014) find that "advanced economy monetary policy seems to drive EMEs' policy rates beyond what domestic factors would suggest", a relation observed both for short-term and long-term rates.

[9] Albrizio et al (2019) find evidence that an exogenous increase in funding costs in advanced economies leads to statistically significant declines in cross-border bank lending.

find that the two-year bond yields remain closely linked to the monetary policy rate and are less affected by foreign flows. For long-term rates however, the participation of foreign investors explains a higher proportion of yields, thus implying a weaker influence of the policy rate.

Besides affecting yield levels, a higher participation of foreign agents in local financial markets could increase yield volatility. There is evidence that foreign investors are more sensitive to international financial conditions, as compared with local agents (Ebeke and Kyobe (2015); Peiris (2010)). Hence, a higher participation of foreign investors in local markets could amplify spillover effects from foreign financial conditions.[10] This could be challenging for central banks, as a higher sensitivity to external conditions and more volatile markets might hamper the transmission of monetary policy shifts to market interest rates.

2.1 Effects of foreign participation in the TES market on domestic credit and interest rates

The increased participation of foreign investors in the Colombian local public bond market affected domestic financial conditions in at least two ways. First, given its size and timing, it had a substantial impact on TES yields. Second, by reducing the latter, it may have pushed down bank loan rates. Moreover, since banks were important sellers of TES to foreign investors, the enlarged foreign participation in the TES market implied changes in banks liquidity and credit supply that influenced corporate real and financial variables.

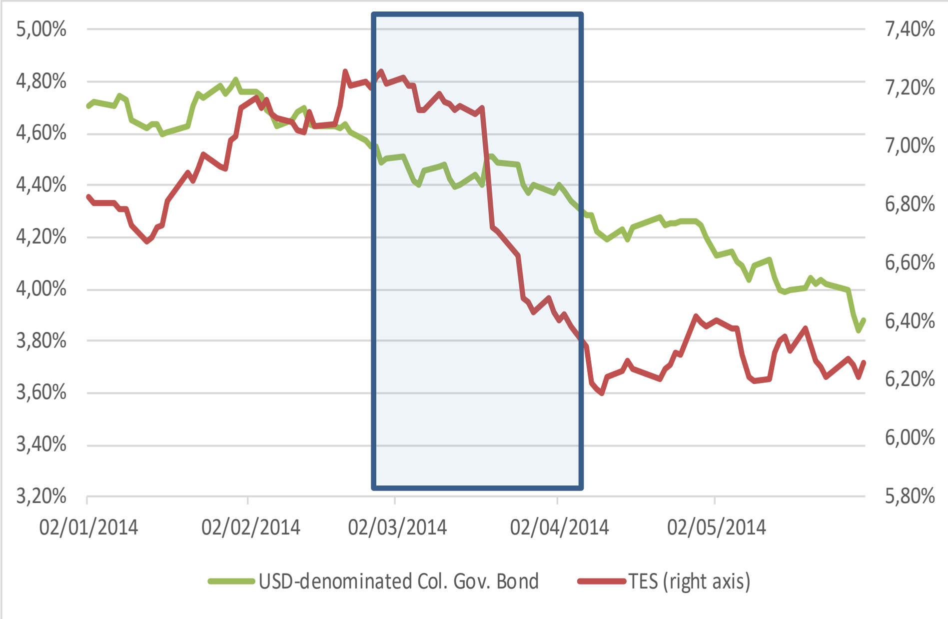
This is in accordance with the results of the model presented in Appendix 1, in which a cut of the tax rate on portfolio investment earnings results in increased participation of foreign investors in the local markets and a reduction in local interest rates. Likewise, if “portfolio balance effects” are allowed, an increase in the size of foreign portfolios in which local bonds are included also produce greater foreign participation in local markets and lower domestic interest rates, even if foreign interest rates remain unchanged. Interestingly, TES yields dropped markedly around the time of the JP Morgan announcement without a significant concomitant move in the yields on USD-denominated Colombian government bonds (Graph 8), indicating that “portfolio balance channels” may be relevant.[11]

[10] Ebeke and Kyobe (2015) provide evidence that higher foreign participation in local-currency bond markets increases the transmission of global financial shocks to local markets and is also associated with higher volatility and lower yields.

[11] Alternatively, this divergence could be explained under a UIP hypothesis by strong COP appreciation expectations. The latter would have been consistent with a sharp instant depreciation of the COP, which did not happen at the time, or with the expectation of higher levels of the COP in the future, which would require an explanation.

10-Year TES and USD-denominated Colombian government bond yields

Graph 8



Source: Central Bank of Colombia

The 2014 JP Morgan rebalancing makes it possible to analyse the effects of higher foreign participation on local interest rates in Colombia, as it caused an exogenous inflow of foreign investors into the local sovereign bond market. As a first illustration, a Wald test suggests that the spread between the TES yield and the policy rate decreased after the JP Morgan announcement (Graph 9).[12] This result is confirmed with causal inference techniques that isolate the effect of the index rebalancing from other sources of changes in local yields. Based on both a difference-in-difference estimation and a synthetic control method, Garcia (2019) finds that the JP Morgan index rebalancing produced a permanent reduction of up to 94 bp in the TES 10-year yield.

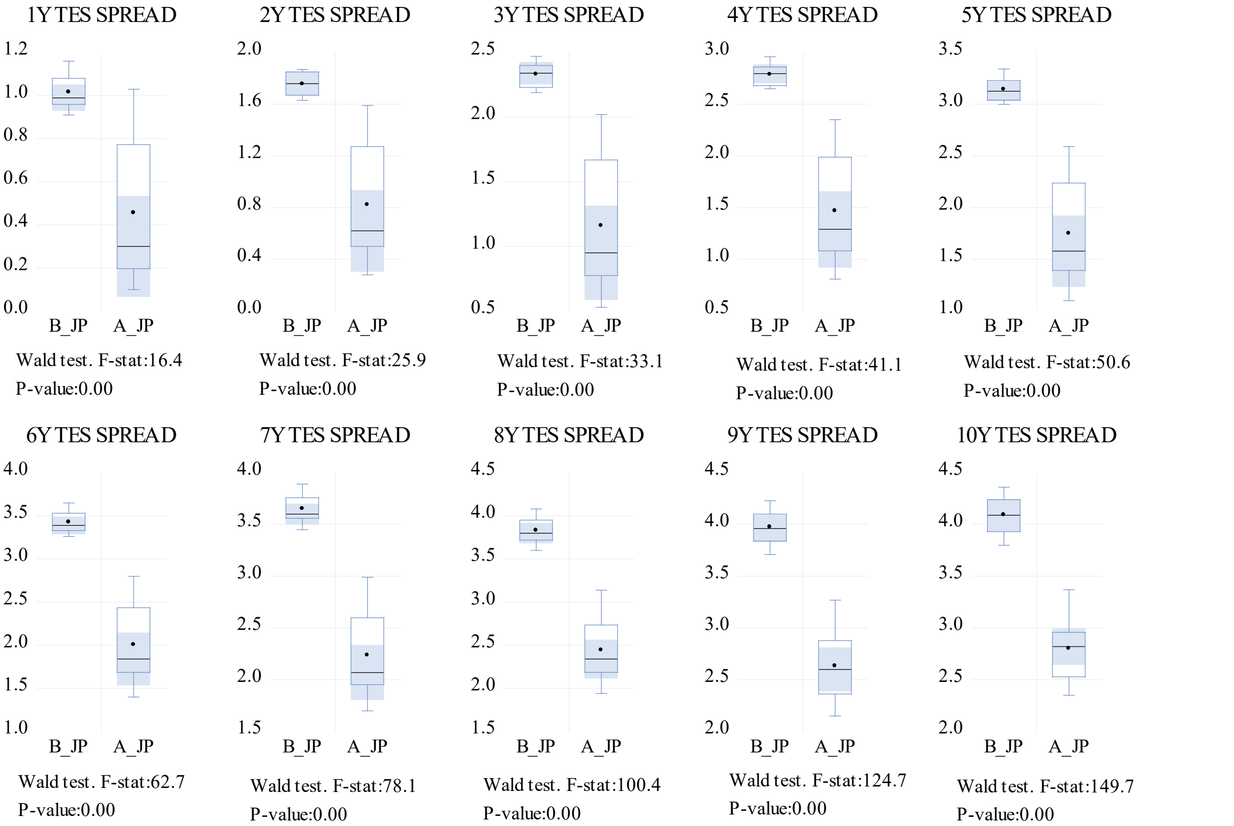
In the case of lending interest rates, the Wald tests also point to a significant decrease of average commercial, preferential, consumer and mortgage loan rates minus the policy rate after the JP Morgan rebalancing. These results also hold at a more disaggregated level by maturities (Graph 10).

Between February and June 2014, bank liquidity increased after foreign investors purchased a significant portion of banks' TES holdings. As a result, bank credit supply rose, stimulating economic activity. Using a two-stage estimation procedure, López et al (2020) show that firms obtained larger amounts of credit in 2014 from banks that sold more TES, and that the increased loan supply was associated with larger levels of debt, revenues and investment at the firm level in that year. Williams (2018) reaches similar results by comparing the responses of TES market-maker banks and non-market-maker banks to the JP Morgan announcement. Market-maker banks sold

[12] The comparison of these subsamples does not include exclusively the effect of the JP Morgan announcement. It may also be influenced by the impact of the "Taper Tantrum" on interest rates in 2013.

TES to foreign investors, increased loan supply and induced higher levels of sales, output, GDP and employment in industries that were more exposed to them.

TES-policy rate spread before and after the JP Morgan announcement (2013–15) Graph 9

