Liquidity Premium and Buyback Auctions in Domestic Brazilian Government Bonds

Gyorgy Varga
(varga@fce.com.br)
14/11/2018

Abstract

This article investigates the return differential between liquid and illiquid Brazilian Government bonds, to find out if there is a liquidity premium among this asset like the evidence for the United States. We also investigate the effect of the Brazilian Treasury buyback auctions on the liquidity premium and the market impact cost by the Treasury. The result does not show positive or negative significant premium even when the bonds object of the buyback where excluded.

JEL Classification: E44, G12, G14, H63.
Keywords: Liquidity effect; Liquidity and asset pricing; Emerging markets, Flight to liquidity; Government bond markets; On-the-run bonds and Off-the-run bonds.

1. Introduction

The financial market literature has appointed several frictions that may affect a simple present value pricing model for Government bonds. They are (a) data collection problem like nonsynchronous collection or reporting error; (b) new/old bond (Krishnamurthi 2002); (c) clientele effect (Schaefer 1982); (d) eligible for use in the overnight repurchase market (Jordan and Jordan 1997); (e) tax regime effects (Kamara 1994); (f) tax clientele (Schaefer 1982); (g) tax timing option (Jordan and Jordan 1991); (h) matching with futures contract maturity dates (Dunne and Portes 2007, Yuan 2005) and liquidity (Warga 1992).

This study focus on the effect of liquidity and reproduce the technique from Warga (1992) to measure the impact of liquidity on the return of Brazilian Government bonds traded
in domestic market with local currency. As far as we know, this is the first of this kind for the
Brazilian market. For the United States Government bond market, Warga (1992) has found an
annual return differential of 55 basis points between illiquid and liquid bonds. He classified as
liquid the bonds recently issued and know as *on-the-run* and illiquid the *off-the-run*. Further
studies have found a lower premium, Amihud and Mendelson (1991) found 43 basis points,
Kamara (1994) found 34 basis points and Longstaff (2004) 10 to 16 basis points. For another
country, Japan, Boudoukh and Whitelaw (1993) found 50 basis points.

In Brazil, the Government has four main kinds of bonds in the market, they are: (1) Letra
Financeira do Tesouro - LTN bullet with fixed interest rates; (2) Nota do Tesouro Nacional - F
- NTNF, is coupon bond with fixed interest rate; (3) Nota do Tesouro Nacional - B- NTNB, is
coupon bond indexed to inflation and (4) Letra Financeira do Tesouro - LFT is a bullet bond
indexed to the overnight rate. In order to have comparable returns we use the fixed rate bonds
LTN and NTNF, which comprises 37% of the Government debt as of December, 2016 and
inflation indexed bond NTNB that comprises 29%.

In the next section, we shown the description of the data, in section three there is the
returns on several portfolios with more and less liquid bonds, in section four the trading strategy
used to calculate the return differential, in section five the results and in section six the
conclusion.

2. Data

The data come from Quantum\(^1\). The criteria for liquid bonds are what the Brazilian
Treasury call *on-the-run*, the bonds that are issued recently (within the year) and the *off-the-run*
the bonds no longer issued. This liquidity criteria is pretty common worldwide and in Brazil is

\(^1\) Quantum is a large provider of Brazilian financial market data. The data used here was downloaded in April,
announced at the beginning of the year. The Treasury department issue every year the "Plano Anual de Financiamento - PAF", annual financing plan, where they describe all the bonds they intend to issue during the following year. They intend to have a set of bonds maturities with liquidity to well define a local currency term structure. They also say that they may execute buyback auctions to retire illiquid bonds or even sell off-the-run bonds to correct market distortions. Therefore we have classified all outstanding bonds each year in on-the-run if they are sold that year, and off-the-run if they are not. We also know if an off-the-run bond was bought back in each year.

Regarding the bond price to calculate the trading strategy return, there are three possibilities. The indicative price provided by ANBIMA (Brazilian Financial Market Association), the reference price from BMFBOVESPA (Brazilian Future and Stock Exchange) or the Central Bank Average traded price. The first one is an indicative price collected with several bond traders, averaged and divulged daily by ANBIMA. There is no commitment with this price, they may reflect dealers' opinions about prices rather than actual trades. The second is calculated by non-arbitrage models with no reference to the liquidity cost although based on several traded financial instruments. The third one is based on transactions registered at the SELIC, which is Government bond settlement system. Certainly the last one is closest to real market prices subject to the liquidity cost and was the one used here.

