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Article

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

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ABSTRACT

Since 2014, participation of foreign investors in the Colombian local public bond market has increased substantially. One of the factors that has driven this result is the increased weight of Colombia in JP Morgan's Government Bond Index. Some evidence suggests that the resulting inflows have reduced bond and loan interest rates and raised the loan supply. There is also evidence of an increased sensitivity of local public bond yields to CDS and EMBI given the inflows, 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.

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,¹ 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.

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[#] Economist, Technical Deputy Governor, Chief Officer for Monetary Operations and International Investments, and Director of the International Affairs Unit, respectively. The opinions contained in this document are the sole responsibility of the authors and do not necessarily reflect the opinion Banco de la República (the Central Bank of Colombia) or its Board of Directors. We want to show our sincerest appreciation to Santiago García-Verdú and the anonymous referees at the Latin American Journal of Central Banking for their invaluable comments. We are also grateful to Sebastian García and Juan Pablo Maya for their excellent assistance and contributions, and to Mauricio Villamizar for his comments and suggestions.

¹ Between 2010Q1 and 2019Q2, foreign participation in the local currency government debt market, measured as their share of the outstanding, increased significantly in Peru (17% to 54%), Colombia (4.0% to 26%), Mexico (14% to 30%), Thailand (4.0% to 18%), Russia (2.0% 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.

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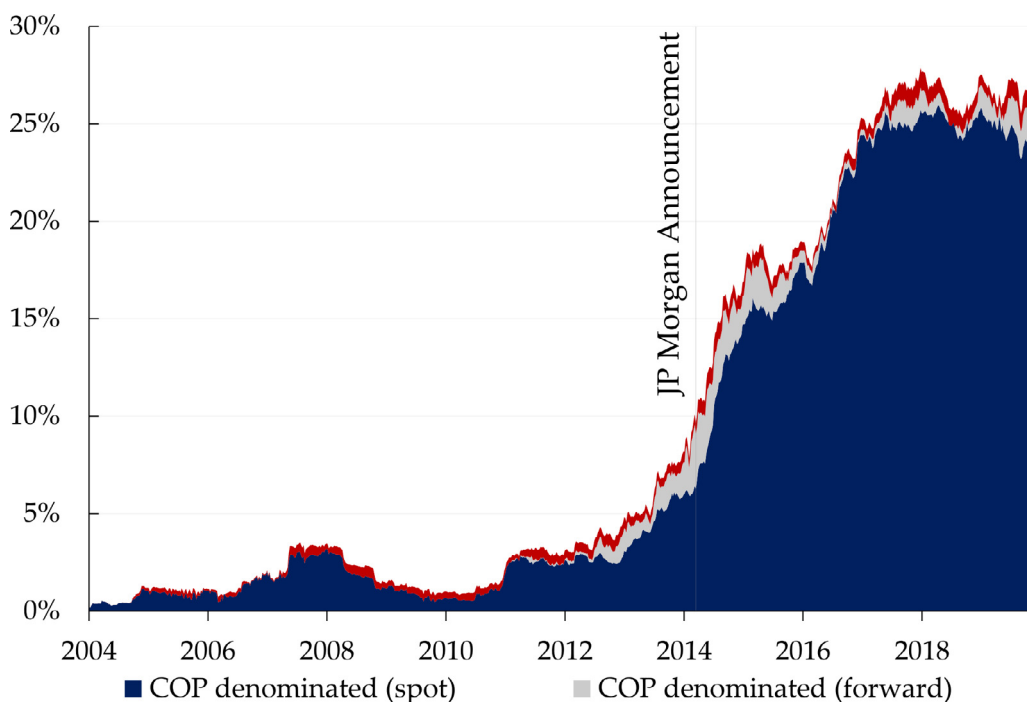


Fig. 1. Offshore investors' stock in local sovereign bonds as a percentage of outstanding. Source: *Banco de la República*.

Colombia is a case in point. Participation of global investors in the local public debt market has significantly risen over the last five years (Fig. 1). The main driver for this increase was the significant positive change in Colombia's weight in the JPMorgan GBI-EM Global Diversified (GBI-EM-GD) index in 2014.^{2, 3, 4}

In this context, our paper adds to the literature on portfolio inflows in EMEs' local currency bonds, and its contribution is twofold. On the one hand, it presents a stylized open economy model in which "portfolio balance channels" in the local banking sector and investment decisions by foreigners are important. Although this model is not formally tested in the empirical section, it allows to explore some of the channels and possible effects of the increase in foreign investors in EMEs' government bond markets. In addition, we explore some stylized facts and empirical evidence regarding the effect of a higher foreign investors flows in local financial conditions in Colombia. Particularly, we look at three questions. First, what is the relationship between the increased foreign participation in the domestic sovereign bond market and local bond and lending interest rates? Second, has the higher participation of foreigners in the local public bond market been associated with changes in 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?

In this context, we present evidence that suggests that the resulting inflows have reduced bond and loan interest rates while rising loan supply. There is also indication of an increased sensitivity of local public bond yields to CDS and EMBI after 2014, although the influence of external financial conditions on domestic lending rates has remained subdued. Finally, we find that the transmission of domestic monetary policy shocks to public bonds and lending interest rates has remained relatively unaltered after the increase in foreign participation in the local bond market.

This article consists of six sections besides the introduction. The second section reviews the literature on portfolio inflows to EMEs' local government bonds and the importance of benchmark-driven portfolio inflows. The third section describes the main stylized facts regarding the increasing participation of offshore investors in the Colombian government debt market. Section four presents the model

² A benchmark that tracks local currency bonds issued by EME governments.

³ Other countries have experienced a similar relationship with inclusion/exclusion in an index. From 1 July 2009 to 1 July 2011, Russia's participation in the GBI-EM-GD index increased from 0.61% to 9.16%. Foreigners' holdings of government bonds increased from 0.4% of the outstanding by 2009Q3 to 5.4% by 2011Q4, representing approximately USD 2.38 billion in non-resident inflows. In May 2020, 14 Israeli local-currency government bonds were included in the FTSE World Government Bond Index, comprising 0.32% of the index. At the same time, foreign participation in sovereign bonds increased from 5.2% in April 2020 to 6.9% in August 2020, representing approximately USD 3.67 billion in non-resident inflows. From April to December 2008, Czech Republic was excluded from the GBI-EM-GD, from a weight of 10%. During this period, foreign participation on local sovereign bonds decreased from 29.7% to 24.3%, representing approximately USD 1 billion of non-resident outflows.

⁴ In 2012, it was reduced from 33% to 14%, and in 2018 to 5.0%.

that helps to understand some of the implications of higher investor participation in the government debt market. The fifth section presents and analyzes the empirical results. The last section summarizes the main findings and discusses some policy implications.

2. Literature review

Since the Global Financial Crisis (GFC), EMEs' local-currency bonds have received a steady increase of foreign flows (Arslanalp and Poghosyan, 2014). Nonetheless, while foreign participation in local-currency sovereign bond markets provides an additional source of financing and reduces sovereign yields, it raises concerns about the increased sensitivity of yields to shifts in market sentiment (Ebeke and Kyobe, 2015) and to external funding shocks (Arslanalp and Poghosyan, 2014). Peiris (2010) estimates the impact of foreign participation in determining long term local currency government bond yields and volatility in a group of EMEs from 2000–2009. Using a panel of 10 EMEs, the author shows that greater foreign participation in the domestic government bond market tends to significantly reduce long-term government 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-GD index. 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 compared with local agents (Ebeke and Kyobe, 2015). Hence, a higher participation of foreign investors in local markets could amplify spillover effects from foreign financial conditions⁵. 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.

One driver that has been affecting the dynamics of portfolio flows into EMEs' local-currency bonds is related with the increasing interest in benchmark indices (such as J.P Morgan's GBI-EM Global Index and Barclays' EM Local Currency Bond Index). An investment is benchmark-driven to the extent that its portfolio allocation across countries is guided by a country's weight in a benchmark index (IMF, 2019; Arslanalp and Tsuda, 2015). Several influential studies have found evidence that investment benchmarks are increasingly shaping portfolio allocation dynamics in EMEs (Arslanalp et al., 2020; Arslanalp and Tsuda, 2015; Raddatz et al., 2017). These studies highlight that the growing role of benchmark-driven investments appears to reflect the confluence of several factors and may be contributing to more synchronized portfolio flows. According to Arslanalp et al. (2020), these factors include: rising assets under management of passive funds, an increasing number of active funds, and a growing number of countries represented in benchmark indices. Together, these factors may have contributed to more correlated portfolio flows to countries included in benchmarks indices, such as Colombia since 2014.

The literature also highlights the role of taxes as an important determinant of the participation of foreigners in local financial markets. Nevertheless, the studies have focused on equity markets, finding evidence that portfolio investment is quite sensitive to tax levels (Amiram and Frank, 2010; Chan et al., 2005; Ammer et al., 2012; Desai and Dharmapala, 2011). Overall, the studies support the hypothesis that favorable tax policies on dividend income increase foreign portfolio investments. To our knowledge, there are no studies that assess the tax treatment for sovereign bond holdings. However, looking at those jurisdictions that have changed the level of tax rates applied to foreigners in the sovereign bond markets and the evolution of the participation of foreigners it is possible to observe that the findings for equities also apply for bonds. Cases such as China, Colombia, Poland, and Thailand experienced tax cuts between 2010 and 2019 and an increase in foreign participation in their local public debt markets. On the other hand, Egypt and Uruguay experienced tax hikes and a reduction in their foreign participation in local public bonds.⁶

3. JP Morgan's change in Colombia's weight in 2014: some stylized facts

In March 2014, JP Morgan announced that Colombia's weight in the GBI-EM-GD index would be increased from 3.9% to 8.0%, by the end of September 2014⁷. Given the estimated size of funds that followed the index in 2014 (USD 218 billion), inflows expected for Colombia were USD 9 billion, which was close to the actual amount received during 2014.⁸ This was also the year with the highest public bond portfolio inflows ever (Fig. 2). This shows that most foreign investors in the Colombian public bond market at that time

⁵ 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.

⁶ Between 2010 and 2019 the withholding tax rate reduction in percentage points were: China (10), Colombia (28), Egypt (-12), Poland (20), Thailand (15), and Uruguay (-25). Meanwhile, the change of foreign participation in local-currency bonds were: China (8.68), Colombia (23.75), Egypt (-0.92), Poland (2.18), Thailand (11.65), and Uruguay (-6.44).

⁷ A stronger participation of foreigners in Colombia's sovereign bonds was accompanied by a smaller participation in other countries of the region. From March to September 2014 (announcement of Colombia's GBI-EME-GD increase until its full implementation), foreigners' participation in the public bond stock changed from 7.8% to 13.7%. During the same time period, foreign holdings of sovereign debt denominated in local currency in the rest of the region decreased from 23.6% to 22.8%. In the same line, with the increase in Colombia's weight in 2014, Chile's and Peru's weight decreased (from 0.13% to 0.11% and from 1.65% to 1.47%, respectively).

⁸ 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, and from 18 March to 31 December 2014 they were \$8.6 billion. Even if the size of the predicted (weight change times the amount of money that follows the index) and observed levels of capital inflows after the inclusion of the GBI-EM-GD index suggest a certain level of causality among these variables, it is not a formal proof of that. Indeed, there were some other variables that could explain the behavior of the capital inflows that we are not testing in the empirical section.