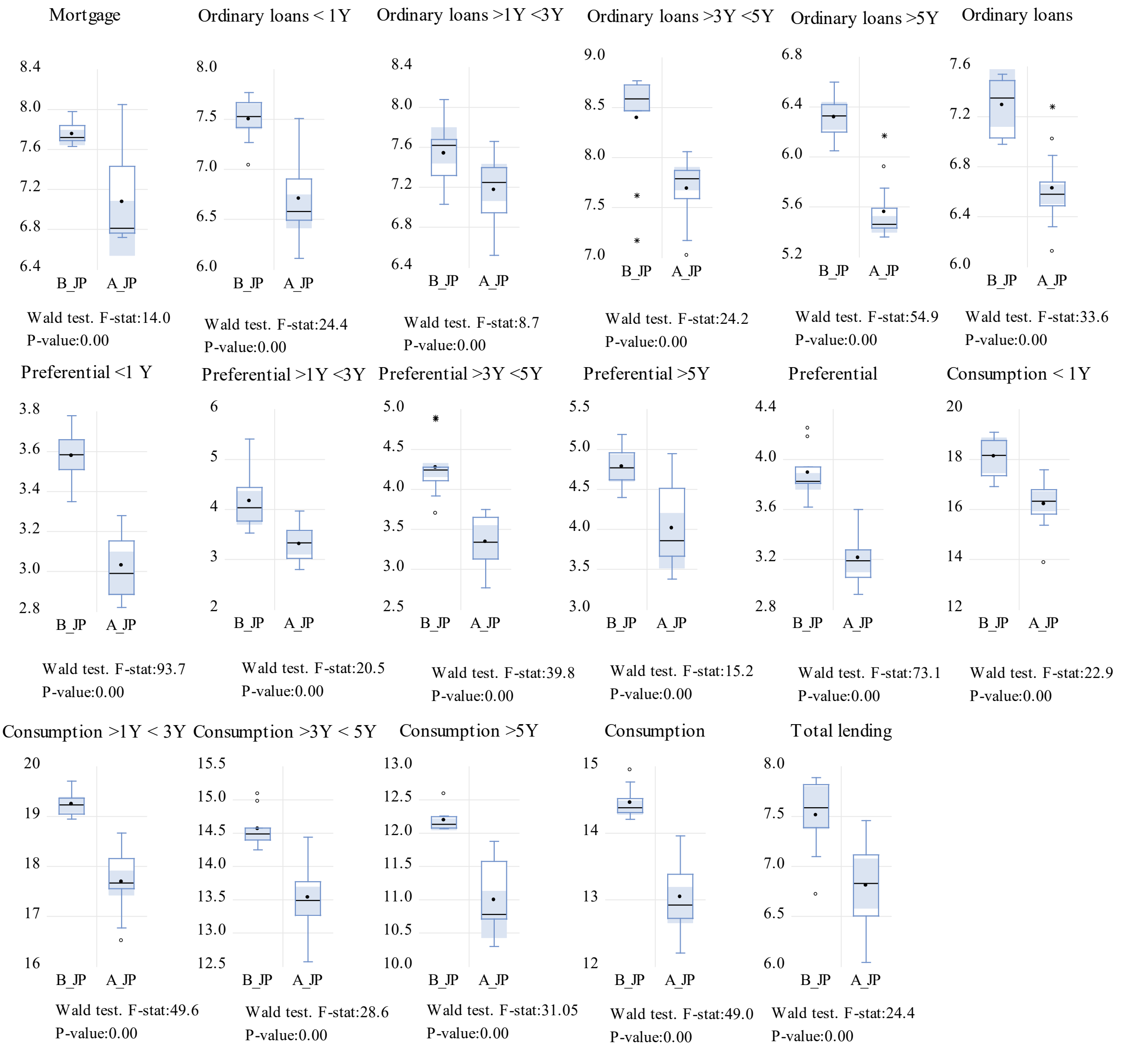


Note: Wald test (F-statistic and probability) is used to test the difference between the subsamples (H0: the spread is the same in both periods). B_JP: before JP Morgan change in 2014 (June 2013 to March 2014). A_JP: after JP Morgan change in 2014 (April 2014–June 2015). The box portion represents the first and third quartiles (middle 50% of the data). The mean is represented by the black dots, the black line stands for the median and the blue shaded areas are the median 95% confidence interval.

Source: Central Bank of Colombia and authors' estimates.

Lending rates-policy rate spreads before and after the JP Morgan announcement

Graph 10



Note: Wald test (F-statistic and probability) is used to test the difference between the subsamples (H0: the spread is the same in both periods). B_JP: before JP Morgan change in 2014 (June 2013 to March 2014). A_JP: after JP Morgan change in 2014 (April 2014-June 2015). The box portion represents the first and third quartiles (middle 50% of the data). The mean is represented by the black dots, the black line stands for the median and the blue shaded areas are the median 95% confidence interval. Points above and below the boxplot are outliers.

Source: Central Bank of Colombia and authors' estimates.

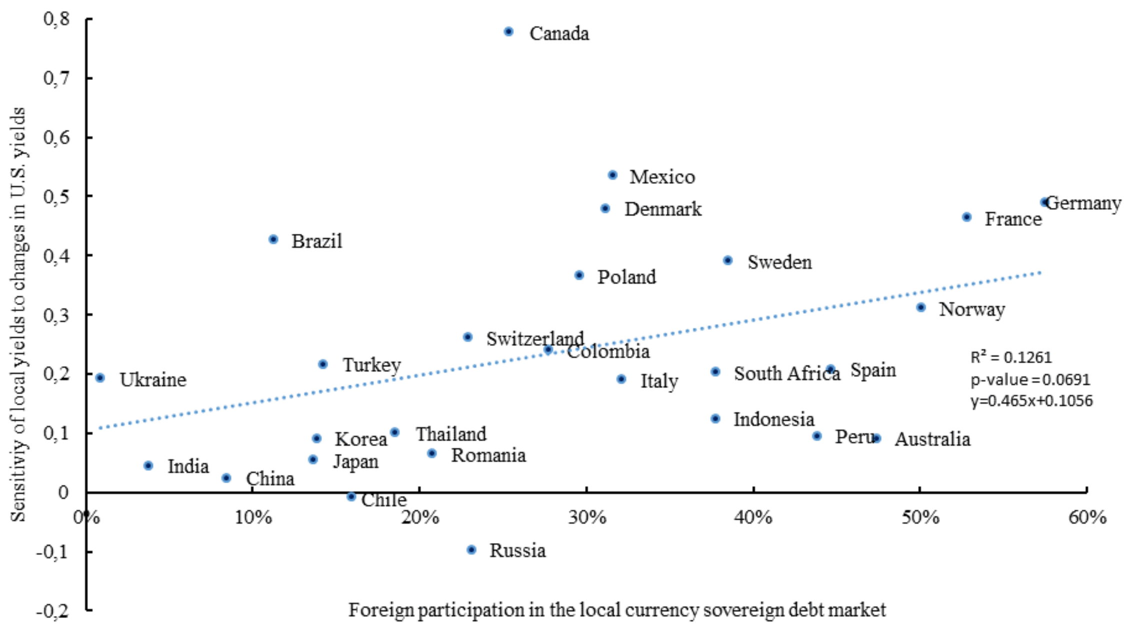
2.2. Effects of foreign participation in the TES market on local sensitivity to international conditions

According to the model presented in Appendix 1, if an increased participation of foreigners in the local bond market is the result of lower taxes on the proceeds of foreign investment or of larger foreign portfolios, then local interest rates would be generally *less* sensitive to changes in external interest rates after the increase in foreign participation. However, in more complex settings, if foreign and local investors were to behave differently, the results might change in this regard.

For example, greater foreign participation in the domestic sovereign debt market can make local yields more sensitive to international financial conditions if foreign investors weigh external factors in their portfolio allocation more than investors confined to local markets do. Foreign investors´ higher responses to global shocks imply that they could amplify spillover effects from international financial conditions to local markets. In particular, passive investment strategies could increase the sensitivity of local markets to global factors, as investors benchmarked to financial indices focus less on country-specific developments (IMF (2019)). Graph 11 shows that there is a statistically significant positive correlation between the percentage of local sovereign bonds held by foreigners and the sensitivity of local yields to changes in US yields, after controlling for international risk aversion.

Sensitivity of local yields to changes in US yields and foreign participation in the local currency sovereign debt market

Graph 11



The sensitivity of local interest rates is calculated as the β coefficient in the following regression: dy=α+βdy*+θVIX+ξ , where dy is the difference in the 10-year yield of sovereign bonds denominated in local currency, dy^* is the difference of the 10-year yield of U.S treasuries, and VIX is the Chicago Board Options Exchange Volatility Index. The information regarding foreign participation in the local currency sovereign debt market is obtained from Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014).

Source: Central Bank of Colombia.

An examination of the importance of external variables in the determination of TES and local lending interest rates (Graph 12) suggests that[13] (i) TES yields have been influenced by the five-year Colombia CDS, the EMBI, the VIX and the return and volatility of the JP Morgan EM currency index throughout the whole 2008–19 sample; (ii) there is some evidence that the sensitivity to the CDS and EMBI may have

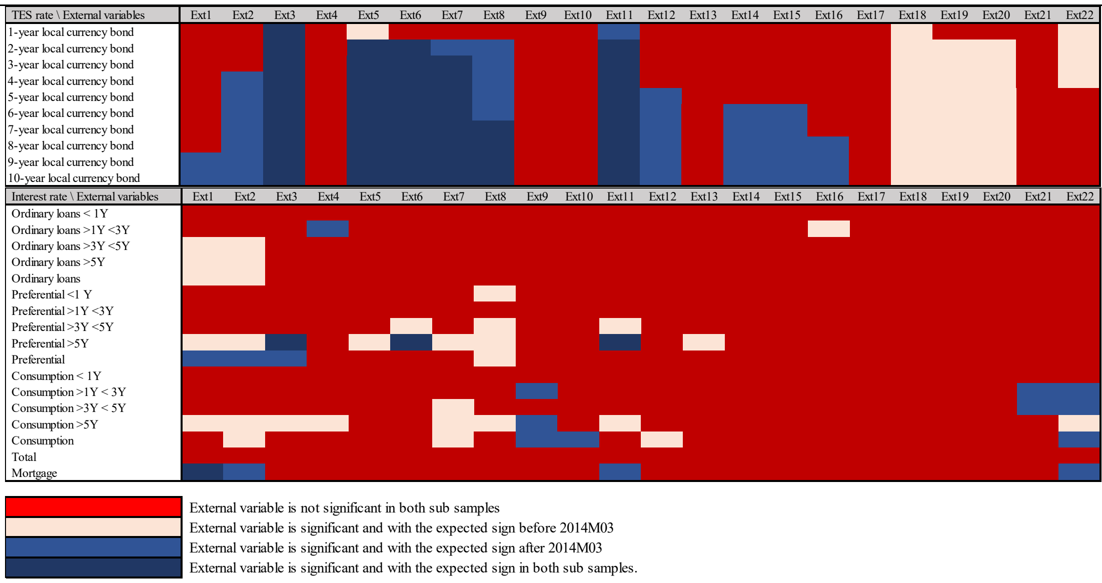
[13] Graph 12 indicates whether the external variables were significant (and with the expected signs) determinants of domestic interest rates before the JP Morgan announcement (light red), after the announcement (light blue), during the whole sample period (dark blue) or not significant across sub-samples (red). The estimation sample goes from January-2008 to October-2019.

increased between samples;[14] (iii) the correlation of the Brent oil price, the US shadow interest rate and the short-term US Treasury rates with long-term TES rates became important after 2014 (the year of the jump in foreign participation in the TES market); (iv) in contrast, the correlation between long-term US treasury yields and TES rates weakened after 2014; (v) domestic lending rates do not exhibit strong correlation with external variables in the whole 2008–19 sample; and (vi) US monetary policy shocks do not seem to strongly influence either TES or lending rates in the whole sample.

The above results indicate that the sensitivity of TES yields to shifts in external conditions experienced some changes after 2014, when the participation of foreigners in the local TES market increased markedly. However, there were no significant changes in the influence of external variables on domestic lending interest rates.

Significance of the relationship between local interest rates and external variables

Graph 12



Note: The threshold for significance used in the table is 10% (HAC s.e.)

Code	Description
Ext1	Log of WTI oil price
Ext2	Log of Brent oil price
Ext3	Colombian 5-year CDS
Ext4	Log DXY index
Ext5	VIX index
Ext6	JP Morgan EM currency volatility index
Ext7	Log of JP Morgan EM currency index
Ext8	S&P 500 index
Ext9	LIBOR rate
Ext10	FED Funds rate
Ext11	EMBI Colombia

Code	Description
Ext12	US shadow rate
Ext13	1- month US yield
Ext14	3-month US yield
Ext15	6-month US yield
Ext16	1-year US yield
Ext17	2-year US yield
Ext18	3-year US yield
Ext19	5-year US yield
Ext20	10-year US yield
Ext21	US monetary policy shock Jarociński & Karadi
Ext22	US equity shock Jarociński & Karadi

To assess the sensitivity of local interest rates to external drivers the following equation is estimated: $\Delta i_t^j = (1-d)\left(\gamma_0^{j,k,b} + \gamma_1^{j,k,b}\Delta ext_t^k + \sum_{l=1}^{L}\lambda_l^{k,b}\, x_t^k\right) + d\left(\gamma_0^{j,k,a} + \gamma_1^{j,k,a}\Delta ext_t^k + \sum_{l=1}^{L}\lambda_l^{k,a}\, x_t^k\right) + \varepsilon_t^{j,k}$. Where i_t^j represents the interest rate j, ext_t^k is the external variable k, and x_t^k are control variables (the first difference of the logarithm of CPI, the economic activity index, a local monetary policy shock). The dummy variable d equals 0 before March 2014 and 1 thereafter. US monetary and equity shocks are obtained from Jarociński and Karadi (2020) and are available from January 2005 to December 2016. US monetary and equity shocks are included in levels since they are stationary variables (Appendix 2).