The sample ranges from 2007 to 2016. Only bonds with actual price were included in our sample. Few bonds were excluded due to exaggerated price.

3. Returns

Similar to Warga (1992) we created four different portfolios in order to control for the duration risk. Each portfolio comprises all available bonds with one year duration range. To
verify the liquidity effect we have segregated portfolios with only bonds off the run, on the run and bonds no subject to buy back.

On table 1 we show the results on the return differentials.

<table>
<thead>
<tr>
<th>Portfolios</th>
<th>Average Return</th>
<th>Std Dev</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full sample - daily return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1 year</td>
<td>0,0444%</td>
<td>0,1472%</td>
<td>0,30</td>
</tr>
<tr>
<td>1-2 years</td>
<td>0,0484%</td>
<td>0,1681%</td>
<td>0,29</td>
</tr>
<tr>
<td>2-3 years</td>
<td>0,0417%</td>
<td>0,3144%</td>
<td>0,13</td>
</tr>
<tr>
<td>3-4 years</td>
<td>0,0523%</td>
<td>0,4166%</td>
<td>0,13</td>
</tr>
<tr>
<td></td>
<td>Off the run - On the run - daily return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1 year</td>
<td>0,0021%</td>
<td>0,2024%</td>
<td>0,01</td>
</tr>
<tr>
<td>1-2 years</td>
<td>0,0007%</td>
<td>0,3508%</td>
<td>0,00</td>
</tr>
<tr>
<td>2-3 years</td>
<td>-0,0039%</td>
<td>0,3446%</td>
<td>(0,01)</td>
</tr>
<tr>
<td>3-4 years</td>
<td>-0,0033%</td>
<td>0,4602%</td>
<td>(0,01)</td>
</tr>
<tr>
<td></td>
<td>No buy back - On the run - daily return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1 year</td>
<td>0,0030%</td>
<td>0,1959%</td>
<td>0,02</td>
</tr>
<tr>
<td>1-2 years</td>
<td>0,0006%</td>
<td>0,1562%</td>
<td>0,00</td>
</tr>
<tr>
<td>2-3 years</td>
<td>-0,0047%</td>
<td>0,2295%</td>
<td>(0,02)</td>
</tr>
<tr>
<td>3-4 years</td>
<td>-0,0022%</td>
<td>0,1918%</td>
<td>(0,01)</td>
</tr>
</tbody>
</table>

Table 1. Daily returns on four different portfolios based on the duration of the available bonds.

The less liquid bonds (of the run) does not show significant superior returns. Neither the bonds subject to the Government buy back.

4. Trading strategy

Similar to McCulloch (1975) we assume a “Typical” shape for the term structure and derive mispriced bonds to implement a trading strategy with illiquid versus liquid bonds. The return differential is based on a long position on an illiquid bond and short positions on two
liquid bonds. This type of trading strategy is known as butterfly. The quantity of each bond is calculated in order to have a long position with the same absolute value and duration of the short position. Therefore, this strategy has no need for financing and no (first order) interest rate risk.

We start with one long position in the illiquid bond ($P_2$) and need to calculate the short on the other two liquid bonds ($P_1$ and $P_3$). To match their value we have:

$$-1 \ P_2 = q_1 P_1 + q_3 P_3$$  \hspace{1cm} (1)$$

The duration match has to respect the equation:

$$-1 \ D_2 = q_1 D_1 + q_3 D_3$$  \hspace{1cm} (2)$$

where $P_i$ and $D_i$ is each $i$ bond market price and duration respectively.