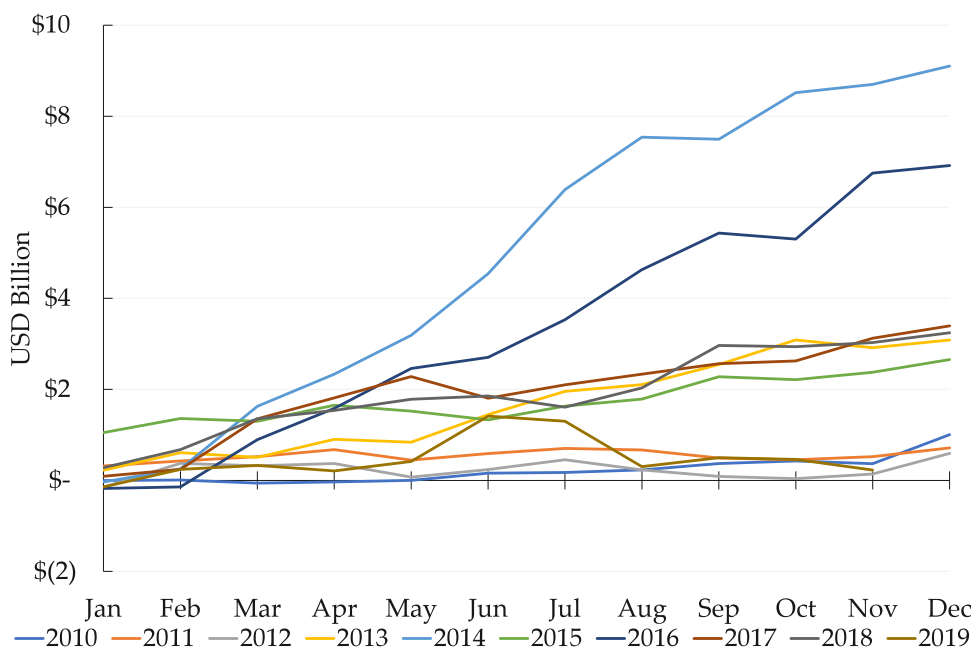
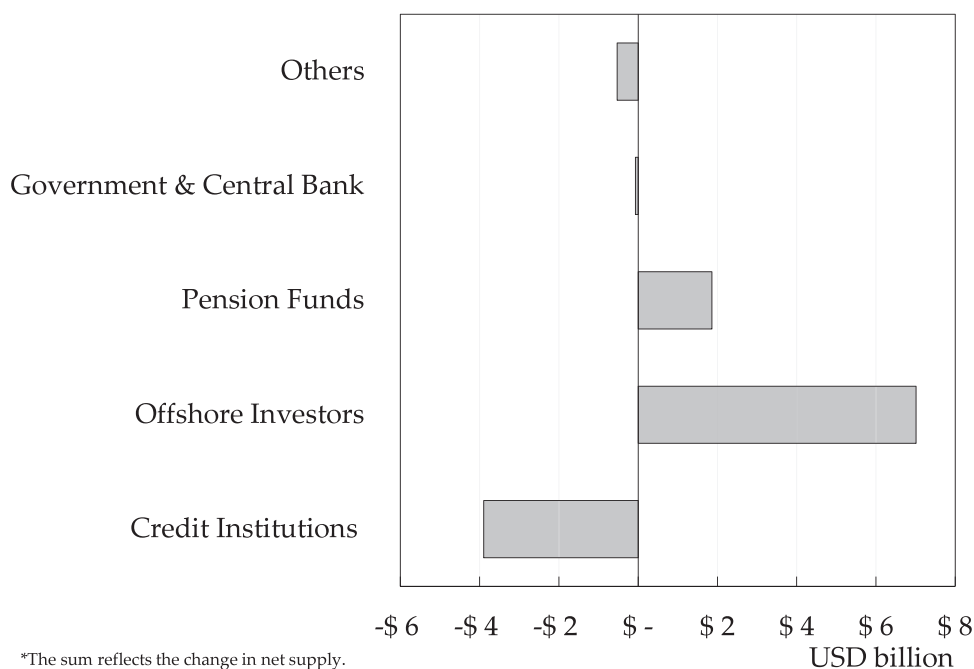


Fig. 2. Non-resident net purchases in sovereign local bonds. Accumulated yearly sum. Sources: *Banco de la República*.



*The sum reflects the change in net supply.

Fig. 3. Net sovereign bond purchases in 2014 by type of investor. Between 18 March (before JP Morgan's announcement) and 1 October (after the 2014 change was in place). Source: *Banco de la República*.

followed the index very closely. This is in line with the relevance of benchmark-driven investors mentioned by [Arslanalp et al. \(2020\)](#). Central Bank's estimates suggest that 80% of the investors with a significant presence in Colombia use this index as a benchmark.⁹

Foreign investors bought Colombian sovereign bonds in local currency (TES) from banks (Fig. 3). The reduction of TES in the hands of banks increased their liquidity and translated into an increased credit supply (Fig. 4). From March to December 2014, the

⁹ Based on communications with the main investors.

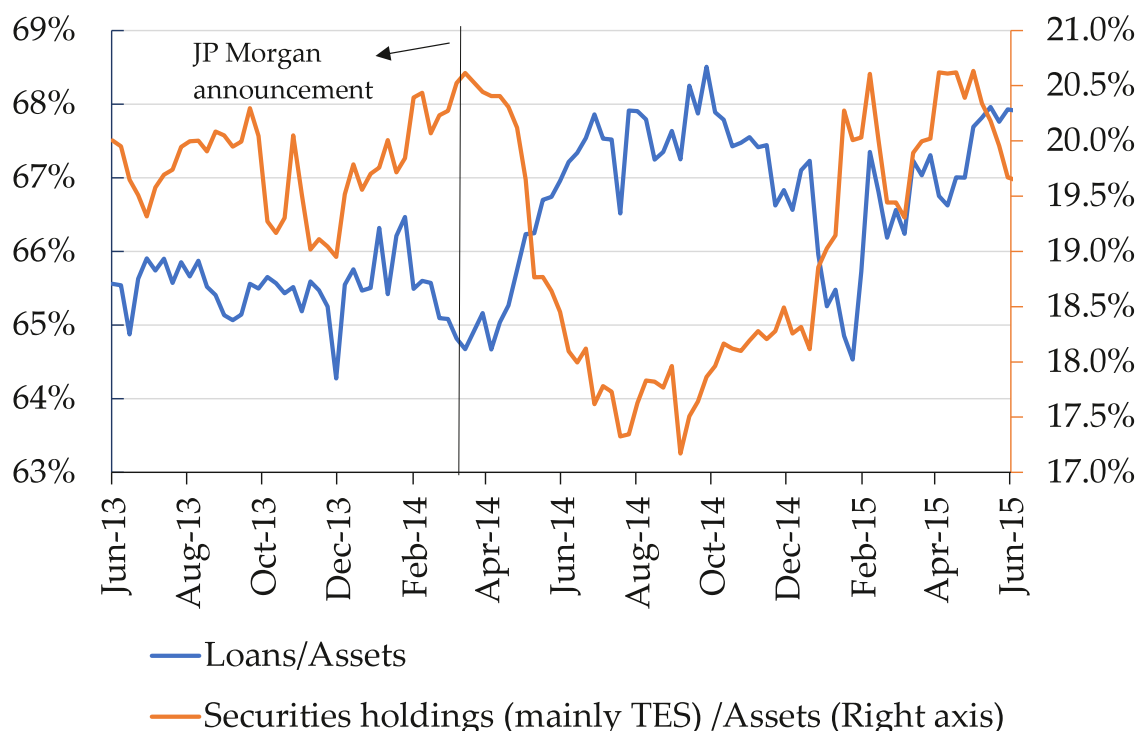


Fig. 4. Credit Establishments' Assets. Source: Banco de la República.

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's policy interest rate also fell (Fig. 5).

Countries' weight in JP Morgan's GBI-EM-GD index corresponds mainly to local bonds' capitalization and to market access to foreign investors. Although we did not evaluate empirically the exogeneity of this change, according to JP Morgan, Colombia's increase in 2014 did not respond to any specific event that occurred in the Colombian economy; rather, it was a consequence of the country's relative macroeconomic stability of the country and of tax and long-standing regulatory policies (JP Morgan, 2014).¹⁰ Additionally, JP Morgan is subject to a regulatory scheme that obliges it to maintain this decision processes in complete confidentiality, for which it is reasonable to assume that the decision was completely unexpected (López et al., 2020).

Although Colombia's weight in the JP Morgan index has experienced changes since 2015, foreigners' holdings of TES have continued to increase in the last couple of years (Fig. 6). This has occurred because some investors in Colombia have not followed the JP Morgan index and because the funds that use the index have grown. 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, once more, probably because the size of the funds that followed the index increased as the country's weight went down.¹¹

The type of foreign investor in the local public debt market (Fig. 7) has also changed in recent years. In 2012, foreign 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.

4. Effects of foreign investors on local financial conditions

As illustrated, the increased participation of foreign investors in the local bond market may be associated with significant changes in local financial conditions. However, foreign participation is itself an endogenous variable, depending on several domestic and external factors. Hence, understanding its relationship with domestic financial conditions requires an exploration of its determinants and their possible effects on local financial conditions. For this purpose, a simple two-period model of a small open economy is developed in which "portfolio balance channels" in the local banking sector and foreigners' investment decisions are important¹².

¹⁰ In December 2012 the tax regulation for foreign portfolio became clearer, and in December 2013 the tax rate was reduced from 33% to 14%.

¹¹ 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 (Fig. 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.

¹² The rationale behind this feature will become apparent below.