Source: Central Bank of Colombia.

[14] The Wald test shows that the sensitivity of TES rates at different tenors to CDS and EMBI could have increased after the JP Morgan announcement (March 2014). In the case of the VIX, JP Morgan EM FX index and JP Morgan EM FX volatility, the estimated parameters are statistically equal (Appendix 2).

2.3 Effects of foreign participation in the TES market on monetary policy transmission

To examine the possible effects that a greater foreign participation in the TES market may have on the transmission of domestic monetary policy, a methodology is used in which monetary policy shocks are identified and their transmission to market and lending rates is estimated recursively. The identification of unanticipated monetary policy shocks may reduce potential bias in the estimation of transmission parameters, as the effects of anticipated policy shifts are incorporated in market interest rates before the shifts occur.

The policy shocks were constructed as the difference between actual policy rates and their expected values.[15] The latter were obtained from the one-month overnight IBR[16] index swap. The transmission to market interest rates was estimated by means of local projections methods (Jordà (2005)), based on the following specification:

$$\Delta i_{t+h}^{j} = \mu_h^j + \beta_h^j \psi_t + \sum_{l=1}^{L} \gamma_h^{j,l} x_t^l + \xi_{h,t}$$

Where $h = 1 \ldots H$ represents the projection horizon, i_t^j is the interest rate j, ψ_t is the domestic monetary policy shock, x_t^l are control variables (the first difference of the logarithm of CPI and the economic activity index), $\xi_{h,t}$ is the projection residual and β_h^j and $\gamma_h^{j,l}$the projection coefficients. The local projection impulse-response function of Δi_t^j with respect to the monetary policy shock is given by $\{\beta_h^j\}_{h\geq 0}$.

Graph 13 shows the estimated transmission coefficients for commercial ordinary, commercial preferential, consumer, mortgage and average lending interest rates, as well as for the 10-year TES yield, for the whole 2008–19 sample.[17] Transmission is stronger for commercial loan rates, with the total effect on their level being completed after eight months.[18] For consumer and mortgage loan rates, transmission is lower, while the 10-year TES yield only responds contemporaneously to the policy shock.[19]

15 Vargas et al (2012), Huertas et al (2018) and López et al (2020) use similar strategies to compute responses to monetary policy shocks, although they used different methodologies to identify the shocks. Vargas et al (2012) obtain them by regressing policy interest rates on a wide set of macroeconomic variables available before the monetary policy decision. Huertas et al (2018) use a survey of interest rate expectations to calculate the policy shock. López et al (2020) estimate the shocks using the methods of Romer and Romer (2004) and Bańbura et al (2010). A comparison of the monetary policy shock used by López et al (2020), the Bloomberg survey surprises, and the proposed measure are shown in Appendix 2.

16 IBR stands for "*Indicador Bancario de Referencia*", which is the transactions-based, one-day Colombian "Libor". Appendix 2 compares this shock with other shocks that have been used in the literature.

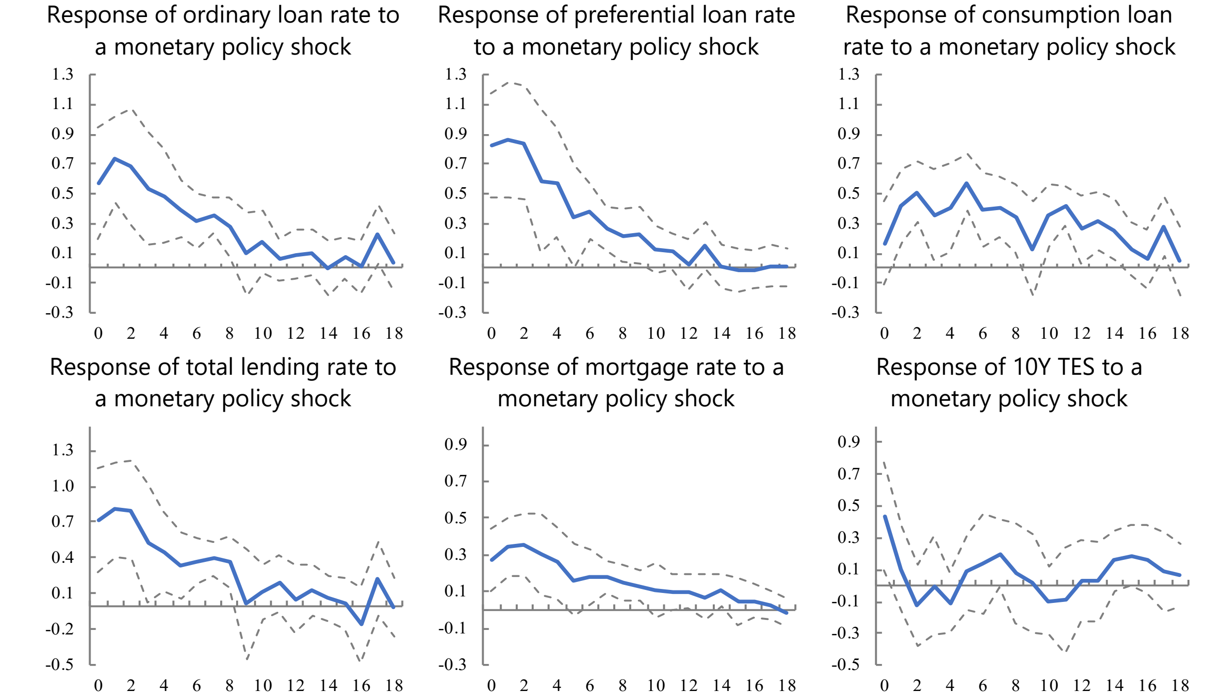
17 Graph 13 includes the contemporary effect of the shock on interest rates (h=0).

18 Since the econometric specification is based on the monthly first differences of the interest rates, the response of their level to the monetary policy shock is given by the cumulative sum of the estimates shown in Graph 12.

19 As shown in Graph 13, the contemporaneous transmission coefficient is statistically different from zero for all but consumer loan interest rates. This is odd, since market interest rates were included as monthly averages and, thus, should not be affected by the contemporaneous shock, as the latter generally occurs at the end of each month. This might suggest that the shock was not completely unanticipated by the agents that form prices in the loan and bond markets. It might also be the case that some Board meeting dates in the sample were not exactly at the end of the month, but some

LP impulse response to a monetary policy shock (M01 2008–M10 2019)

Graph 13



Source: Authors' estimates.

To test for changes in the transmission of monetary policy shocks after the increase of Colombia´s weight in the JP Morgan GBI-GD, recursive least squares (RLS) were applied to the above specification and CUSUM tests were performed.[20] Graph 14 indicates that the RLS estimates of the one-month-ahead transmission coefficients have been stable since well before the change in Colombia's weight. Graph 15 shows the corresponding CUSUM tests, which confirms the coefficient stability results. The same outcomes are obtained for all transmission coefficients, as illustrated by the recursive estimates of the transmission coefficient for a rolling sample (Graph 16).

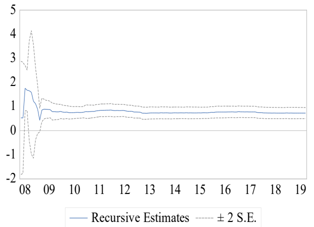
weeks earlier. In these circumstances it is possible that a policy surprise be included in the contemporaneous average market interest rates. Miranda-Agrippino and Ricco (2017) remark that policy shocks calculated with the methodology used in this exercise are *assumed* to be exogenous and unanticipated, but they might not be so. Hence, they suggest regressing the calculated policy shocks on "Greenbook" forecasts and shock lags, and to use the resulting residuals as a more appropriate measure of monetary policy surprises.

20 This approach was preferred to an estimation in separate samples because of the short length of the 2014–19 period. In the presence of short samples, the estimation of the transmission coefficients may be biased downwards by "perceived policy mistakes", since in these cases monetary policy shocks are not followed by a response in market interest rates.

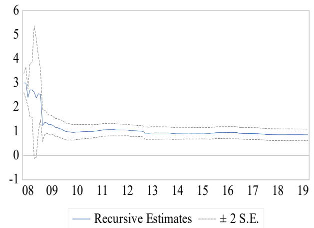
Sensitivity of interest rates to a monetary policy shock at projection horizon h=1

(recursive estimates) Graph 14

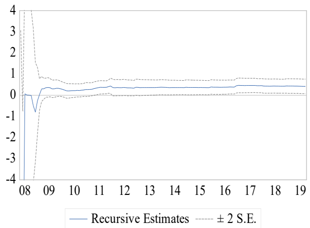
Sensitivity of ordinary loan rate



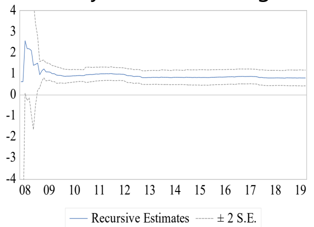
Sensitivity of preferential loan rate



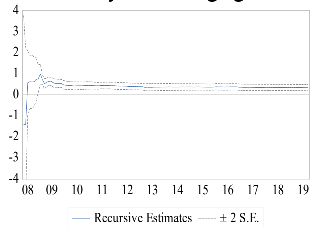
Sensitivity of consumption loan rate



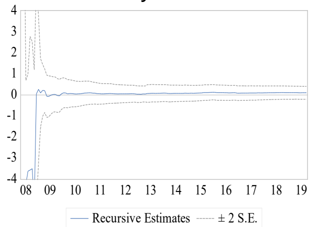
Sensitivity of total lending rate



Sensitivity of mortgage rate



Sensitivity of 10Y TES

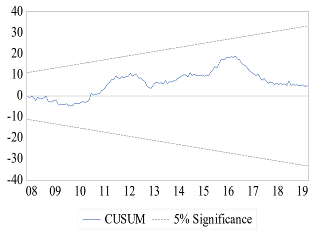


Source: Authors' estimates.

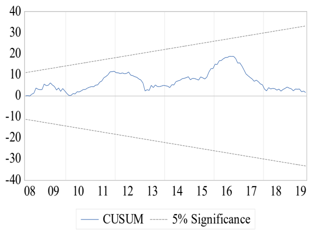
CUSUM Test for interest rates at projection horizon h=1

Graph 15

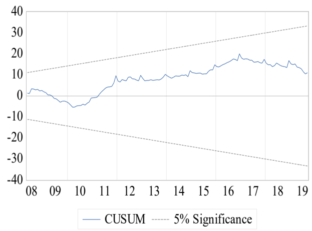
CUSUM Test -ordinary loan rate



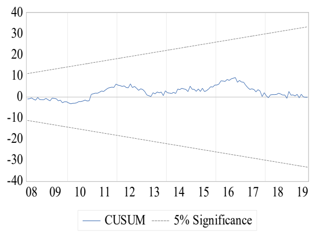
CUSUM Test - preferential loan rate



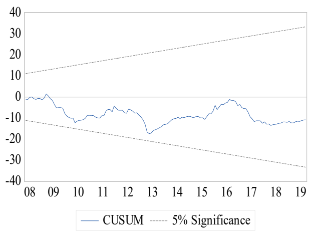
CUSUM Test -consumption loan rate



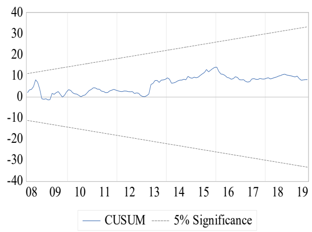
CUSUM Test - total lending rate



CUSUM Test -mortgage rate



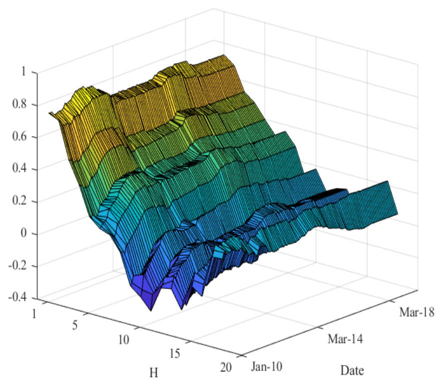
CUSUM Test -10Y TES



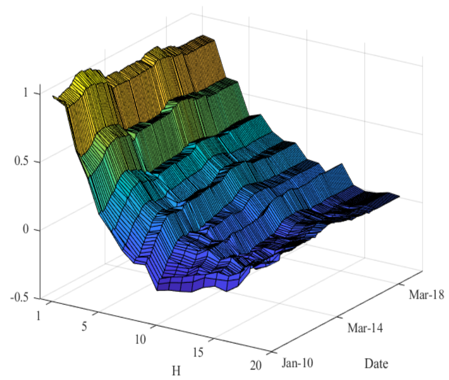
Source: Authors' estimates.