We have a system of two equation and two unknowns ($q_1$ and $q_3$):

$$q_1 \frac{\partial P_1}{\partial i} + q_3 \frac{\partial P_3}{\partial i} = q_2 \frac{\partial P_2}{\partial i}$$

$$q_1 P_1 + q_3 P_3 = q_2 P_2$$  \hspace{1cm} (3)$$

The solution is:

$$\begin{bmatrix} q_1 \\ q_3 \end{bmatrix} = \begin{bmatrix} \frac{\partial P_1}{\partial i} & \frac{\partial P_3}{\partial i} \\ P_1 & P_3 \end{bmatrix}^{-1} \begin{bmatrix} q_2 \frac{\partial P_2}{\partial i} \\ q_2 P_2 \end{bmatrix}.$$ 

Replacing the first derivative by the Modified Duration $MD = -\left( \frac{\partial P}{\partial i} \right) / P$, for simplicity we call $D$=$MD$, we have for $q=1$:

$$\begin{bmatrix} q_1 \\ q_3 \end{bmatrix} = \begin{bmatrix} -D_1 P_1 & -D_3 P_3 \\ P_1 & P_3 \end{bmatrix}^{-1} \begin{bmatrix} -D_2 P_2 \\ P_2 \end{bmatrix}.$$
where
\[
\begin{bmatrix}
-D_1 R_1 & -D_3 P_3 \\
R_1 & P_3
\end{bmatrix}^{-1} = \frac{1}{-D_1 R_1 P_3 + D_3 R_1 P_3}
\begin{bmatrix}
P_3 & D_3 P_3 \\
-R_1 & -D_1 R_1
\end{bmatrix} = \frac{1}{R_1 P_3 (D_3 - D_1)}
\begin{bmatrix}
P_3 & D_3 P_3 \\
-R_1 & -D_1 R_1
\end{bmatrix}
\]

Then:
\[
\begin{pmatrix}
q_1 \\
q_3
\end{pmatrix} = \left( \frac{1}{(D_3 - D_1) P_4 P_3} \right) \begin{pmatrix}
-D_2 P_2 P_3 + D_3 P_2 P_3 \\
D_2 P_2 P_1 - D_1 P_2 P_1
\end{pmatrix} = \frac{P_2}{(D_3 - D_1) P_4 P_3} \begin{pmatrix}
P_3 (D_3 - D_2) \\
P_1 (D_2 - D_3)
\end{pmatrix}
\]

The quantities for the short position are:
\[
q_1 = \frac{P_2}{P_1} \frac{(D_3 - D_2)}{(D_3 - D_1)} \quad \text{and} \quad q_3 = \frac{P_2}{P_3} \frac{(D_2 - D_1)}{(D_3 - D_1)} \quad (4)
\]

For each day, only one butterfly is created. So even if there are more than one illiquid bond, only the less negotiated is chosen. For the two liquid bonds selected to run the short position, we choose the bond with lower duration and another with higher duration, both the closest to the duration of the illiquid bond. More details on this type strategies can be found in Bierwag (1977).

Everyday a profit or loss were calculated according to:
\[
P_{nL_{t+1}} = q_{1,t} (P_{1,t+1} - P_{1,t}) - q_{3,t} (P_{3,t+1} - P_{3,t}) - q_{2,t} (P_{2,t+1} - P_{2,t}) \quad (5).
\]

We arrange the trading strategies above, separately for the set of fixed rate bonds (NTNF and LTN) and the set of indexed bonds (NTND), because they have different market risk due to the indexation.

5. **Results**
Whenever that was possible to assemble the butterfly, it was done, and the transaction was withdrawn in the following business day. A daily PnL (from equation 5) was calculated, in Graph 1a we shown the PnL as a percentage of the value of the long position for the fixed rate bonds. The daily overnight rate (known as Selic rate) is also plotted at the same graph on the left axis.

**Graph 1a.** Selic rate on the left axis and Rolling Daily PnL (cumulated on 60 business days) for the fixed rate bond at the right axis.

The PnL is quite volatile for an arbitrage. There is also some very high profit and losses in some days, like +2% and -2%, in some days.
Graph 1b. Selic rate on the left axis and Rolling Daily PnL (cumulated on 60 business days) for indexed bonds at the right axis.

This bond return has a much bigger duration and is much more volatile than the fixed rate bond. Therefore its PnL is also more volatile.

In Graph 2a, we show the cumulated PnL as a percentage of the average long position for the fixed rate bond.

Graph 2a. Selic rate on the left axis and Cumulated Daily PnL (whole sample period) for the fixed rate bond at the right axis.
The total return was quite negative. In 2013 the daily PnL were highly negative and explains a large part of the cumulated negative result. It should be noticed a negative correlation (-50%) between the level of interest rate and the cumulated daily PnL.