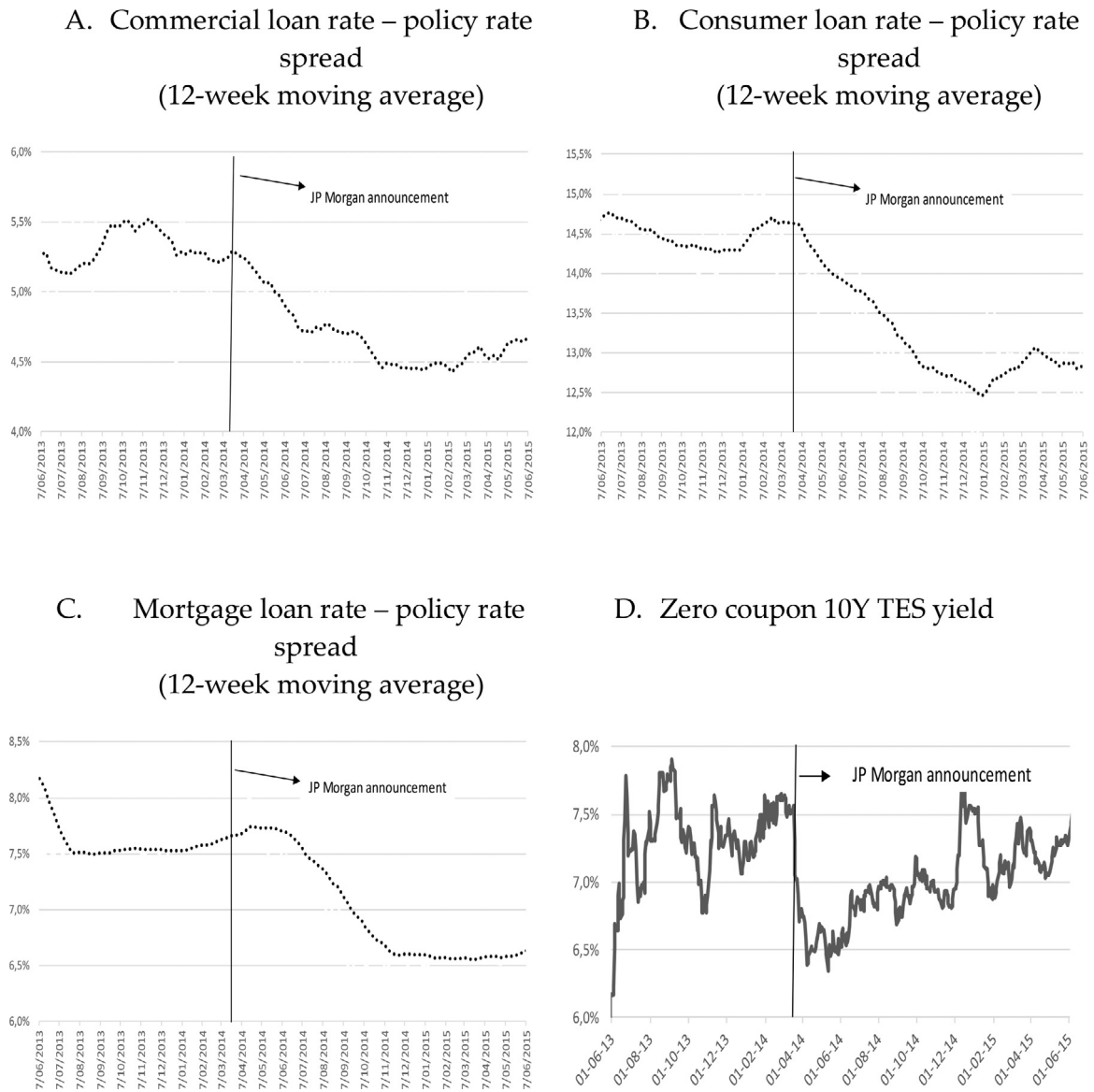


Fig. 5. Selected interest rates before and after the JP Morgan announcement. Source: Banco de la República.

The model is used to address the first two questions posed in the introduction, namely: (i) What is the relationship between the increased foreign participation in the domestic sovereign bond market and local bond and lending interest rates? and (ii) Has the higher participation of foreigners in the local public bond market been associated with changes in the transmission of external financial conditions into the Colombian economy? The third question, pertaining to changes in the transmission of monetary policy cannot be explored with this real model without nominal rigidities.

Given that the increase in foreigners' participation in Colombia's public bonds has been driven both by reductions (and simplification) of taxes on foreign portfolio earnings and increases in the size of foreign portfolios in which the local bonds are included, the model is used to study the impact of these factors on both foreign participation in local bond markets and domestic financial conditions.

The model

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 (y_1^i and y_2^i) in both periods and pay lump sum taxes (T_1 and T_2) 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 and borrowing decisions.

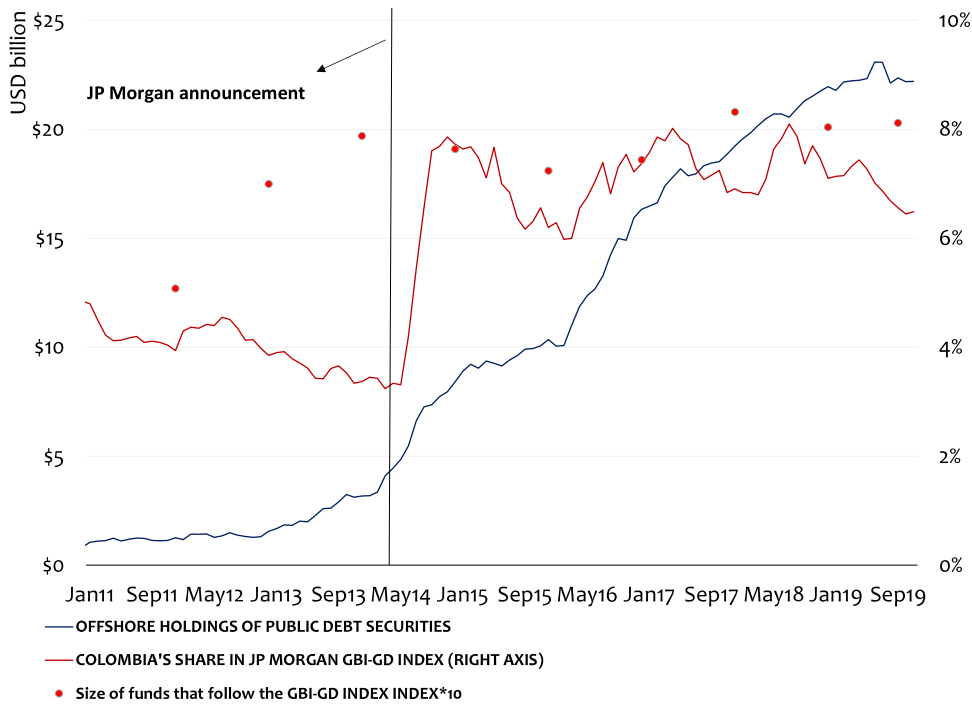


Fig. 6. Colombia's weight in the GBI-GD and foreign participation in the local sovereign bond market. Source: Banco de la República; JP Morgan.

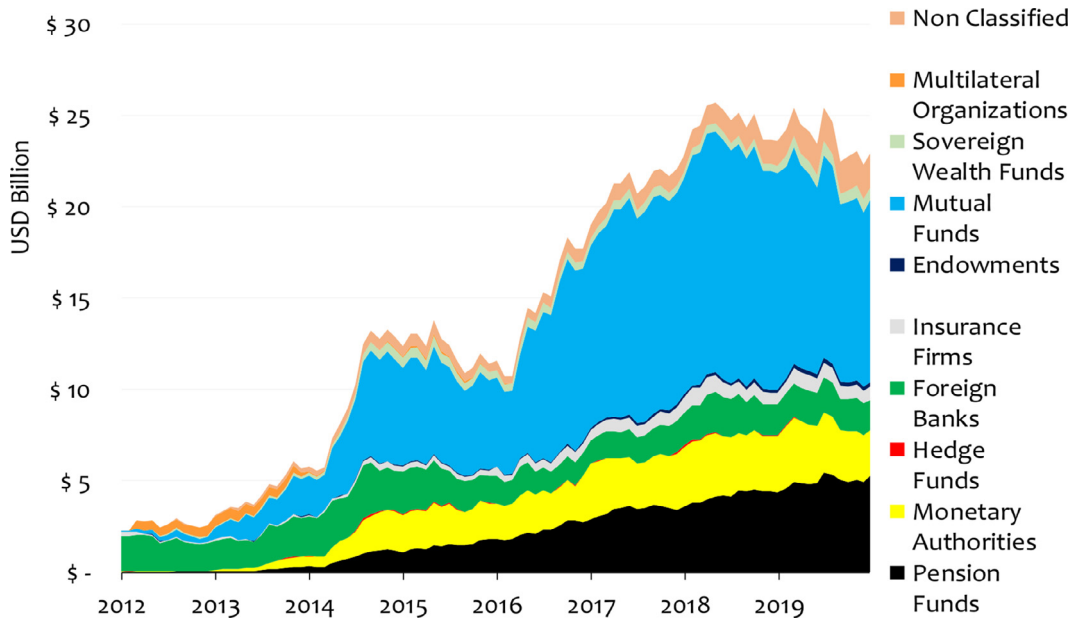


Fig. 7. Foreign investors holdings of local sovereign bonds by investor type. Source: Banco de la República.

The households' problem is the following:

$$\begin{aligned}
 & \max_{c_1^j, c_2^j} u(c_1^j) + \beta^j u(c_2^j) \\
 & s.t. \quad c_1^j + (1+r_k)^{-1} c_2^j = (y_1^j - T_1) + (1+r_k)^{-1} (y_2^j - T_2) \\
 & \text{with } r_k = r_d \text{ if } j = p, \text{ and } r_k = r_l \text{ if } j = i
 \end{aligned}$$

where $u(c)$ is assumed to be a CRRA utility function. The solution to this problem (first order conditions) 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, $\{c_1^p, c_2^p\}$ and $\{c_1^i, c_2^i\}$, are derived from the Euler equation and the inter-temporal budget constraint for each household. Since patient households' savings are only deposited in the local bank and impatient households can only borrow from it, demand for bank deposits, D , and loans, L , are given by:

$$D = (y_1^p - T_1) - c_1^p \quad (1)$$

$$L = c_1^i - (y_1^i - T_1) \quad (2)$$

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 bank's problem is as follows:

$$\begin{aligned} \max_{L, B_b, D} \quad & r_l L + r_b B_b - r_d D - C^B(D, B_b, L) \\ \text{s.t.} \quad & L + B_b = D \end{aligned}$$

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

$$C^B(D, B_b, L) = \theta_d D + \theta_b B_b + \theta_l L - 2\lambda (B_b L)^{1/2} \quad (3)$$

The first order conditions for the bank's optimization problem imply:

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

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

Eqs. (4) and (5) imply:

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

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 is 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:

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

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

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

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

$$(1-t)r_b = r^* + \phi_x - \phi^* + \phi \left((B_x/(W^* - B_x))^{1/2} - ((W^* - B_x)/B_x)^{1/2} \right) \quad (7)$$

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 public expenditures in the second period are adjusted so that the government fulfils its inter-temporal budget constraint. The period-government budget constraints are as follows:

$$G_1 - 2T_1 = B_b + B_x \quad (8)$$

$$2T_2 + r_b B_x t = G_2 + (1 + r_b)(B_b + B_x) \quad (9)$$

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 government's foreign funding must also finance the economy's trade deficit:

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

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 W^* , t and r^* on the domestic economy. When “portfolio balance effects” are ignored (ϕ and $\lambda = 0$), the solution to 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. In this case, the size of the foreign portfolio, W^* , does not have any influence on domestic interest rates or financial conditions. To allow for such an impact, imperfect substitution must be introduced via “portfolio balance effects”. When these 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 model’s main results,¹³ which are presented below:

Result 1: Increases in the size of the foreign portfolio, W^* , which might occur in a context of ampler global liquidity or greater appetite for emerging market risk, reduce, ceteris paribus, local interest rates and raise foreign participation in the domestic bond market (Fig. 1). When “portfolio balance effects” are important, an increase in W^* implies 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 (Eq. (7)). The domestic bond rate reflects the opportunity cost of funds for the bank and determines the deposit and loan interest rates. Thus, the fall in local bond interest rates cuts the opportunity cost of funds for banks and pushes down deposit and loan interest rates as well (Eqs. (4) through (6), Fig. 1). Also, given a supply of government bonds, foreign participation in the domestic bond market rises, since a fraction of the enlarged foreign portfolio is invested in local bonds (Fig. 8). This implies that the bank sells part of its bonds to the foreign investors and, thereby, loans increase, and deposits drop (Fig. 8). Domestic consumption rises as a result of lower equilibrium interest rates. Overall, then, an expansion in the size of the foreign portfolio in which local bonds are included produces both an increase in foreign participation in the domestic bond market and a relaxation of local financial conditions.