Response of interest rates to a monetary policy shock. Local projections estimated recursively from 10M01 to 19M10 Graph 16

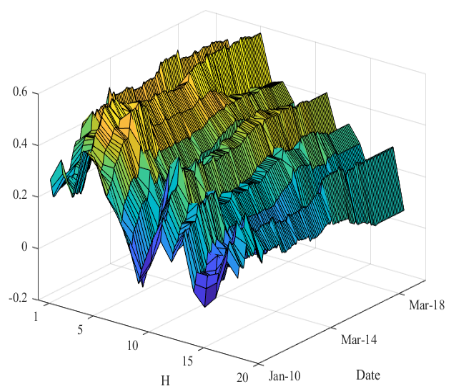
Response of ordinary loan rate



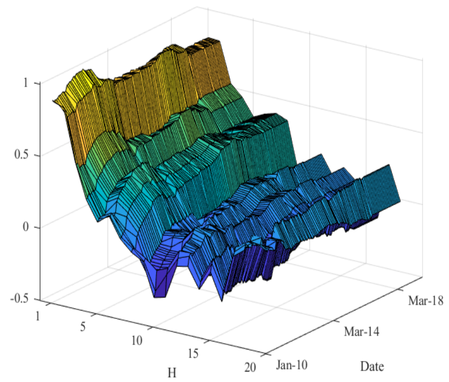
Response of preferential loan rate



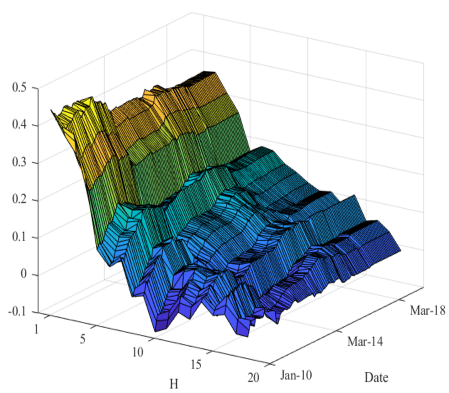
Response of consumption loan rate



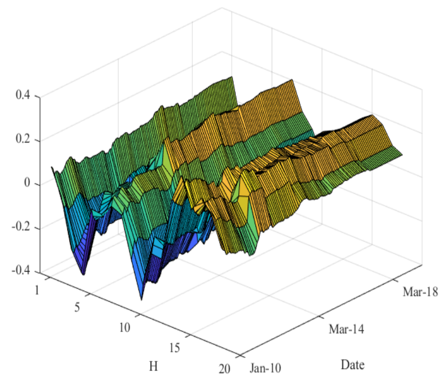
Response of total lending loan rate



Response of mortgage loan rate



Response of 10Y TES



Source: Authors' estimates.

3. Conclusions

The Colombian local public bond market experienced a substantial increase in the participation of foreign investors during 2014 due to a reduction of the tax rates on foreign portfolio investment returns and the increase in Colombia's weighting in the JP Morgan GBI-GD. The resulting inflows reduced bond and loan interest rates and raised loan supply. Since then, foreign investors have maintained a high participation in the public bond market and there is some evidence that the sensitivity of TES yields to CDS and EMBI may have increased, although the influence of external financial conditions on domestic lending rates has remained subdued. US monetary shocks are not found to have a direct impact on TES or loan interest rates, although "shadow" US policy rates have become a significant driver of TES yields since 2014. Finally, there does not seem to have been a shift in the transmission of domestic monetary policy shocks to TES and lending interest rates after the rise in foreign participation in the local bond market.

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Appendix 1

A macroeconomic model of foreign investor effects on a small open economy

A simple two-period, small open economy model is presented to illustrate the effects that changes in the size of foreign investor portfolios or the tax rates on the profits of foreign portfolio investment may have on local interest rates.

A small open economy is assumed to be populated by two households that differ in their time discount rates. As a result, the "patient" household, *p*, will be net creditor and the "impatient" one, *i*, will be net debtor. Both households receive exogenous endowments in both periods and pay lump sum taxes to the government. There is no production in the economy. Households can only save in or borrow from a local bank. Hence, the net creditor household takes the first period bank deposit interest rate, r_d, as the relevant price for its consumption/saving decisions, while the net debtor household takes the first period bank loan rate, r_l, as the relevant price for its consumption/borrowing decisions.

The households' problem is the following:

$$\underset{c_1^j,\ c_2^j}{Max}\ u(c_1^j) + \beta^j\ u(c_2^j)$$
$$s.t.\ \ c_1^j + (1+r_k)^{-1}\ c_2^j = (y_1^j - T_1) + (1+r_k)^{-1}\ (y_2^j - T_2) \quad for\ j \in \{p,i\}\ and\ k \in \{d,l\}$$

u(c) is assumed to be a CRRA utility function. The solution of this problem implies the standard Euler equations, in which the relevant interest rate is the deposit or loan rate for the patient or impatient household, respectively. Optimal consumption paths are derived from the Euler equation and the inter-temporal budget constraint for each household. Demand for bank deposits, *D*, and loans, *L*, are then given by:

$$D = (y_1^p - T_1) - c_1^p \tag{1}$$
$$L = c_1^i - (y_1^i - T_1) \tag{2}$$

There is a local bank that receives deposits from the patient household and uses these resources to make loans to the impatient household and to buy government bonds, B_b. The bank acts as a price taker in all markets. The problem of the bank is as follows:

$$\underset{L,\ B_b,\ D}{Max}\ r_l\, L + r_b\, B_b - r_d\, D - C^B(D, B_b, L)$$
$$s.t.\ \ L + B_b = D$$

The cost function, $C^B(.)$, is set to explicitly allow for imperfect substitution between bonds and loans in the bank´s asset side. Based on Benes (2013) and Vargas et al (2013), the following specification is assumed for the cost function:

$$C^B(D, B_b, L) = \theta_d D + \theta_b B_b + \theta_l L - 2\lambda (B_b\, L)^{1/2}$$

The bank optimisation problem first-order conditions imply:

$$r_l = r_d + \theta_d + \theta_l - \lambda (B_b/L)^{1/2} \tag{4}$$
$$r_b = r_d + \theta_d + \theta_b - \lambda (L/B_b)^{1/2} \tag{5}$$

Equations (4) and (5) imply:

$$r_l = r_b - \theta_b + \theta_l + \lambda ((L/B_b)^{1/2} - (B_b/L)^{1/2}) \tag{6}$$

If $\lambda > 0$, then bonds and loans will be imperfect substitutes. Consequently, the marginal cost of bonds will increase with the exposure of banks to bonds relative to loans, and something similar applies to the marginal cost of loans. Thus, a bank "portfolio" channel is introduced.

The small open economy can trade inter-temporally with the rest of the world. There a single good in the model, so that the exchange rate is always equal to one. The only way in which foreign investors may finance the small open economy is through purchases of government bonds. They are subject to a tax, t, on the return on their investment in local bonds. They allocate a portfolio of size W^* between local, B_x, and foreign bonds, B^*, by solving the following problem:

$$\max_{B_x,\, B^*} \ (1 + r_b\,(1\text{-}t))\, B_x \ + \ (1+r^*)\, B^* \ - \ C^F(B_x, B^*)$$
$$\text{s.t. } W^* = B_x + B^*$$

Domestic and foreign bonds may be imperfect substitutes in the foreign investors´ portfolio. Again, this is captured by the cost function $C^F(.)$:

$$C^F(B_x, B^*) = \phi_x B_x + \phi^* B^* - 2\,\phi\,(B_x B^*)^{1/2}$$

The first-order condition for the foreign investors´ problem implies:

$$(1\text{-}t)\, r_b = r^* + \phi_x - \phi^* + \phi\,((B_x / (W^*\text{-}\, B_x))^{1/2} - ((W^*\text{-}\, B_x)/ B_x)^{1/2}) \qquad (7)$$

Therefore, in the presence of portfolio balance effects ($\phi > 0$), to hold local bonds, foreigners will charge a premium on the return of foreign assets (adjusted for constant marginal costs) that depends on their relative exposure to domestic bonds. Thus, a foreign "portfolio" channel is introduced as well.

The government collects lump sum taxes from households in each period and the tax on foreign portfolio investment returns in the second period. A first-period public deficit is financed through the issuance of bonds that are purchased by the local bank and foreign investors. It is assumed that the second-period public expenditures are adjusted so that the government fulfils its inter-temporal budget constraint. The period-government budget constraints are as follows:

$$G_1 - 2T_1 = B_b + B_x \qquad (8)$$
$$2T_2 + r_b B_x t = G_2 + (1+r_b)\,(B_b + B_x) \qquad (9)$$

There is neither money nor a central bank.

Finally, since it is assumed to be the only way for foreigners to invest in the local economy, the foreign funding of the government must also finance the trade deficit of the economy:

$$B_x = c_1^p + c_1^i + G_1 - y_1^p - y_1^i \qquad (10)$$

A macroeconomic equilibrium is defined as the interest rates, r_b, r_d and r_l, consumption paths, $\{c_1^p, c_2^p\}$ and $\{c_1^i, c_2^i\}$, deposits and loans, D and L, bank and foreign public bond holdings, B_b and B_x, and second-period government expenditure, G_2, such that the Euler equations and equations (1) through (10) are met.

This model is used to explore the effects of changes in t, r^* and W^* on domestic interest rates. When "portfolio balance effects" are ignored (ϕ and $\lambda = 0$), the solution of the model is straightforward. r^* will directly determine local interest rates on the basis of equations (4) through (7), and the quantities of consumption, deposits, loans and bonds will follow from the rest of the model. When "portfolio balance effects" are present (ϕ and $\lambda \neq 0$), the solution of the model becomes cumbersome due to the non-linear nature of the marginal costs. Because of this complexity, in what follows numerical simulations are used to illustrate the main results of the model,[21] which are presented below:

Result 1: Increases in the foreign portfolio size, W^*, ceteris paribus, do not have any effect on local interest rates in the absence of "portfolio balance effects", but they reduce local interest when "portfolio balance effects" are present (Graph A-1.1). Without these effects, foreign and local bonds are (almost) perfect substitutes. Hence, only the foreign interest rate, r^*, and the tax rate on portfolio investment returns, t, determine the local bond interest rate. The size or composition of the foreign portfolio do not matter. The domestic bond rate reflects the opportunity cost of funds for the bank and determines the deposit and loan interest rates, which are, therefore, unaffected as well by changes in W^*. When "portfolio balance effects" are important, an increase in W^* that by assumption is initially invested in foreign bonds implies, ceteris paribus, a decrease in the relative exposure of foreign investors to local bonds. Hence, the premium that investors require to hold them falls, driving down bond rates (equation (7)). This cuts the opportunity cost of funds for banks and pushes down deposit and loan interest rates (equations (4) through (6)).

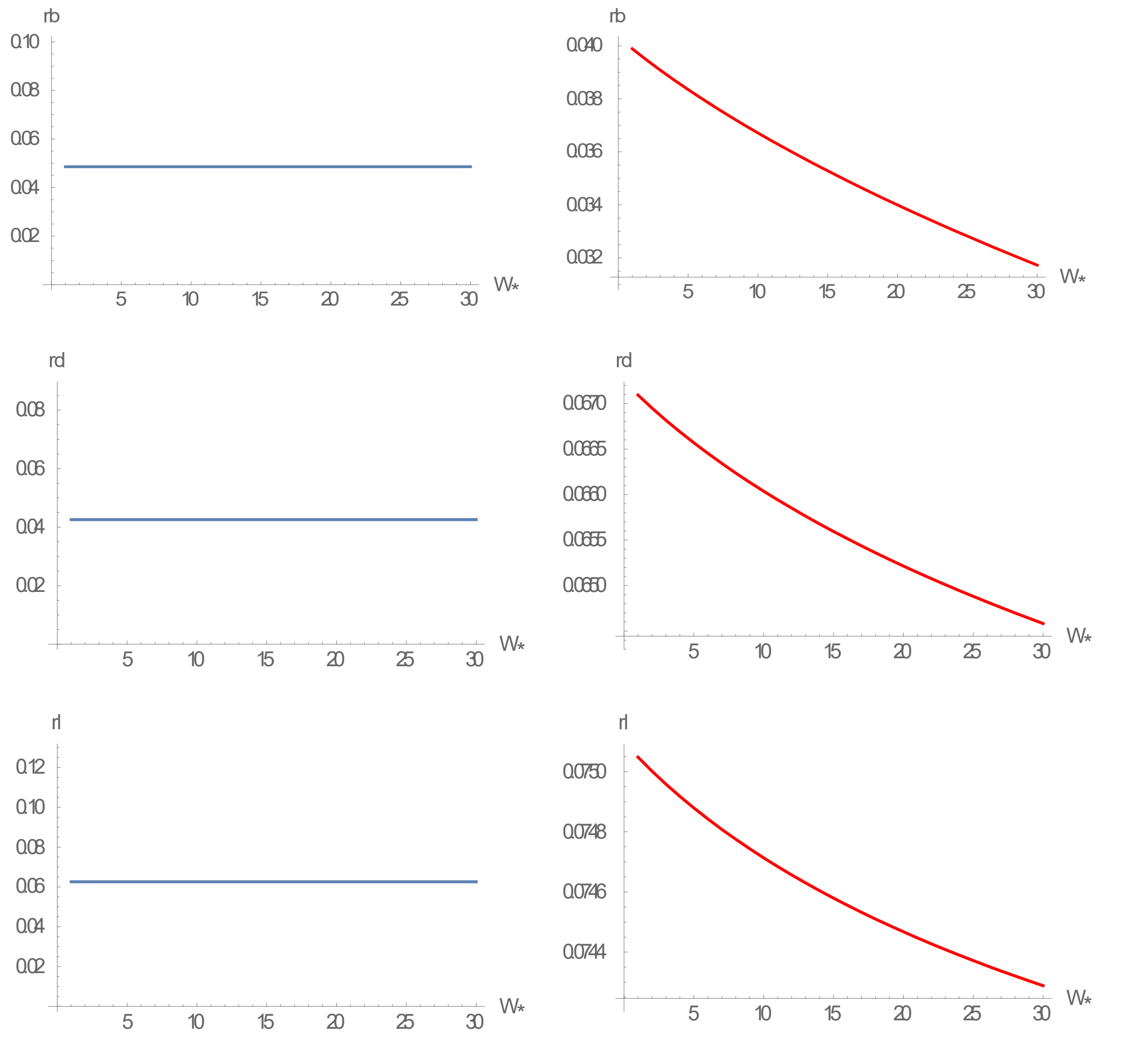
Result 2: As expected, decreases in the tax rate on the proceeds from foreign portfolio investment reduce local interest rates. However, the size of this effect is smaller in the presence of "portfolio balance effects" (Graph A-1.2). Higher tax rates are associated with lower levels of foreign investment and higher exposure of the bank to public bonds. A reduction of the tax rate raises foreign investment, which, ceteris paribus, implies sales of bank-held bonds to foreign investors. The local bonds' weight in the external portfolios increases and so does the premium demanded by foreign investors, partially offsetting the direct negative impact of the tax reduction on bond interest rates (equation (7)). In turn, as bonds fall in the bank's portfolio, the composition of bank's assets becomes more tilted toward loans and this pushes loan interest rates up, partially offsetting the downward effect of the fall of bond interest rates (equation (6)). Deposit interest rates behave similarly. In this case, the effect of the reduction in bond rates is partially offset by the decrease in the marginal cost of bond holdings that results from their decreased weight in the bank asset portfolio (equation (5)).

[21] These simulations assumed the following values for the parameters and the exogenous variables: inter-temporal elasticity of substitution in the CRRA utility function = 1, $\beta^p = 0.98$, $\beta^i = 0.90$, $\theta_d = 0.005$, $\theta_b = 0.001$, $\theta_l = 0.015$, $\lambda = 0.02$, $\phi_x = 0.005$, $\phi^* = 0.001$, $\phi = 0.001$, $y_1^p = 50$, $y_1^i = 50$, $y_2^p = 50$, $y_2^i = 50$, $T_1 = 7.5$, $T_2 = 7.5$, $G_1 = 18$, $t=0.3$ and $W^* = 200$.

Responses of local interest rates to changes in W*

Blue lines: No Portfolio balance effects. Red lines: Portfolio balance effects

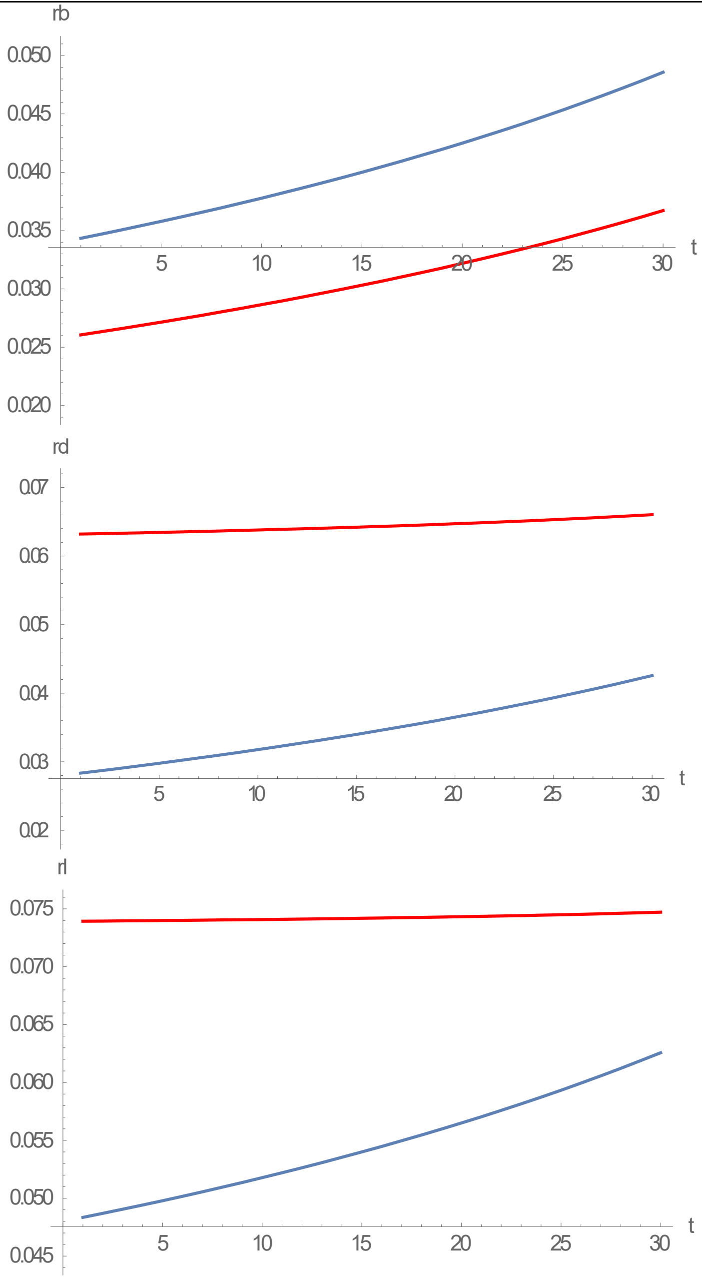
Graph A-1.1



Responses of local interest rates to changes in t

Blue lines: No Portfolio balance effects. Red lines: Portfolio balance effects

Graph A-1.2



Result 3: The effect on local interest rates of a tax reduction is greater for larger initial levels of the tax rate. This can be seen directly from the left-hand side of equation (7). Suppose that "portfolio balance effects" are absent ($\phi = 0$). Then, the right-hand side of equation (7) is unchanged by t. Under these circumstances, a given decrease of t implies an increase in $(1-t)$ that is proportionally larger for higher values of t (lower values of $1-t$). Hence, a larger proportional downward response of r_b is required to balance the equation. Moreover, higher initial values of t are associated with higher initial values of r_b (Result 2). Then, the absolute response of r_b to a fall in t is greater for larger initial values of t, since a higher proportional decline is applied to a larger initial value of the bond rate.[22] The same result is obtained in the presence of "portfolio balance effects", but with the moderating influence introduced by imperfect substitution between foreign and local bonds, and bonds and loans in the foreign investors' and bank's portfolios, respectively.

Result 4: The increases in local interest rates produced by rises in foreign interest rates, r*, are smaller in the presence of "portfolio balance effects" (Graph A-1.3). When foreign interest rates go up, foreign investors drop part of their local bond holdings and sell them to the domestic bank. Consequently, the weight of local bonds in foreign portfolios decreases and the premia required by investors falls, partially offsetting the direct, positive impact of the increase in the foreign interest rate (equation (7)). Likewise, a growing share of local bonds in the bank´s asset portfolio pushes down loan rates, partially offsetting the direct impact of the increase in the opportunity cost of funds for the bank (the bond yield) (equation (6)). Deposit interest rates respond similarly. In this case, the effect of the rise in bond rates is partially offset by the increase in the marginal cost of bond holdings that results from their increased weight in the bank asset portfolio (equation (5)).

Result 5: The response of local rates to changes in external interest rates is higher for greater values of the tax rate, t. This is related to Result 3 and basically reflects the fact that for larger values of t in equation (7), a given hike of r^* requires greater responses of r_b to balance the net returns on foreign and domestic bonds.[23] The same result is obtained in the presence of "portfolio balance effects", but with the moderating influence introduced by imperfect substitution between foreign and local bonds, and bonds and loans in the foreign investors´ and bank´s portfolios, respectively.