Result 2: As expected, decreases in the tax rate on the proceeds from foreign portfolio investment reduce local interest rates and raise foreign participation in the domestic bond market (Fig. 9). As in the foregoing case, the reduction in taxes increases loans, reduces deposits (Fig. 9), and pushes up consumption. However, “portfolio balance effects” partially offset the impact on interest rates. 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 (Eq. (7)). In turn, as bonds fall in the bank’s portfolio, the composition of the bank’s assets tilts more toward loans and this pushes loan interest rates up, partially offsetting the downward effect of the fall of bond interest rates (Eq. (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 (Eq. (5)).

Result 3: the lower the participation of foreign investors in the local bond market, the greater the response of domestic interest rates to an increase in external interest rates. This result holds whether a low foreign participation in the domestic bond market is explained by a small size of the foreign portfolio or by high taxes on the proceeds of foreign portfolio investment. An increase in the external interest rate, r^* , induces a reduction in foreign holdings of local bonds and requires an upward response of the local bond rate to balance the returns on foreign and local bonds. This results in a lower share of the latter in the foreign portfolio, thus reducing their premium and partially offsetting the direct impact of the increase in r^* (Eq. (7)). When the size of the foreign portfolio, W^* , is large, these offsetting “portfolio balance effects” are greater because the local bonds are relatively scarcer and more valuable to foreigners. Similarly, for greater foreign portfolios, the weight of local bonds in the bank’s asset portfolio is smaller and, therefore, the absorption of the bonds shed by foreign investors requires a smaller increase in the premium on loans. Hence, when foreign participation in the local bond market is large due to the large size of the foreign portfolio, the response of local interest rates to shifts in external interest rates is more subdued (Fig. 10). Accordingly, the impact of the latter on domestic loans, deposits and consumption is more subdued as well.

When taxes on the returns on foreign portfolio investment are higher, foreign participation in the local bond market is lower (as shown above) and the transmission of shifts to the external interest rate is stronger. This result reflects the fact that for larger values of t in Eq. (7), a given hike of r^* requires greater responses of r_b to balance the net returns on foreign and domestic bonds. Consequently, the impact of an increase in the external interest rate on lending and deposit rates as well as on loans, deposits, and consumption is also stronger for higher tax rates (Fig. 11).

As shown below, the evidence from Colombia supports the relationship between domestic financial conditions and increased foreign participation in the domestic bond market derived from Results 1 and 2 as obtained from the model. By contrast, the implications of Result 3 are not verified by the data.

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.¹⁴ For instance, Takáts and Vela (2014) suggest that market sentiment could work as a transmission mechanism. As the 2013 *taper tantrum* episode has shown,

¹³ These simulations assumed the following values for the parameters and the exogenous variables: inter-temporal elasticity of substitution in the CRRA utility function = 1, $\beta^p = 0.98$, $\beta^i = 0.91$, $\theta_d = 0.005$, $\theta_b = 0.001$, $\theta_l = 0.015$, $\lambda = 0.02$, $\phi_x = 0.005$, $\phi^* = 0.001$, $\phi = 0.001$, $y_1^p = 50$, $y_1^i = 50$, $y_2^p = 50$, $T_1 = 7.5$, $T_2 = 7.5$, $G_1 = 18$, $t = 0.3$, $r^* = 0.03$ and $W^* = 200$.

¹⁴ 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.

Effects of changes in W^* on the domestic economy¹⁵

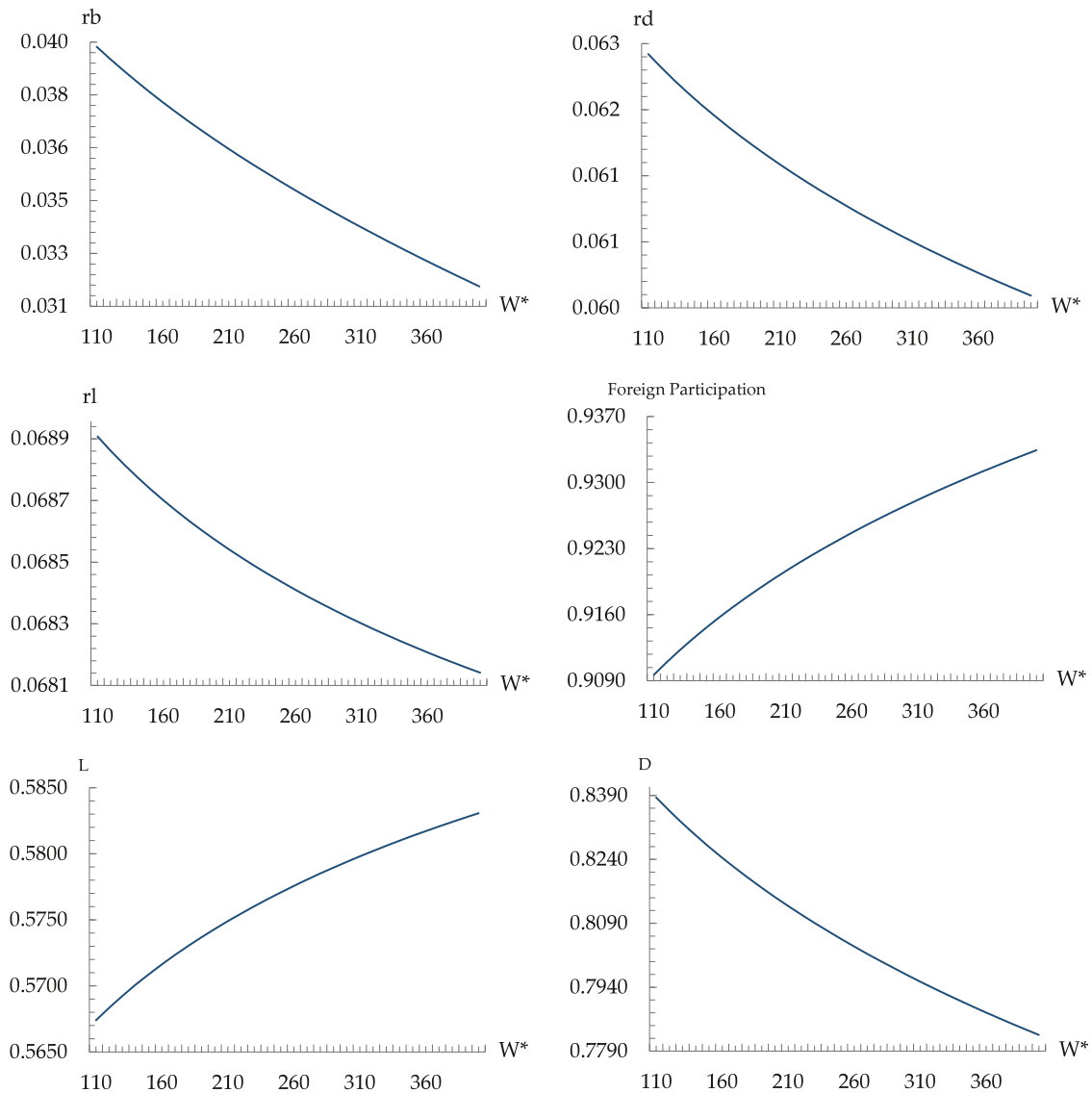


Fig. 8. Effects of changes in W^* on the domestic economy²⁷. Source: Authors' estimates.

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 unclear if the presence of foreign investors amplifies this transmission channel (Correa et al. (2018); Albrizio et al. (2019))¹⁵.

5. Empirical evidence of the effects of foreign participation in the TES market

This section presents some empirical evidence regarding the possible effects of a higher foreign participation in the TES market. Even if we used some of the theoretical predictions of the presented model to motivate the empirical exercises, this section cannot be seen as the complete empirical validation of the model itself. As we pointed out, the main purpose of the model consists in

¹⁵ 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.

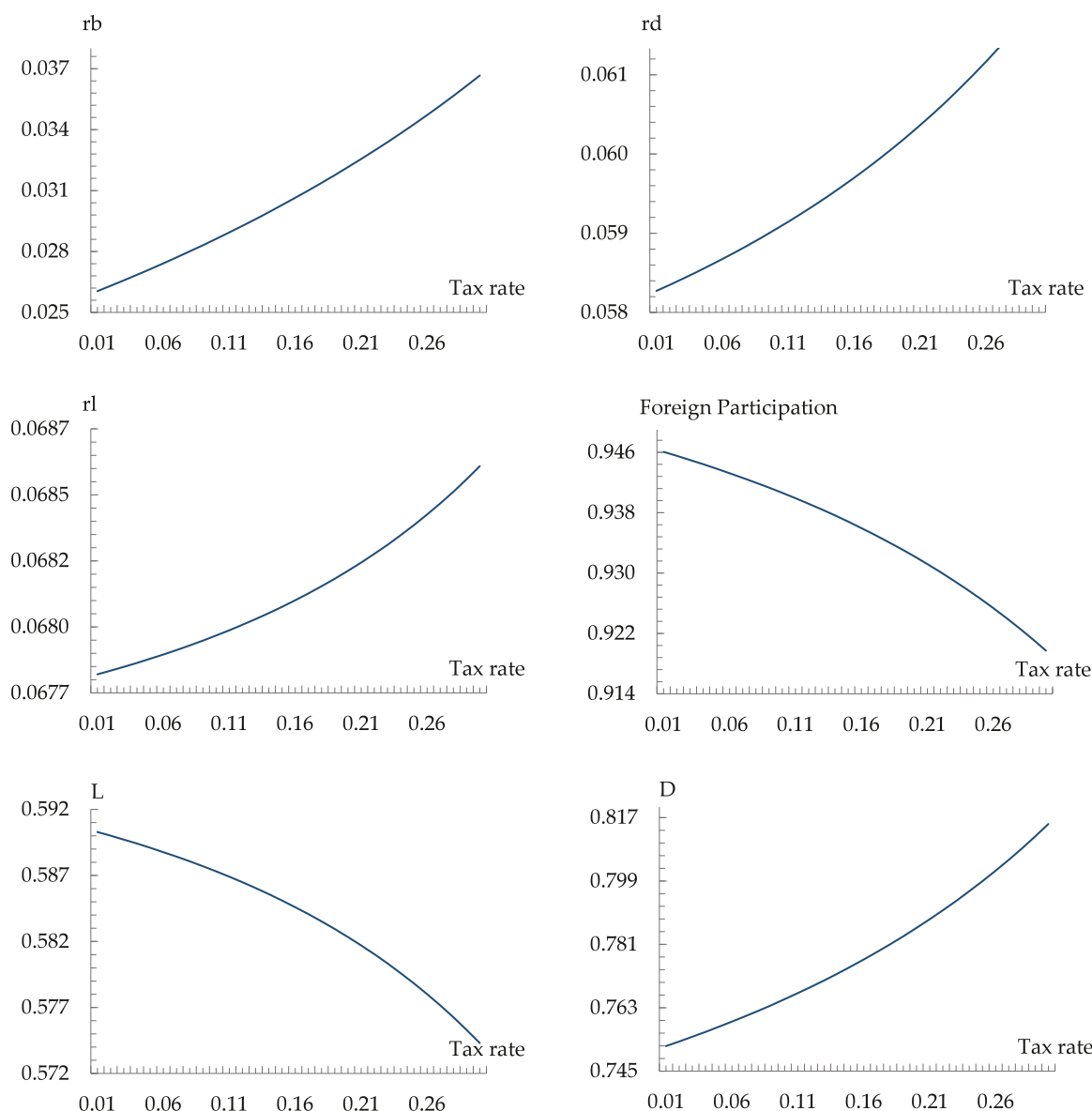


Fig. 9. Effects of changes in t on the domestic economy²⁸. Source: Authors' estimates.

understanding some of the channels through which a higher participation of foreign investors can affect local financial conditions. In this context we assess three questions. First, what is the relationship between the increased foreign participation in the domestic sovereign bond market and local bond and lending interest rates? Second, has the higher participation of foreigners in the local public bond market been associated with changes in 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?