Result 6: Without portfolio balance effects, the response of local rates to changes in external interest rates is invariant with the size of the foreign portfolio, W^* (left panels in Graph A-1.4). This is a reflection of Result 1. In this case, local rates are affected only by foreign interest rates and the tax rate. In contrast, with "portfolio balance effects", the response of local rates to changes in external interest rates is lower for greater values of the foreign portfolio, W^* (right-hand panels in Graph A-1.4). This follows from the functional form assumed for the cost function, that implies high valuation of those assets with very low shares in the portfolios. When W^* grows, the share of local bonds in foreign portfolios declines (since supply remains limited), making them more valuable. An increase in r^* that prompts a reduction of an already small share of local bond holdings in external portfolios strongly reduces the

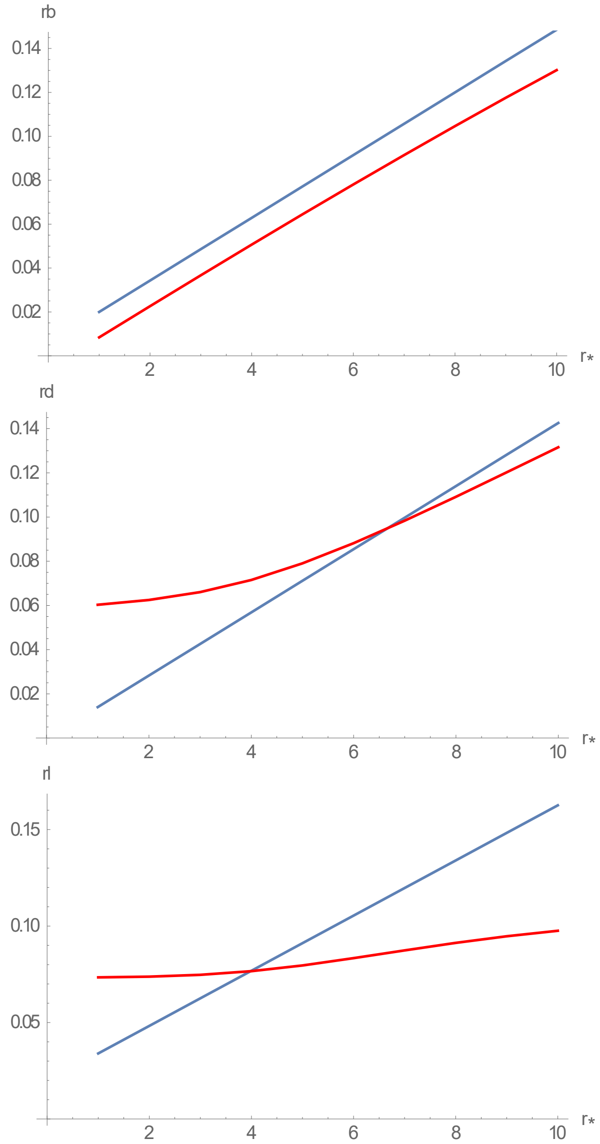
22 Assuming $\phi = 0$, equation (7) implies $r_b = (r^* + \phi_x - \phi^*)/(1-t)$, $dr_b/dt = (r^* + \phi_x - \phi^*)/(1-t)^2 > 0$ and $d^2r_b/dt^2 = (r^* + \phi_x - \phi^*)/(1-t)^3 > 0$.

23 Assuming $\phi = 0$, equation (7) implies $r_b = (r^* + \phi_x - \phi^*)/(1-t)$, $dr_b/r^* = 1/(1-t) > 0$ and $d^2r_b/dr^*dt = 1/(1-t)^2 > 0$.

premium demanded by foreign investors, partially offsetting the direct impact of the increase in *r**.

Responses of local interest rates to changes in r*

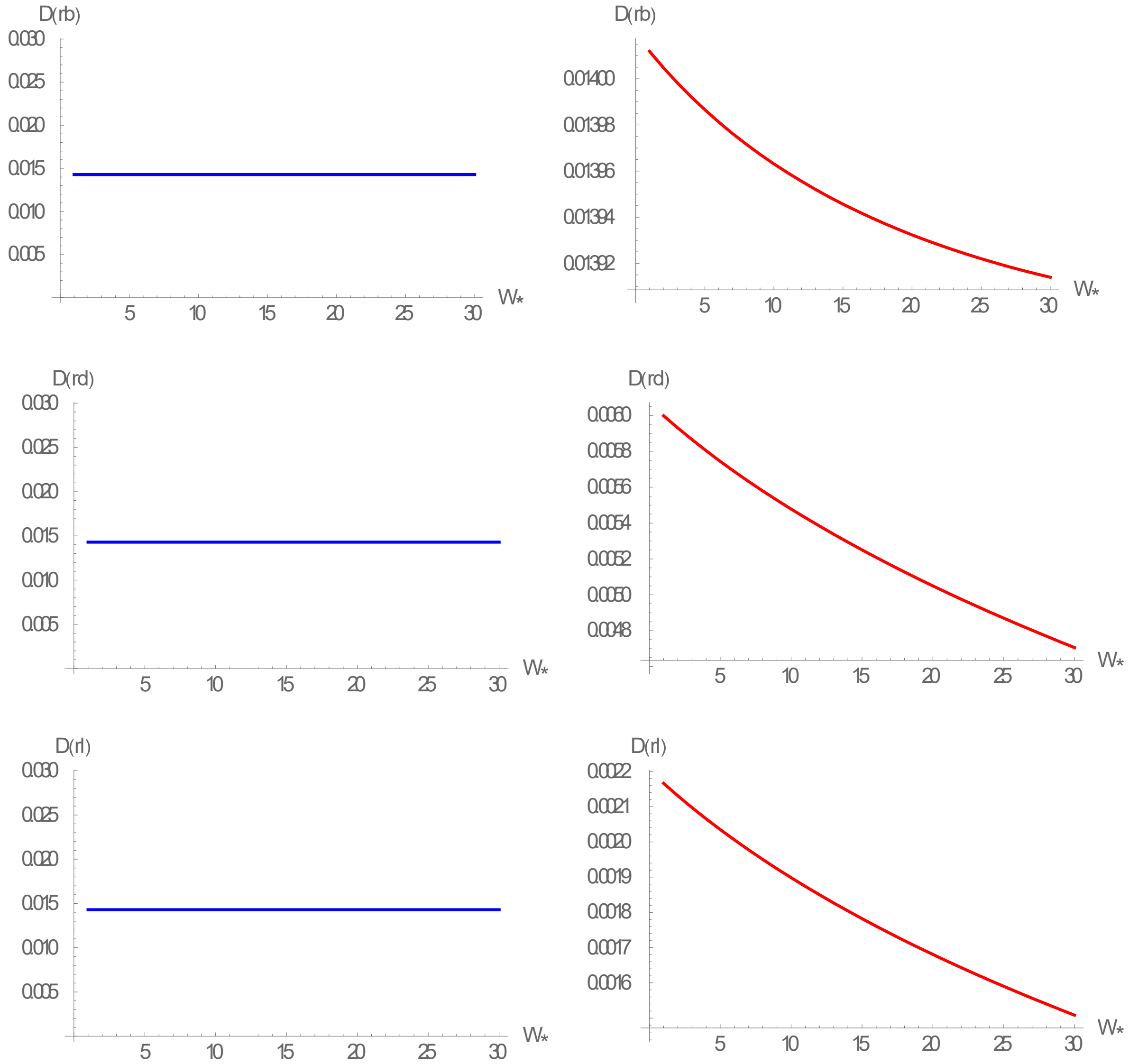
Blue lines: No Portfolio balance effects. Red lines: Portfolio balance effects — Graph A-1.3



Responses of local interest rates to changes in r* as a function of the size of the foreign portfolio, W*

Blue lines: No Portfolio balance effects. Red lines: Portfolio balance effects

Graph A-1.4



Appendix 2

A. Unit root tests (local interest rates – 2005–19)

Interest rate	ADF - Trend and Intercept		ADF - Trend		ADF - None		
	t-Stat	P-Val	t-Stat	P-Val	t-Stat	P-Val	Evidence
Ordinary loans < 1Y	(2.3)	0.4	(1.5)	0.5	(0.8)	0.4	Unit root
Ordinary loans >1Y <3Y	(2.9)	0.2	(2.1)	0.2	(0.9)	0.3	Unit root
Ordinary loans >3Y <5Y	(2.9)	0.2	(2.1)	0.2	(0.9)	0.3	Unit root
Ordinary loans >5Y	(2.7)	0.2	(2.5)	0.1	(0.9)	0.3	Unit root
Ordinary loans	(2.4)	0.4	(1.8)	0.4	(0.8)	0.4	Unit root
Preferential <1 Y	(3.4)	0.1	(2.4)	0.1	(1.0)	0.3	Unit root
Preferential >1Y <3Y	(3.4)	0.1	(2.8)	0.1	(0.9)	0.3	Unit root
Preferential >3Y <5Y	(3.4)	0.1	(2.6)	0.1	(0.8)	0.4	Unit root
Preferential >5Y	(3.1)	0.1	(2.5)	0.1	(0.9)	0.3	Unit root
Preferential	(3.2)	0.1	(2.4)	0.1	(0.9)	0.3	Unit root
Consumption < 1Y	(4.6)	0.0	(4.6)	0.0	(0.4)	0.6	Unit root
Consumption >1Y < 3Y	(3.3)	0.1	(3.2)	0.0	(0.7)	0.4	Unit root
Consumption >3Y < 5Y	(3.4)	0.1	(2.3)	0.2	(0.7)	0.4	Unit root
Consumption >5Y	(3.7)	0.0	(1.7)	0.4	(0.9)	0.3	Unit root
Consumption	(3.3)	0.1	(1.9)	0.3	(0.9)	0.3	Unit root
Total loan rate	(3.0)	0.1	(2.8)	0.1	(0.6)	0.5	Unit root
Mortgage (No VIS) in COP	(3.7)	0.0	(2.2)	0.2	(1.4)	0.1	Unit root
Mortgage (No VIS) in UVR	(2.7)	0.3	(2.3)	0.2	(1.1)	0.3	Unit root
Mortgage (VIS) in UVR	(2.5)	0.3	(1.3)	0.6	(1.0)	0.3	Unit root
Mortgage (VIS) in UVR	(2.3)	0.4	(2.2)	0.2	(0.9)	0.3	Unit root
Mortgages	(2.9)	0.2	(1.8)	0.4	(1.2)	0.2	Unit root
2Y-TES	(2.5)	0.3	(2.0)	0.3	(1.1)	0.3	Unit root
5Y-TES	(3.1)	0.1	(2.4)	0.1	(1.6)	0.1	Unit root
10Y-TES	(3.2)	0.1	(2.7)	0.1	(1.7)	0.1	Unit root

B. Unit root test (external variables – 2005–19)

	ADF - Trend and Intercept		ADF - Trend		ADF - None		
	t-Stat	P-Val	t-Stat	P-Val	t-Stat	P-Val	Evidence
Log of WTI oil price	(3.2)	0.1	(3.0)	0.0	(0.2)	0.6	Unit root
Log of Brent oil price	(2.9)	0.2	(2.7)	0.1	(0.1)	0.7	Unit root
Colombian 5-year CDS	(3.1)	0.1	(2.9)	0.0	(1.2)	0.2	Unit root
Log DXY index	(2.4)	0.4	(1.5)	0.5	0.4	0.8	Unit root
VIX index	(3.3)	0.1	(3.1)	0.0	(1.2)	0.2	Unit root
JP Morgan EM currency volatility index	(3.2)	0.1	(3.0)	0.0	(0.8)	0.4	Unit root
Log of JP Morgan EM currency index	(2.5)	0.3	(0.3)	0.9	(1.1)	0.2	Unit root
S&P 500 index	(1.9)	0.7	(0.1)	0.9	1.4	1.0	Unit root
LIBOR rate	(3.4)	0.0	(3.7)	0.0	(2.5)	0.0	Unit root
FED Funds rate	(3.3)	0.1	(3.2)	0.0	(3.0)	0.0	Unit root
EMBI Colombia	(3.5)	0.0	(3.5)	0.0	(1.5)	0.1	Unit root
US shadow rate	(2.5)	0.3	(2.7)	0.1	(2.7)	0.0	Unit root
1- month US yield	(3.3)	0.1	(3.3)	0.0	(3.0)	0.0	Unit root
3-month US yield	(2.8)	0.2	(2.7)	0.1	(2.5)	0.0	Unit root
6-month US yield	(2.5)	0.3	(2.5)	0.1	(2.4)	0.0	Unit root
1-year US yield	(1.4)	0.9	(1.8)	0.4	(1.7)	0.1	Unit root
2-year US yield	(1.2)	0.9	(2.6)	0.1	(1.4)	0.1	Unit root
3-year US yield	(1.2)	0.9	(1.4)	0.6	(1.4)	0.2	Unit root
5-year US yield	(1.7)	0.7	(1.6)	0.5	(1.3)	0.2	Unit root
10-year US yield	(2.7)	0.3	(1.6)	0.5	(1.2)	0.2	Unit root
US monetary policy shock Jarociński & Karadi	(2.7)	0.2	(2.5)	0.1	(2.2)	0.0	I(0)
US equity shock Jarociński & Karadi	(12.0)	0.0	(11.9)	0.0	(11.9)	0.0	I(0)