5.1. 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 the banks' liquidity and credit supply that influenced corporate real and financial variables.

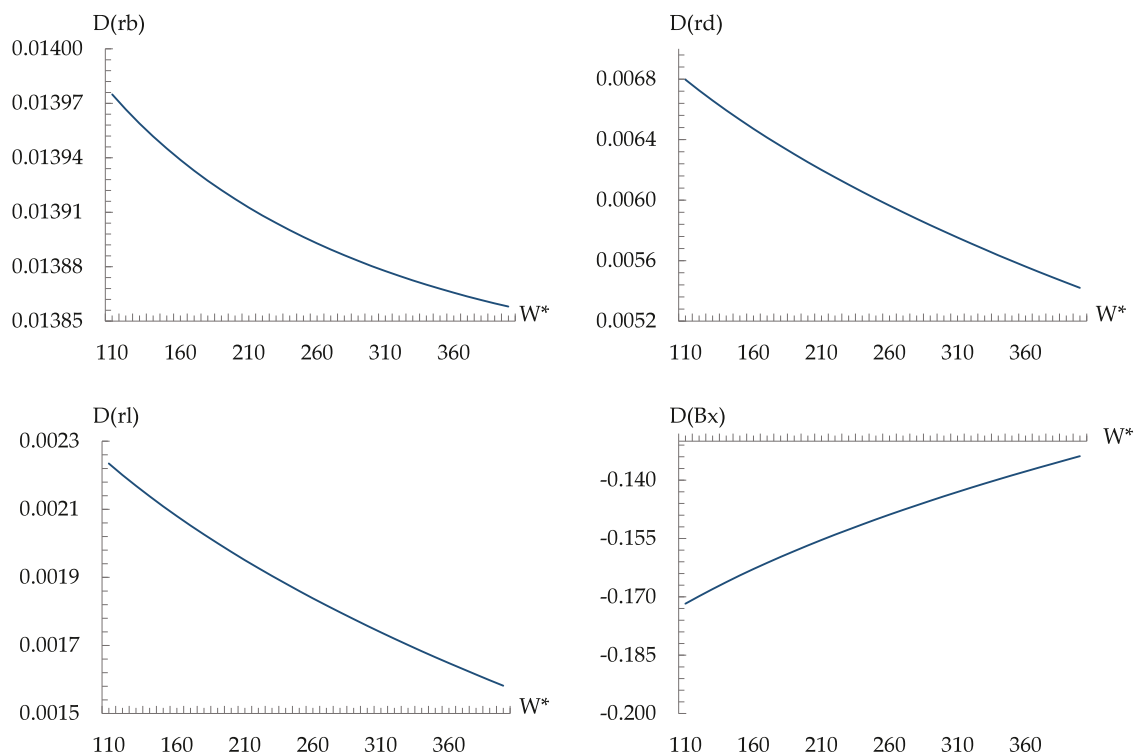


Fig. 10. Effects of changes in r^* as a function of the size of the foreign portfolio (W^*)²⁹. Source: Authors' estimates.

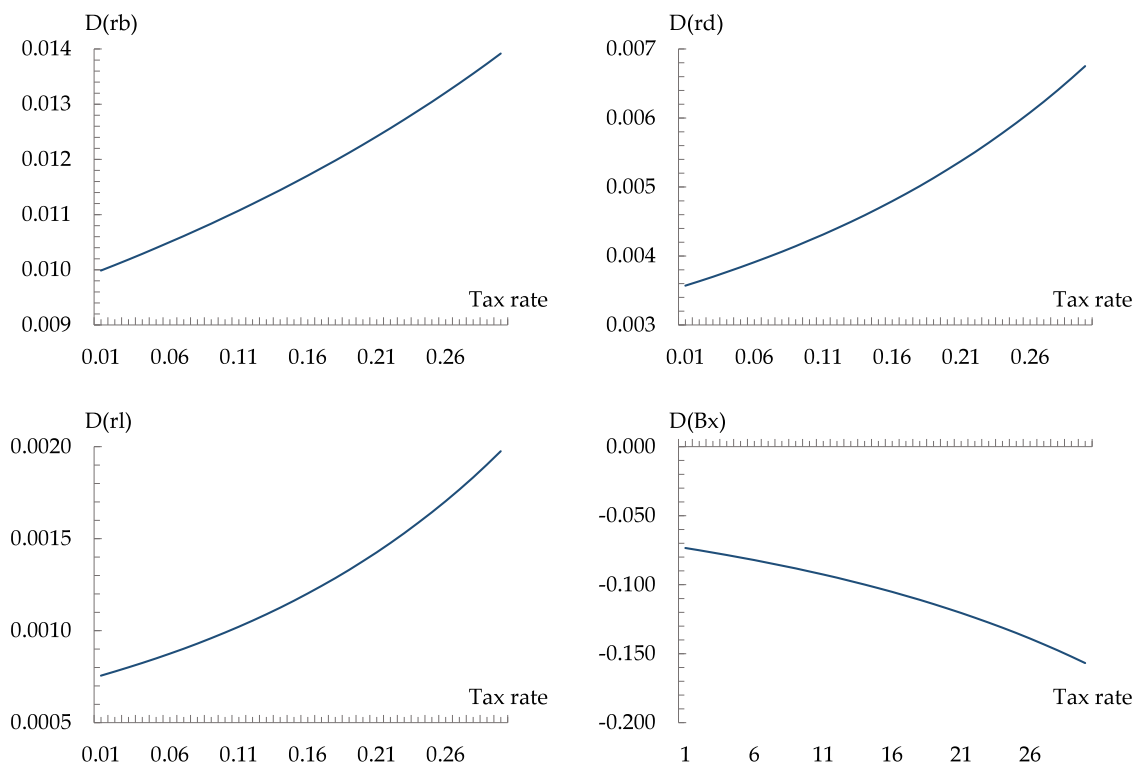


Fig. 11. Effects of changes in r^* as a function of the tax rate on foreign investment returns (t)³⁰. Source: Authors' estimates.

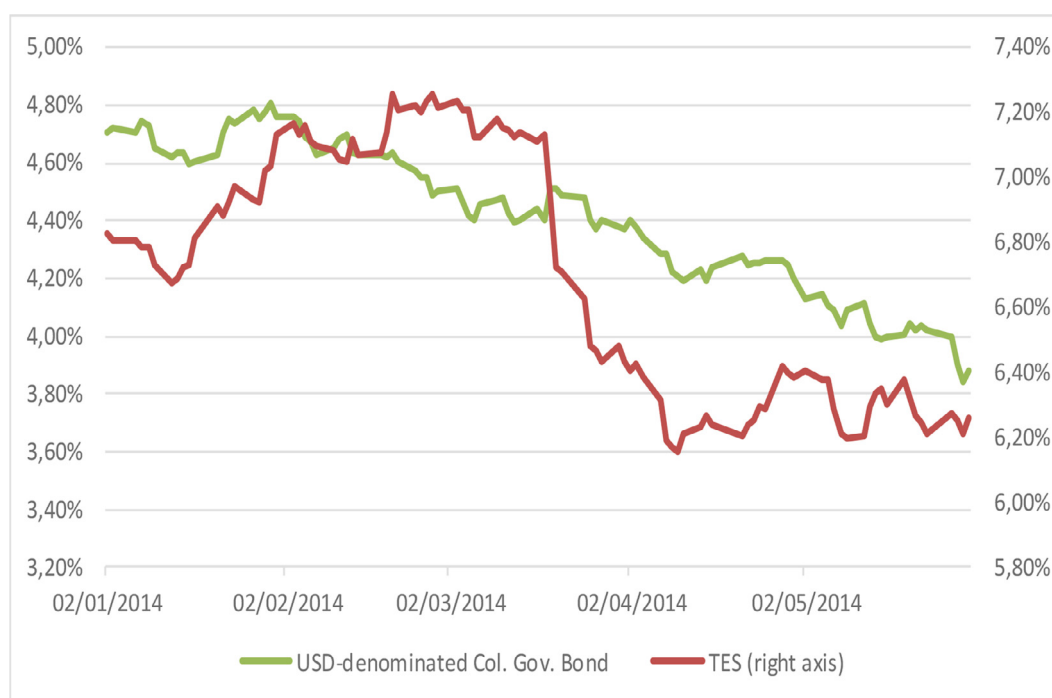


Fig. 12. 10-Year TES and USD-denominated Colombian government bond yields. Source: Banco de la República.

This is in accordance with the results of the model presented, 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 produces 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 (Fig. 12), suggesting that “portfolio balance channels” may be relevant.¹⁶

The 2014 JP Morgan rebalancing allows analyzing the effects of a higher foreign participation on local interest rates in Colombia, as it caused an exogenous inflow of foreign investors into the local sovereign bond market (given the high participation of benchmark-driven investors following the index). 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 (Fig. 13).¹⁷ 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 (Fig. 14).

Between February and June 2014, the banks’ liquidity increased after foreign investors purchased a significant portion of banks’ TES holdings. As a result, the banks’ 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 TES to foreign investors, increased the loan supply and induced higher levels of sales, output, GDP and employment in industries that were more exposed to them.

¹⁶ 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.

¹⁷ 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.

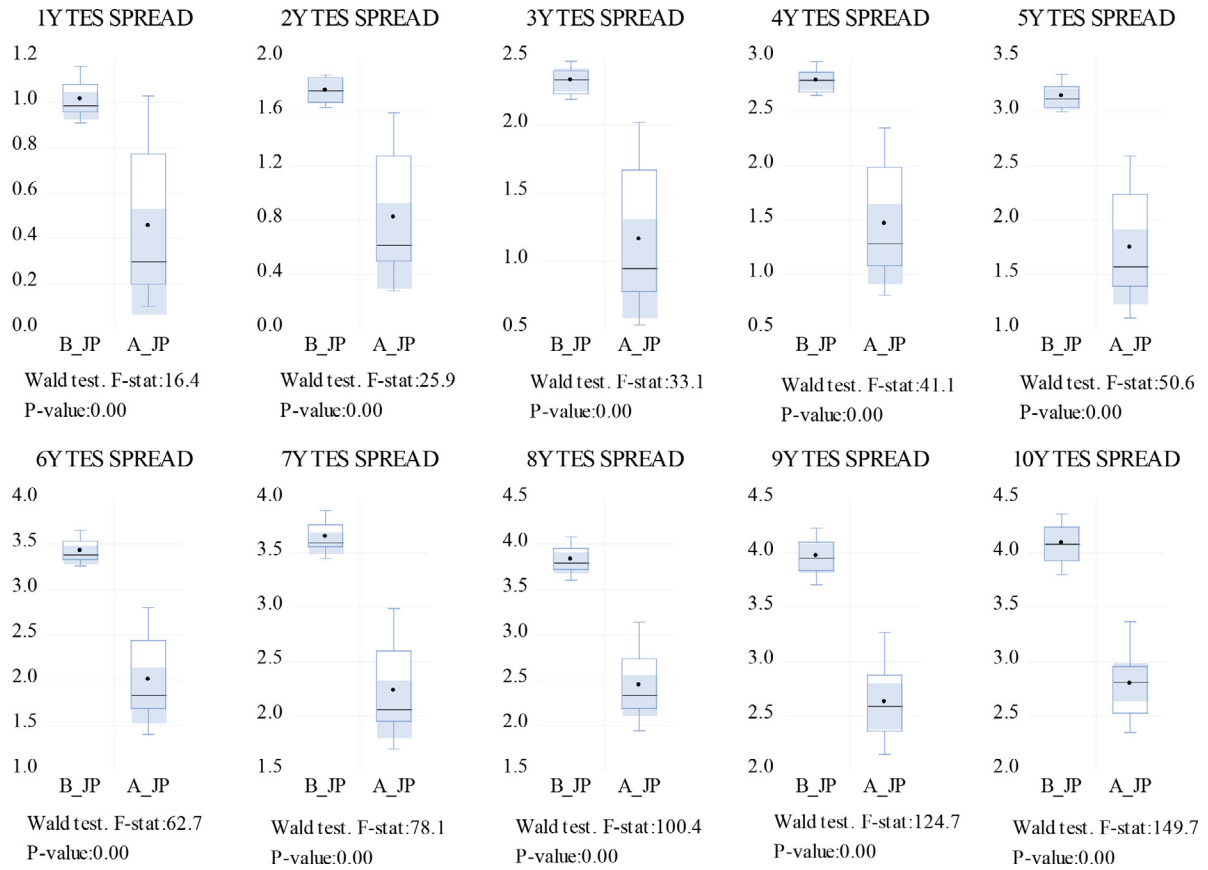


Fig. 13. TES-policy rate spread before and after the JP Morgan announcement (2013–15). Source: *Banco de la República* and authors' estimates. Note: Wald test (F-statistic and probability) is used to test the difference between the subsamples (H0: the spread is the same in both periods). B_JP: before 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. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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

According to the model presented above, 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. As shown above, the same result holds when an enlarged participation of foreign investors in the local bond market stems from a larger size of the foreign portfolio. 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. Particularly, passive investment strategies could increase local markets' sensitivity to global factors, as investors benchmarked to financial indices focus less on country-specific developments (IMF (2019)). Fig. 15 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.

To further explore the sensitivity of local interest rates to external drivers we estimate the following equation:

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

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 the CPI, the economic activity index, and an estimate of the local monetary policy shock. The dummy variable d

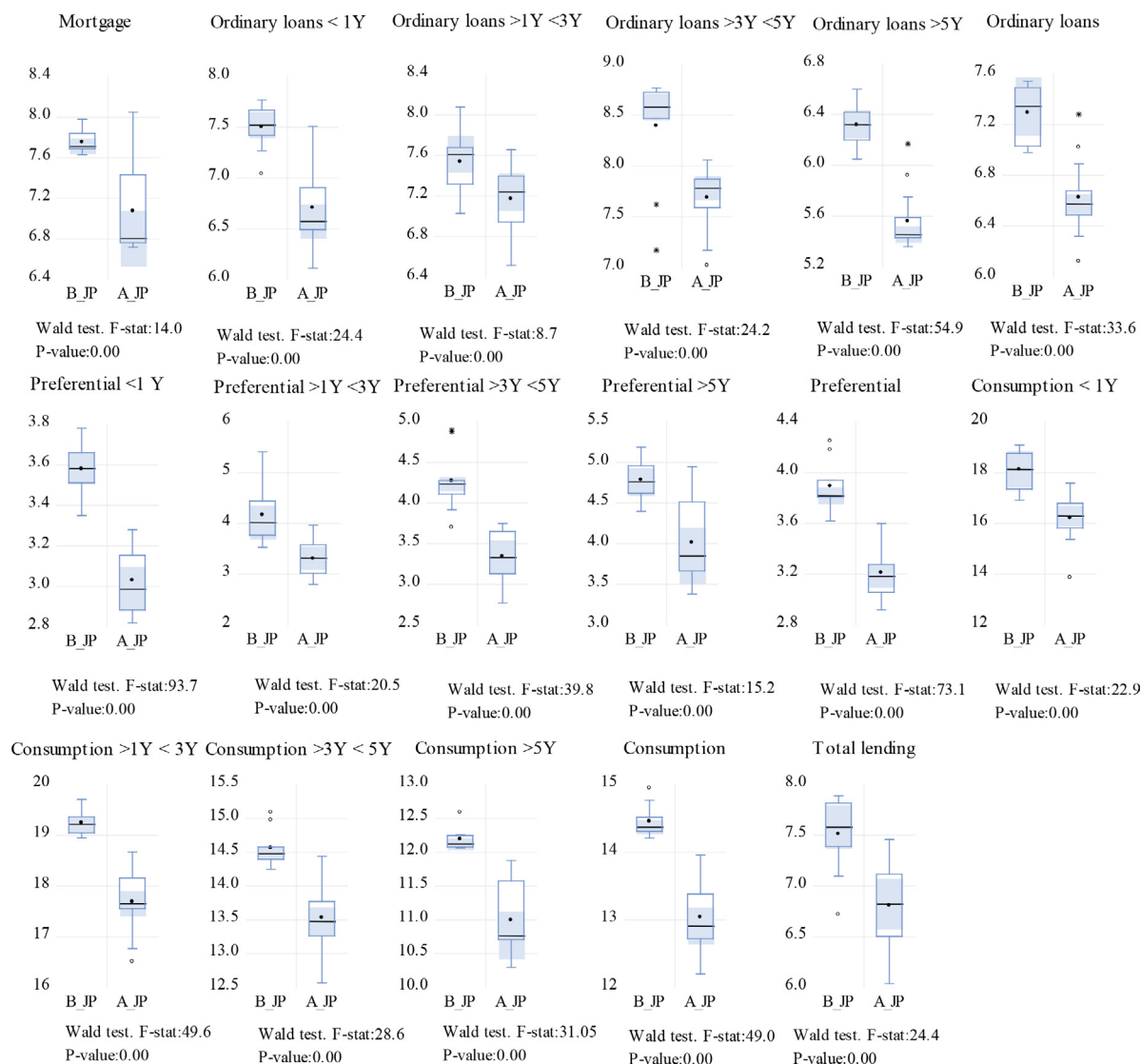


Fig. 14. Lending rates-policy rate spreads before and after the JP Morgan announcement. Source: *Banco de la República* and authors' estimates. Note: Wald test (F-statistic and probability) is used to test the difference between the subsamples (H_0 : the spread is the same in both periods). B_JP: before 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 areas shaded in blue are the median 95% confidence interval. Points above and below the boxplot are outliers. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

equals 0 before March 2014 and 1 thereafter¹⁸. To summarize these estimates, Fig. 16 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.

An examination of the importance of external variables in the determination of TES and local lending interest rates suggests that: (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

¹⁸ US monetary and equity shocks are obtained from Jarociński & Karadi and are available from January 2005 to December 2016. US monetary and equity shocks are included in levels since they are stationary variables (See Appendix for details).

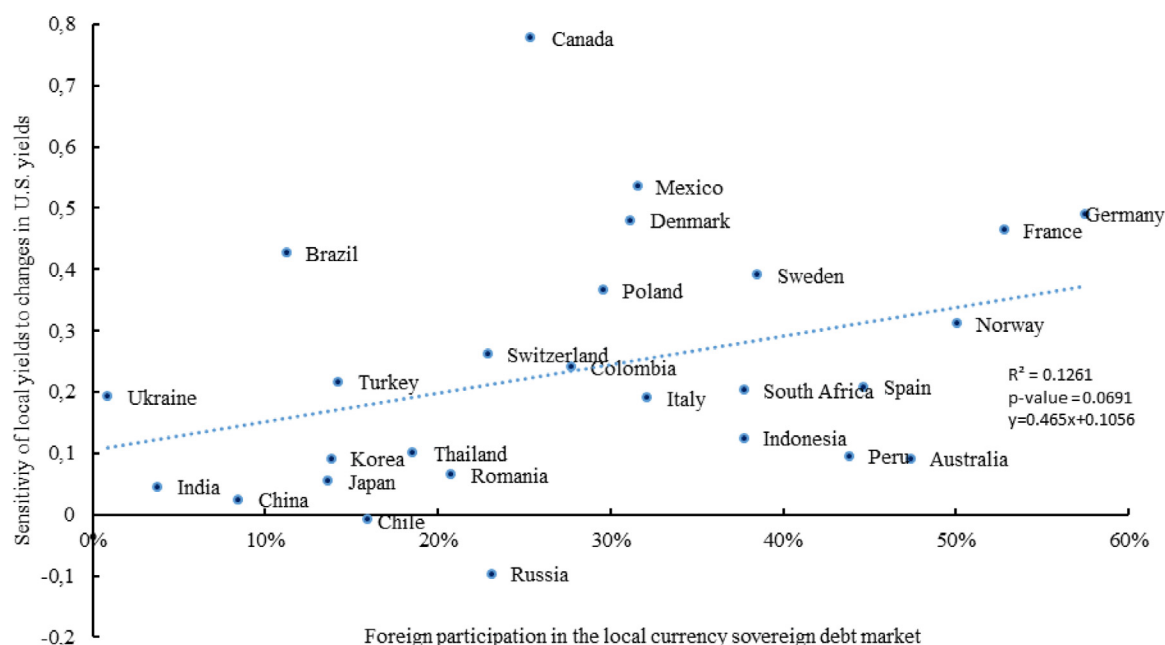


Fig. 15. Sensitivity of local yields to changes in US yields and foreign participation in the local currency sovereign debt market. Source: Authors' estimates. The sensitivity of local interest rates is calculated as the β coefficient in the following regression: $y = \alpha + \beta dy^* + \theta VIX + \xi$, 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. This specification was proposed by the BIS in a note for the June 2018 meeting of BIS Governors. The information regarding foreign participation in the local currency sovereign debt market is obtained from Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014).

may have increased between samples;¹⁹ (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.

These results suggest 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.²⁰

5.3. 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. The latter were obtained from the one-month overnight IBR²¹ index swap. 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

¹⁹ 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 (See Appendix for details).

²⁰ It is important to note that there could be non-linearities existent in these relationships that are not tested. In addition, the specific type of non-linearity in this relationship is difficult to identify and could vary over time.

²¹ IBR stands for “Indicador Bancario de Referencia”, which is the transactions-based, one-day Colombian “Libor”. In the Appendix we compare this shock with other shocks that have been used in the literature.