C. Sensitivity of local interest rates to external drivers (Wald test)

To assess the sensitivity of local interest rates to external drivers the following equation is estimated:

$$\Delta i_t^j = (1-d)\left(\gamma_0^{j,k,b} + \gamma_1^{j,k,b}\Delta ext_t^k + \sum_{l=1}^{L}\lambda_l^{k,b}\, x_t^k\right) + d\left(\gamma_0^{j,k,a} + \gamma_1^{j,k,a}\Delta ext_t^k + \sum_{l=1}^{L}\lambda_l^{k,a}\, x_t^k\right) + \varepsilon_t^{j,k}$$

Where i_t^j represents the interest rate *j*, ext_t^k is the external variable *k*, and x_t^k are control variables, namely the first difference of the logarithm of CPI, the economic activity index and the one-month IBR monetary policy shock. The dummy variable *d* equals 0 from January 2005 to March 2014 and 1 thereafter. The US monetary policy and the equity shock variables are included in levels since they are stationary. Using this specification, the significance of the selected external variables is evaluated before and after March 2014. The equation was estimated using OLS and HAC standard errors and covariance. From this equation, the null hypothesis is $\gamma_{before}^k = \gamma_{after}^k$ for the variables that were significant for the local TES yields before and after March 2014. The results show that the sensitivity of TES yields to CDS and EMBI between the two subsamples may have increased.

	Δ(CDS)			
	$\Upsilon_{CDS,before}$	$\Upsilon_{CDS,after}$	Wald test (F-stat)	P-value
2-year TES	0.002***	0.005***	5.555	0.020
	[0.0008]	[0.0009]		
5-year TES	0.003423***	0.008***	6.535	0.012
	[0.0016]	[0.0010]		
10-year TES	0.005148***	0.00949***	4.561	0.035
	[0.0017]	[0.0010]		

	Δ(EMBI)			
	$\Upsilon_{EMBI,before}$	$\Upsilon_{EMBI,after}$	Wald test (F-stat)	P-value
2-year TES	0.002***	0.004***	7.056	0.009
	[0.0006]	[0.0007]		
5-year TES	0.003***	0.007***	11.140	0.001
	[0.0009]	[0.0007]		
10-year TES	0.005***	0.008***	6.183	0.014
	[0.0009]	[0.0009]		

	Δ(VIX)			
	$\Upsilon_{VIX,before}$	$\Upsilon_{VIX,after}$	Wald test (F-stat)	P-value
2-year TES	0.0145***	0.012**	0.110	0.740
	[0.0049]	[0.0049]		
5-year TES	0.0271***	0.022***	0.137	0.711
	[0.0093]	[0.007]		
10-year TES	0.035***	0.028***	0.232	0.631
	[0.0115]	[0.0094]		

	Δ(JP Morgan EM currency volatility index)			
	$\Upsilon_{JPVOL,before}$	$\Upsilon_{LPVOL,after}$	Wald test (F-stat)	P-value
2-year TES	0.038*	0.070**	0.663	0.417
	[0.0197]	[0.0347]		
5-year TES	0.080***	0.102***	0.220	0.640
	[0.0263]	[0.039]		
10-year TES	0.116***	0.134***	0.133	0.716
	[0.0283]	[0.0423]		

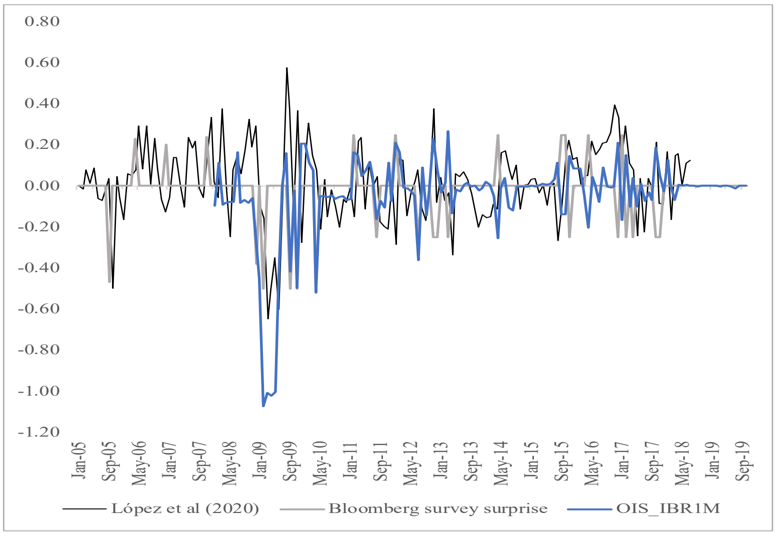
	ΔLOG(JP Morgan EM currency index)			
	$\Upsilon_{JPFX,before}$	$\Upsilon_{JPFX,after}$	Wald test (F-stat)	P-value
2-year TES	-0.017	-0.037**	1.226	0.270
	[0.0111]	[0.0148]		
5-year TES	-0.039**	-0.072***	1.380	0.242
	[0.0195]	[0.0201]		
10-year TES	-0.061***	-0.100***	1.689	0.196
	[0.0205]	[0.0223]		

	ΔLOG(S&P 500)			
	$\Upsilon_{SP,before}$	$\Upsilon_{SP,after}$	Wald test (F-stat)	P-value
2-year TES	-0.688	-1.784**	1.347	0.248
	[0.6121]	[0.7158]		
5-year TES	-1.416	-3.216***	1.257	0.264
	[1.0380]	[1.2217]		
10-year TES	-2.428**	-3.578**	0.395	0.531
	[1.1277]	[1.4382]		

Parameter estimates, [Std. error] and Wald test. HAC standard errors *** Significant at 1% ,** Significant at 5%, * Significant at 10%.

Source: authors' estimates.

D. Monetary policy shocks comparison



Note: López et at (2020) monetary policy shock is computed following Romer and Romer (2004) and is available from January-2005 up to June-2018. The Bloomberg survey surprise is computed as the difference of the policy rate and the survey expectations. The OSI_IBR1M monetary policy shock is computed using the one-month IBR swap rate set before the monetary policy meeting.

Sources: López et al (2020); Bloomberg; authors' estimates.

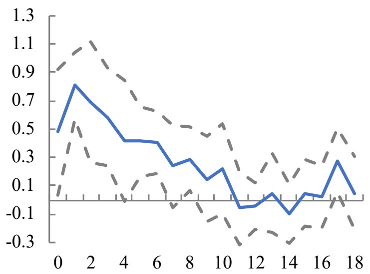
E. Diagnostic statistics for interest rate equations at h=1

The following table shows the diagnostic statistics $\Delta i^j_{t+h} = \mu^j_h + \beta^j_h \psi_t + \sum_{l=1}^{L} \gamma_h^{j,l} x_t^l + \xi_{h,t}$ at *h=1* for the equations used to compute the LP impulse responses exhibited in Graph 12.

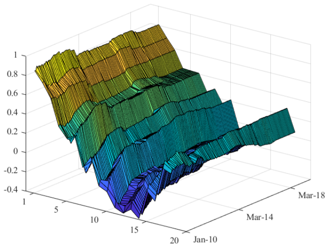
Interest rate equation	Monetary policy shock parameter at h=1	P-value (HAC)	R2	DW-Stat.	LM-test up to 24 lags (P-value)	Jarque-Bera Stat.	Jarque-Bera P-value.	Heteroskedasticity Test: Breusch-Pagan-Godfrey (P-Value, H0 Homoskedasticity)
Ordinary rate	0.73	0.00	0.28	2.20	0.02	2.25	0.32	0.14
Preferential rate	0.86	0.00	0.32	1.63	0.12	5.00	0.08	0.47
Consumption rate	0.42	0.00	0.05	2.28	0.00	51.12	0.00	0.32
Total lending rate	0.81	0.00	0.16	2.72	0.00	9.25	0.01	0.88
Mortgage rate	0.35	0.00	0.23	1.59	0.19	16.98	0.00	0.25
TES 2Y	0.47	0.01	0.15	1.47	0.04	14.95	0.00	0.20
TES 5Y	0.20	0.30	0.03	1.50	0.01	112.69	0.00	0.45
TES 10Y	0.10	0.45	0.01	1.57	0.03	114.57	0.00	0.76

F. Response of interest rates to a monetary policy shock. Local projections and local projections estimated recursively from 10M01 to 19M10

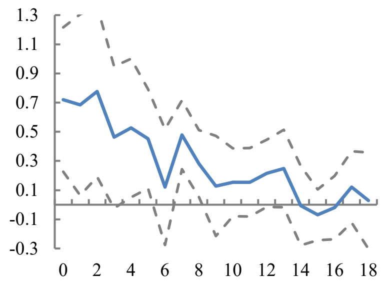
Response of ordinary loans < 1Y full sample



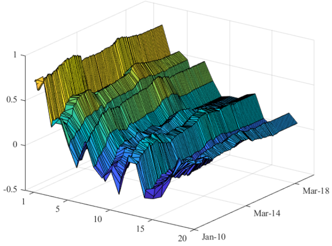
Response of ordinary loans < 1Y - recursive



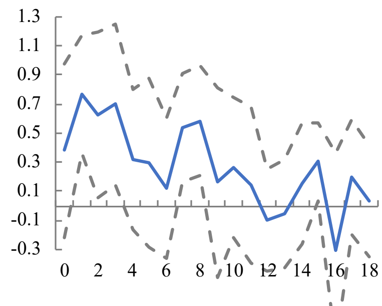
Response of ordinary loans >1Y <3Y full sample



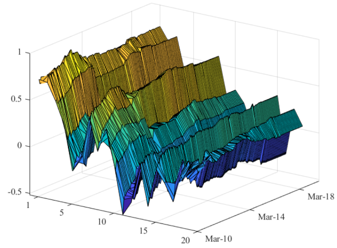
Response of ordinary loans >1Y <3Y – recursive



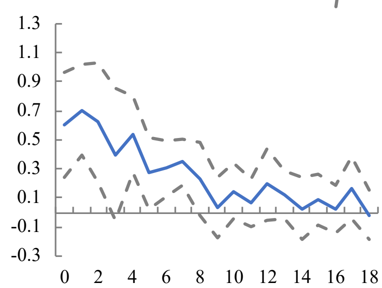
Response of ordinary loans >3Y <5Y full sample