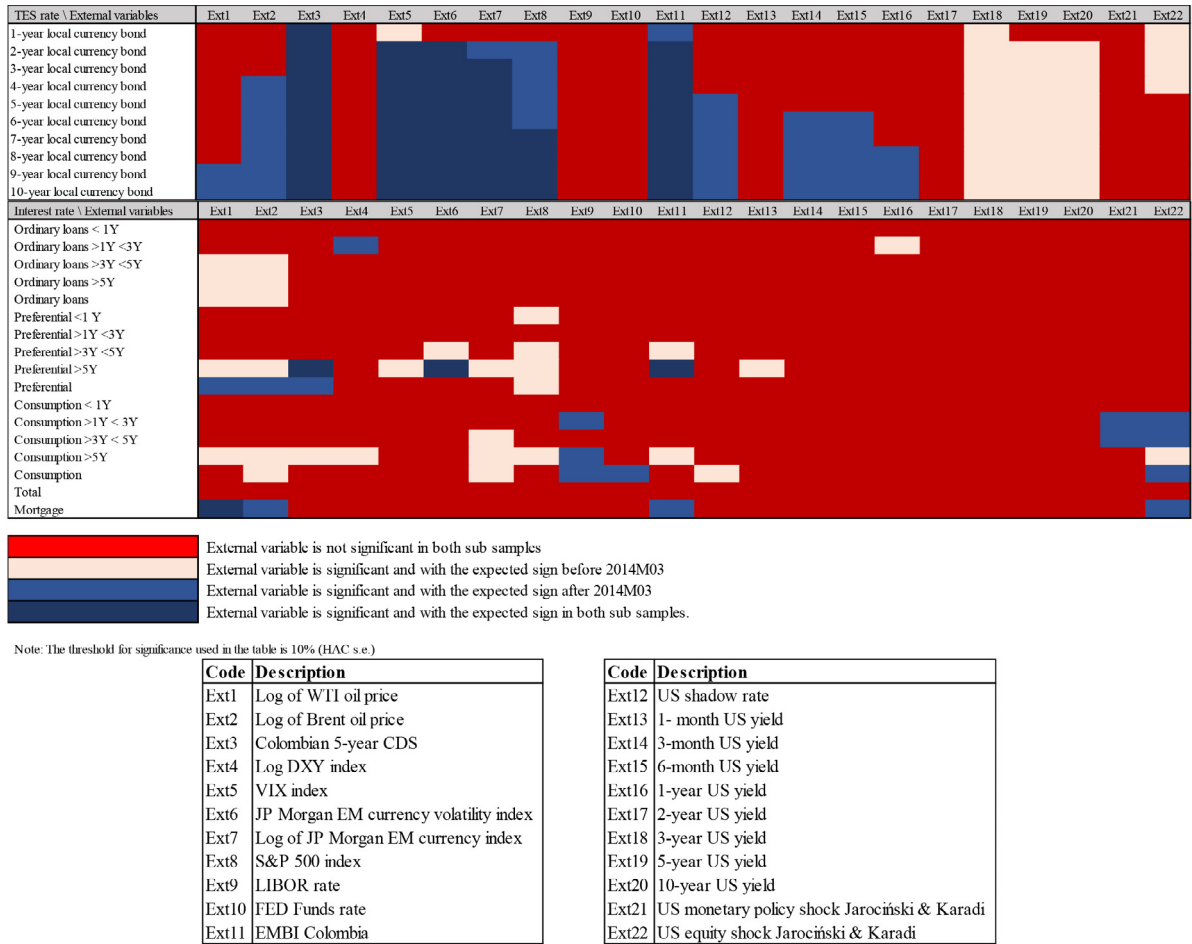


Fig. 16. Significance of the relationship between local interest rates and external variables. Source: Authors' estimates. Fig. 16 indicates whether the external variables were significant (and with the expected signs) determinants of domestic interest rates before the JP Morgan announcement (light red), 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. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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)²².

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 $h = 1 \dots H$ 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 $\{\beta_h^j\}_{h \geq 0}$.

Fig. 17 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.²³ Transmission is stronger for

²² A comparison of the monetary policy shock used by López et al (2020), the Bloomberg survey surprises, and the proposed measure are shown in the Appendix.

²³ Fig. 17 includes the contemporary effect of the shock on interest rates ($h=0$).

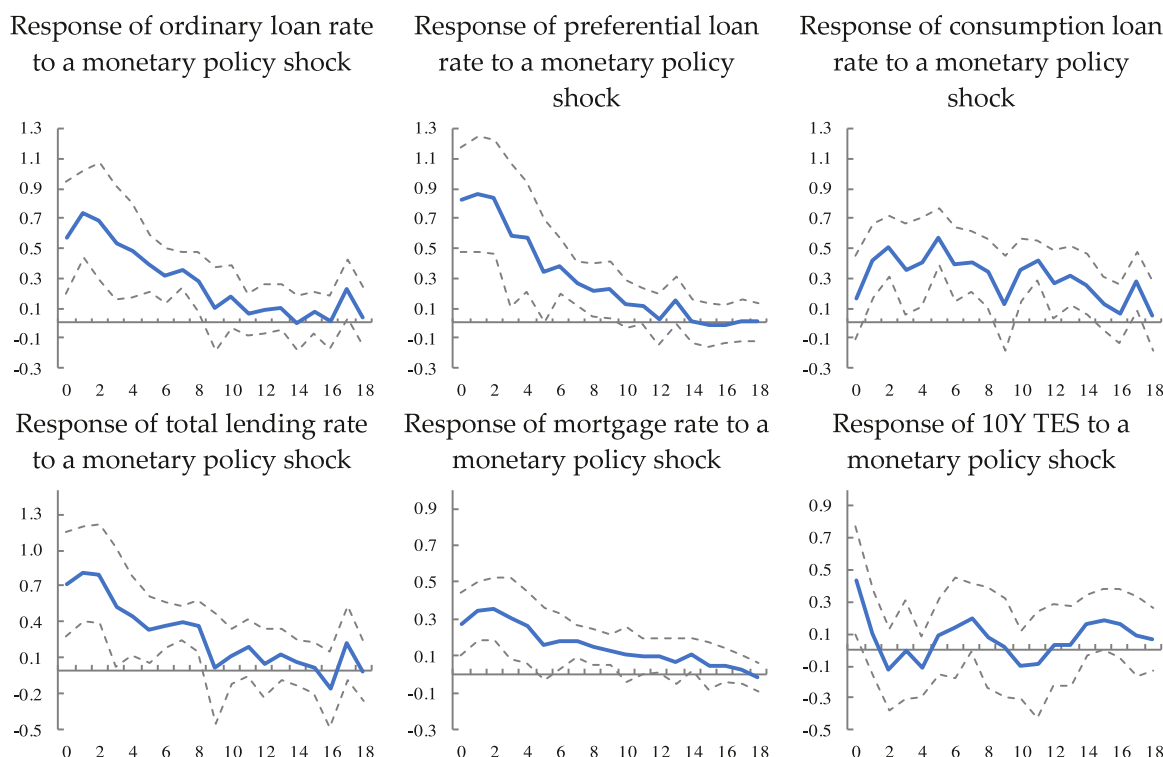


Fig. 17. LP impulse response to a monetary policy shock (M01 2008–M10 2019). Source: Authors' estimates. Dotted lines represent 95% confidence intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

commercial loan rates, with the total effect on their level being completed after eight months.²⁴ For consumer and mortgage loan rates, transmission is lower, while the 10-year TES yield only responds contemporaneously to the policy shock.²⁵

To test for changes in the transmission of monetary policy shocks after 2014, recursive least squares (RLS) were applied to the above specification and CUSUM tests were performed.²⁶ Fig. 18 suggests that the RLS estimates of the one-month-ahead transmission coefficients have been stable since well before the change in Colombia's weight. Fig. 19 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 (Fig. 20).

6. Conclusions

The Colombian local public bond market experienced a substantial increase in the participation of foreign investors during 2014. This result was driven, among other factors, by the increased weight of Colombia in JP Morgan's Government Bond Index. The resulting inflows reduced bond and loan interest rates and raised the 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

²⁴ 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 Fig. 17.

²⁵ As shown in Fig. 17, 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 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.

²⁶ 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.

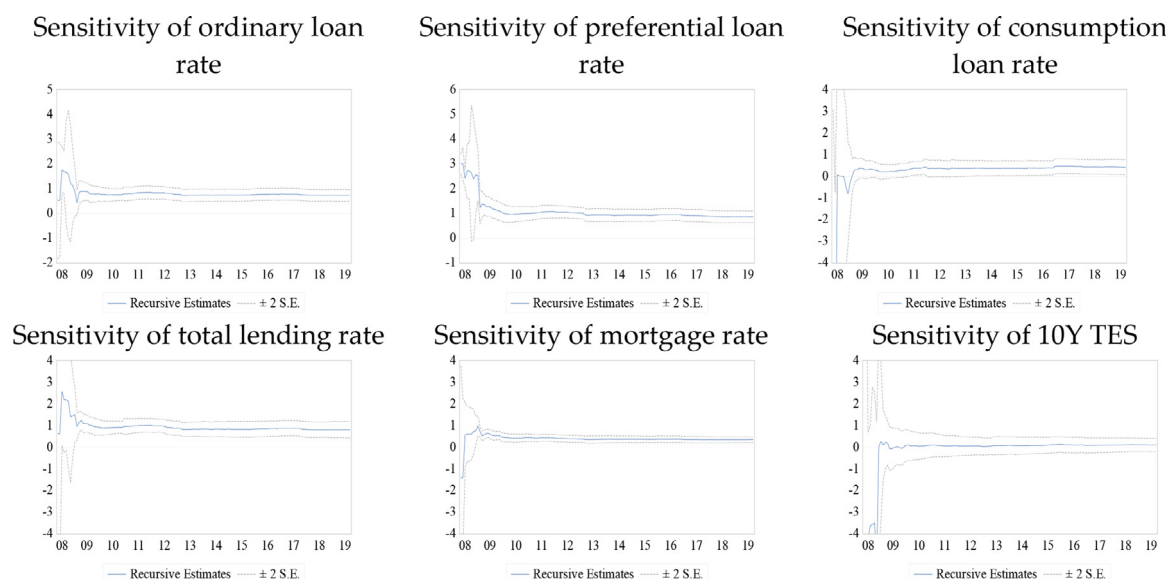


Fig. 18. Sensitivity of interest rates to a monetary policy shock at projection horizon $h=1$ (recursive estimates) Source: Authors' estimates. Recursive parameters and 95% confidence intervals.

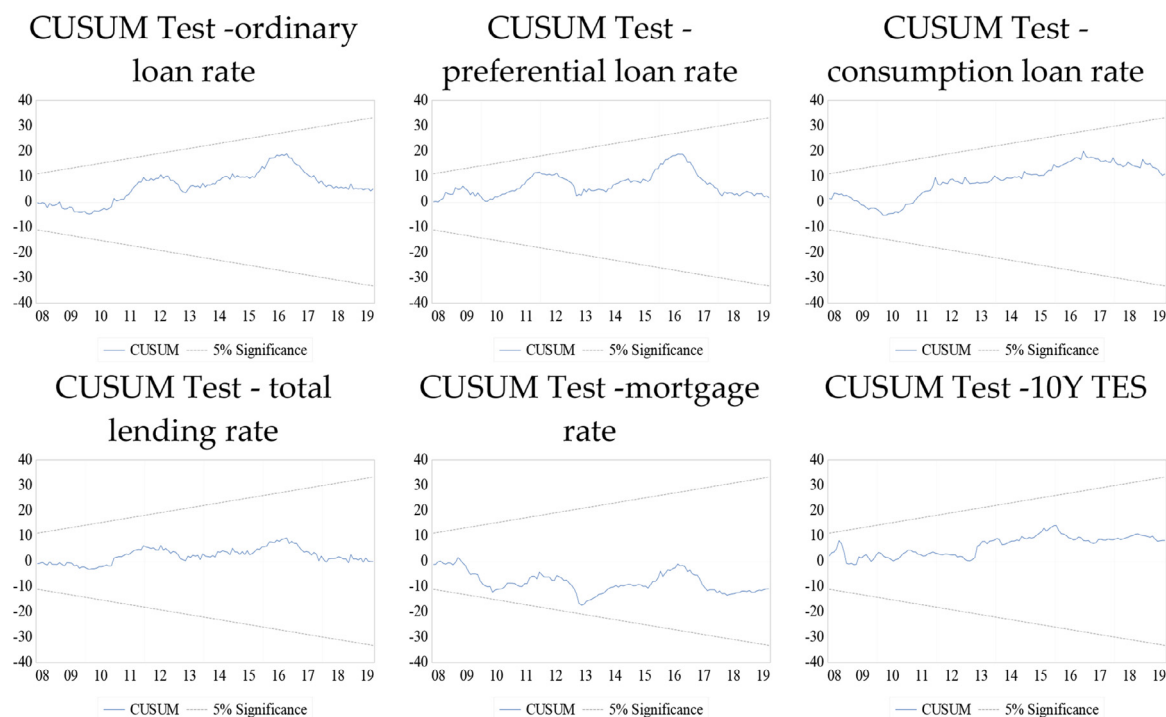
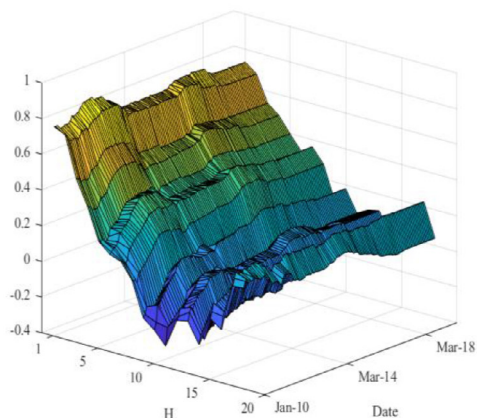