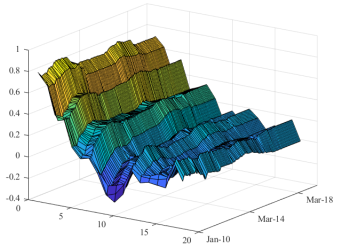
Response of ordinary loans >3Y <5Y - recursive



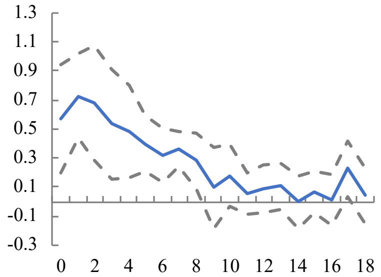
Response of ordinary loans >5Y full sample



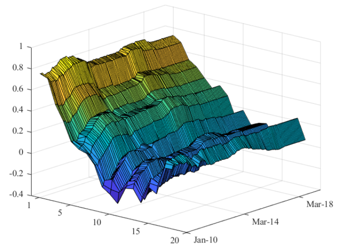
Response of ordinary loans >5Y - recursive



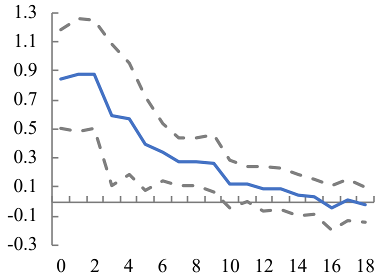
Response of ordinary loans full sample



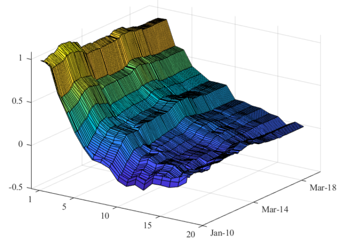
Response of ordinary loans - recursive



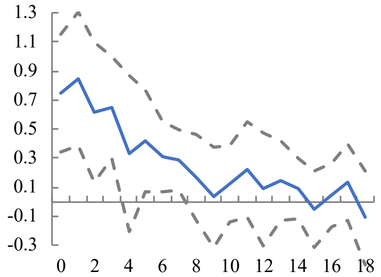
Response of preferential <1 Y full sample



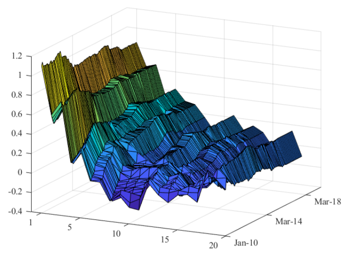
Response of preferential <1 Y - recursive



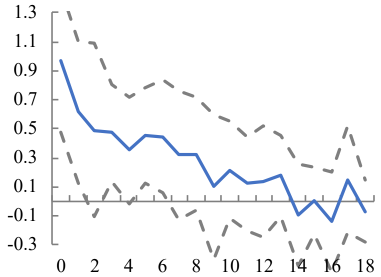
Response of preferential >1Y <3Y full sample



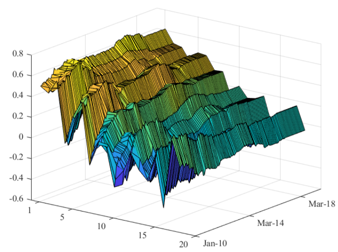
Response of preferential >1Y <3Y - recursive



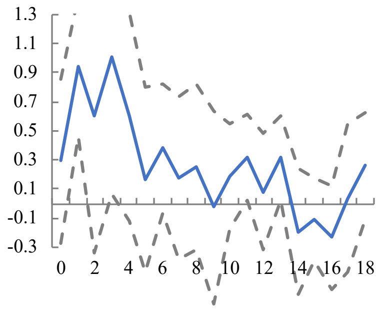
Response of preferential >3Y <5Y full sample



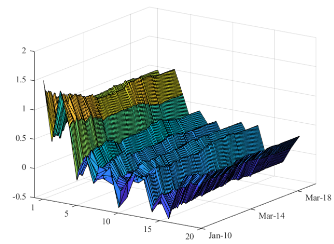
Response of preferential >3Y <5Y - recursive



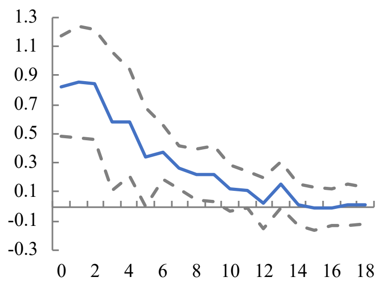
Response of preferential >5Y full sample



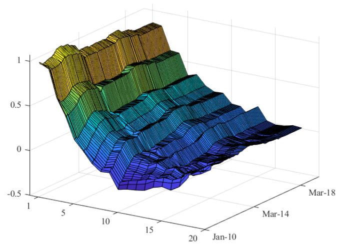
Response of preferential >5Y - recursive



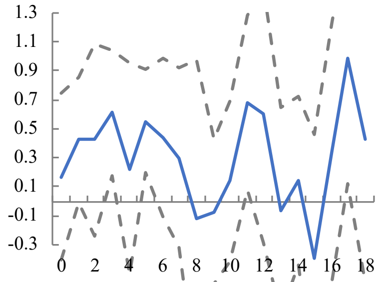
Response of preferential full sample



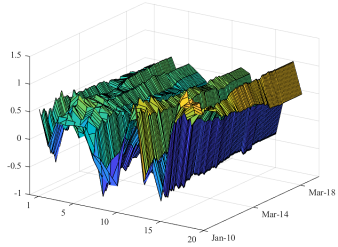
Response of preferential - recursive



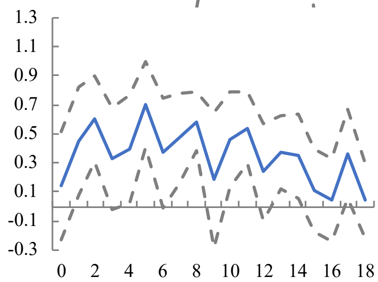
Response of consumption < 1Y full sample



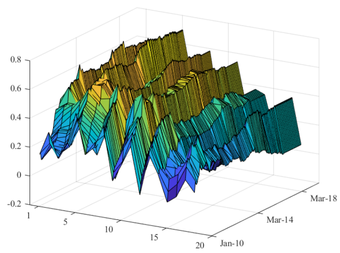
Response of consumption < 1Y – recursive



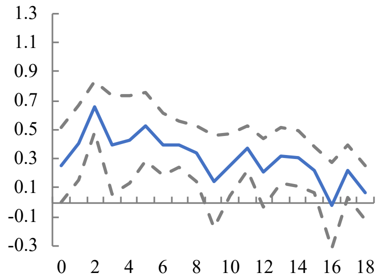
Response of consumption >1Y < 3Y full sample



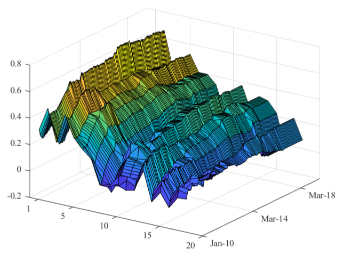
Response of consumption >1Y < 3Y - recursive



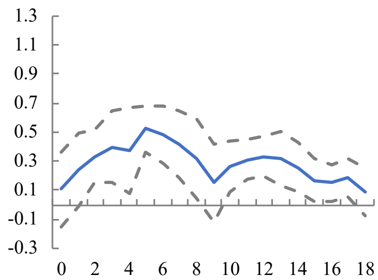
Response of consumption >3Y < 5Y full sample



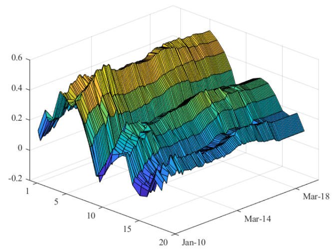
Response of consumption >3Y < 5Y - recursive



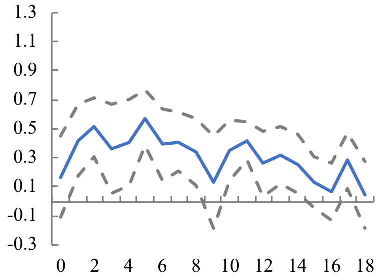
Response of consumption >5Y full sample



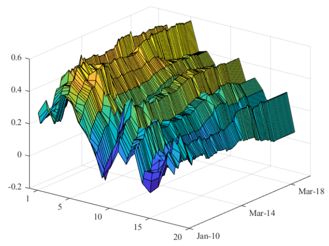
Response of consumption >5Y - recursive



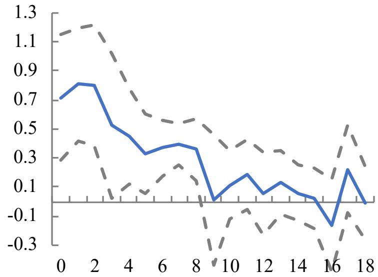
Response of consumption full sample



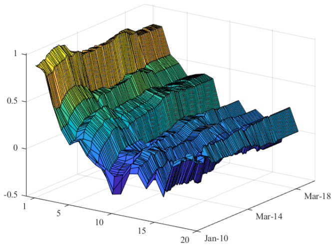
Response of consumption - recursive



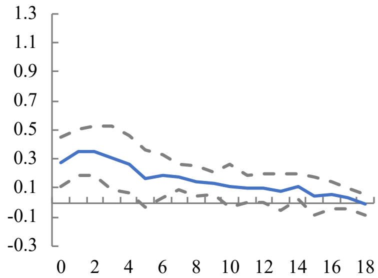
Response of total loan rate full sample



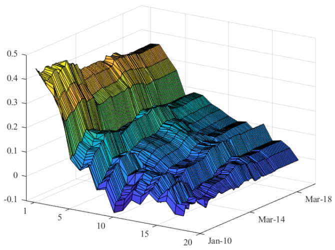
Response of total loan rate - recursive



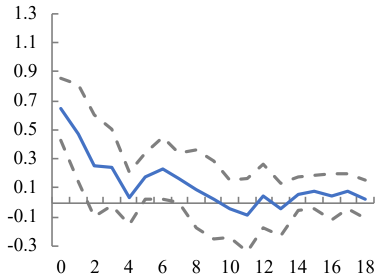
Response of mortgages full sample



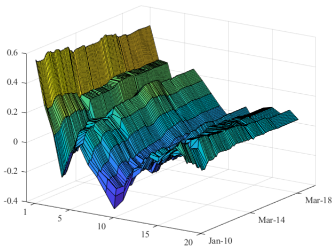
Response of mortgages - recursive



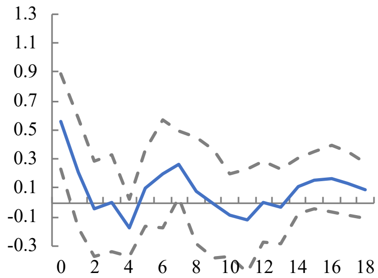
Response of 2Y-TES full sample



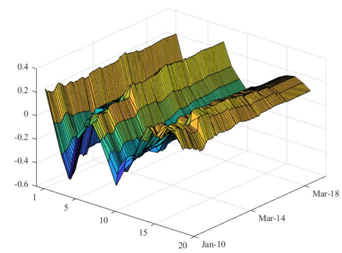
Response of 2Y-TES - recursive



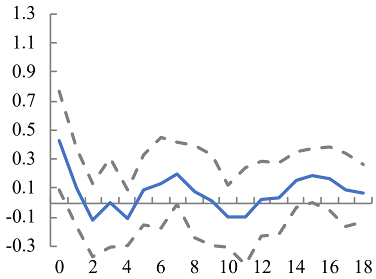
Response of 5Y-TES full sample



Response of 5Y-TES - recursive



Response of 10Y-TES full sample



Response of 10Y-TES - recursive