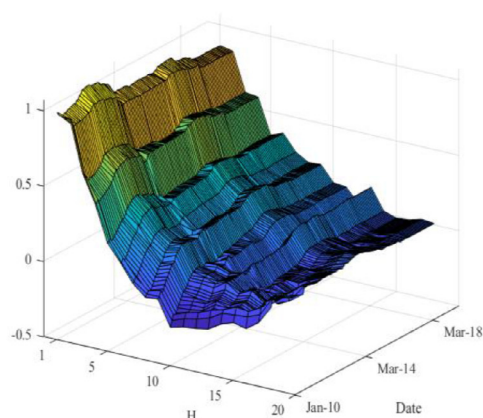
Fig. 19. CUSUM Test for interest rates at projection horizon $h = 1$. Source: Authors' estimates. CUSUM test and 5% significance levels.

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.

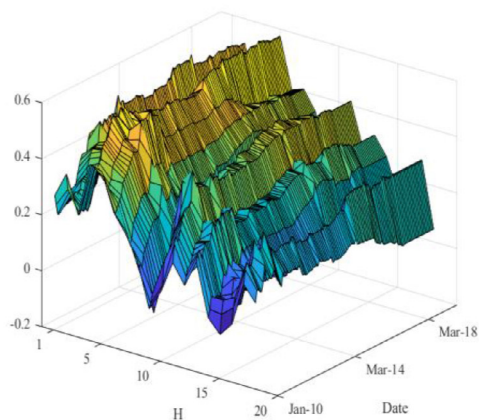
Response of ordinary loan rate



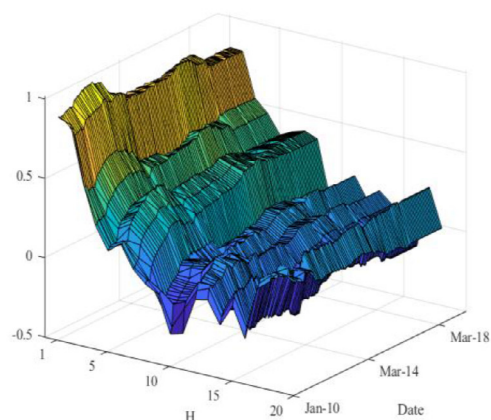
Response of preferential loan rate



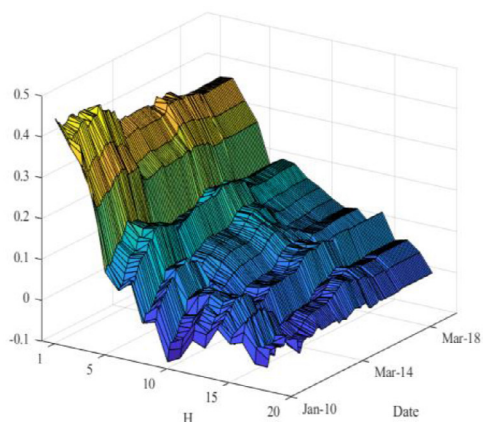
Response of consumption loan rate



Response of total lending loan rate



Response of mortgage loan rate



Response of 10Y TES

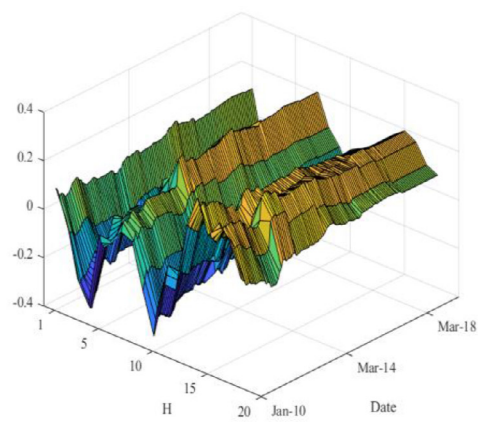


Fig. 20. Response of interest rates to a monetary policy shock. Local projections estimated recursively from 10M01 to 19M10. Source: Authors' estimates.

Appendix

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

Interest rate	ADF - Trend and Intercept		ADF - Trend		ADF - None		Evidence
	t-Stat	P-Val	t-Stat	P-Val	t-Stat	P-Val	
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		Evidence
	t-Stat	P-Val	t-Stat	P-Val	t-Stat	P-Val	
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)

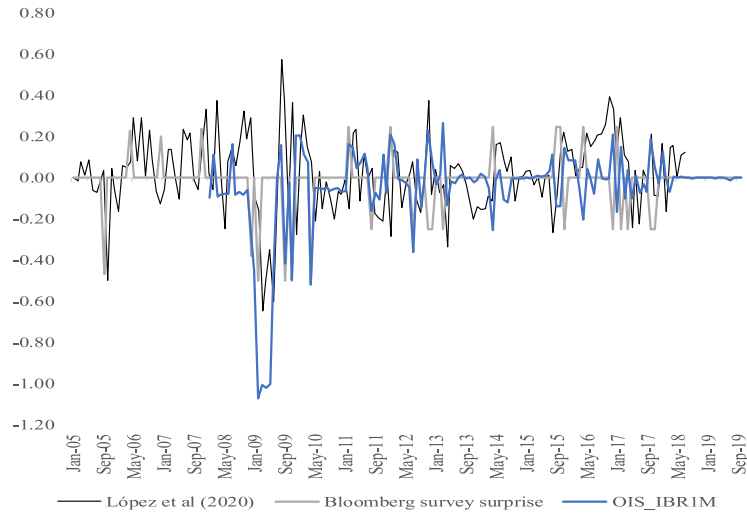
C. Sensitivity of local interest rates to external drivers (Wald test)

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

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

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

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. Results show that the sensitivity of TES yields to CDS and EMBI between the two subsamples may have increased.



	$\Delta(\text{CDS})$				$\Delta(\text{EMBI})$			
	$\Upsilon_{\text{CDS, before}}$	$\Upsilon_{\text{CDS, after}}$	Wald test (F-stat)	P-value	$\Upsilon_{\text{EMBI, before}}$	$\Upsilon_{\text{EMBI, after}}$	Wald test (F-stat)	P-value
2-year TES	0.002*** [0.0008]	0.005*** [0.0009]	5.555	0.020	0.002*** [0.0006]	0.004*** [0.0007]	7.056	0.009
5-year TES	0.003423*** [0.0016]	0.008*** [0.0010]	6.535	0.012	0.003*** [0.0009]	0.007*** [0.0007]	11.140	0.001
10-year TES	0.005148*** [0.0017]	0.00949*** [0.0010]	4.561	0.035	0.005*** [0.0009]	0.008*** [0.0009]	6.183	0.014

	$\Delta(\text{VIX})$				$\Delta(\text{JP Morgan EM currency volatility index})$			
	$\Upsilon_{\text{VIX, before}}$	$\Upsilon_{\text{VIX, after}}$	Wald test (F-stat)	P-value	$\Upsilon_{\text{JPVOL, before}}$	$\Upsilon_{\text{JPVOL, after}}$	Wald test (F-stat)	P-value
2-year TES	0.0145*** [0.0049]	0.012** [0.0049]	0.110	0.740	0.038* [0.0197]	0.070** [0.0347]	0.663	0.417
5-year TES	0.0271*** [0.0093]	0.022*** [0.007]	0.137	0.711	0.080*** [0.0263]	0.102*** [0.039]	0.220	0.640
10-year TES	0.035*** [0.0115]	0.028*** [0.0094]	0.232	0.631	0.116*** [0.0283]	0.134*** [0.0423]	0.133	0.716

	$\Delta\text{LOG}(\text{JP Morgan EM currency index})$				$\Delta\text{LOG}(\text{S\&P 500})$			
	$\Upsilon_{\text{JPFX, before}}$	$\Upsilon_{\text{JPFX, after}}$	Wald test (F-stat)	P-value	$\Upsilon_{\text{SP, before}}$	$\Upsilon_{\text{SP, after}}$	Wald test (F-stat)	P-value
2-year TES	-0.017 [0.0111]	-0.037** [0.0148]	1.226	0.270	-0.688 [0.6121]	-1.784** [0.7158]	1.347	0.248
5-year TES	-0.039** [0.0195]	-0.072*** [0.0201]	1.380	0.242	-1.416 [1.0380]	-3.216*** [1.2217]	1.257	0.264
10-year TES	-0.061*** [0.0205]	-0.100*** [0.0223]	1.689	0.196	-2.428** [1.1277]	-3.578** [1.4382]	0.395	0.531

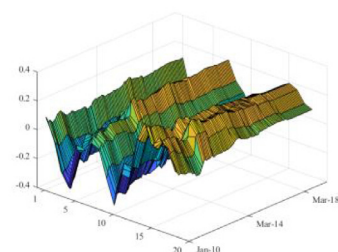
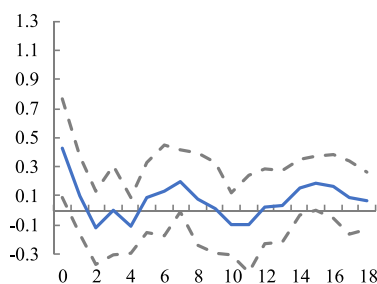
Source: authors' estimates. Parameter estimates, [Std. error] and Wald test. HAC standard errors *** Significant at 1.0%, ** Significant at 5.0%, * Significant at 10%.

D. Monetary policy shocks comparison

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

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

The following table shows the diagnostic statistics $\Delta_{t+h}^j = \mu_h^j + \beta_h^j \psi_t + \sum_{l=1}^L \gamma_h^{j,l} x_t^l + \varepsilon_{h,t}$ at $h=1$ for the equations used to compute the LP impulse responses exhibited in Fig. 17.



Source: Authors' estimates. Dotted lines represent 95% confidence intervals.

Interest rate equation	Monetary policy shock parameter at h=1	P-value (HAC)	R ²	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

Source: Authors' estimates. Dotted lines represent 95% confidence intervals.

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