In Graph 2b, we show the cumulated PnL as a percentage of the average long position for the indexed rate bond.

Graph 2b. Selic rate on the left axis and Cumulated Daily PnL (whole sample period) for the fixed rate bond at the right axis.

The total return was quite negative. In 2013 there was also a highly negative PnL that explains a large part of the cumulated negative result. It should also be noticed a negative correlation between the level of interest rate and the cumulated daily PnL.

In table 1a, we show the results separated by the long position (portfolio), short position (hedge), sum of long and short and sum as a percentage of average long notional. All these numbers are for the whole sample. In the first line we show the total cumulated PnL, in the
second average daily PnL, in the third its standard deviation, in forth its t-statistics and in the last two lines the maximum and minimum daily PnL.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Hedge</th>
<th>PnL</th>
<th>%PnL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>797,12</td>
<td>-797,70</td>
<td>-0,58</td>
</tr>
<tr>
<td>Average</td>
<td>0,49</td>
<td>-0,49</td>
<td>0,00</td>
</tr>
<tr>
<td>STD</td>
<td>2,73</td>
<td>2,26</td>
<td>3,10</td>
</tr>
<tr>
<td>t stat</td>
<td>0,18</td>
<td>-0,22</td>
<td>0,00</td>
</tr>
<tr>
<td>Max</td>
<td>19,40</td>
<td>12,72</td>
<td>21,97</td>
</tr>
<tr>
<td>Min</td>
<td>-22,53</td>
<td>-16,41</td>
<td>-19,62</td>
</tr>
</tbody>
</table>

**Table 1a.** Total cumulated PnL for the long position (Portfolio), short position (Hedge) and the combination of both (PnL) for fixed rate bonds.

The daily PnL is negative but it is not significant. In table 2a, we show the results annually.

<table>
<thead>
<tr>
<th>PnL</th>
<th>Cumulated</th>
<th>Average</th>
<th>t-stat</th>
<th>%PnL</th>
<th>Cumulated</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>-2,82</td>
<td>-0,705</td>
<td>-0,26</td>
<td>-0,31%</td>
<td>-0,076%</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>-35,61</td>
<td>-0,360</td>
<td>-0,10</td>
<td>-3,69%</td>
<td>-0,037%</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>70,63</td>
<td>0,423</td>
<td>0,10</td>
<td>7,39%</td>
<td>0,044%</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>-4,17</td>
<td>-0,028</td>
<td>-0,01</td>
<td>-0,43%</td>
<td>-0,003%</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>13,76</td>
<td>0,084</td>
<td>0,04</td>
<td>1,43%</td>
<td>0,009%</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>2,59</td>
<td>0,013</td>
<td>0,01</td>
<td>0,25%</td>
<td>0,001%</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>-26,23</td>
<td>-0,120</td>
<td>-0,04</td>
<td>-2,58%</td>
<td>-0,012%</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>-1,58</td>
<td>-0,008</td>
<td>-0,00</td>
<td>-0,17%</td>
<td>-0,001%</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>-36,75</td>
<td>-0,169</td>
<td>-0,07</td>
<td>-4,85%</td>
<td>-0,022%</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>19,58</td>
<td>0,084</td>
<td>0,03</td>
<td>2,17%</td>
<td>0,009%</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2a.** Annual cumulated PnL, average PnL, cumulated PnL as percentage of the notional and average PnL as percentage of the notional for fixed rate bonds.

There were six years with average PnL negative and four positives but none significant.
The average annual premium was negative -8 basis points, completely different than the results for US, although not significant.

For the indexed bonds we have similar results in table 1b.
These results show no positive premium for liquidity. It can be a consequence of the Brazilian buyback of illiquid bonds. To evaluate this possibility we recalculate the trading strategies without bonds that were bought back by the treasury on each year.

In table 3a, we show the result for the fixed rate bonds and the whole period. The average and cumulated PnL became positive but still not significant.

A similar result is obtained to indexed bonds as shown in table 3b.
6. Conclusion

Our result does not show a positive and significant liquidity premium like the evidence for the US. Several facts can explain this result. The most simple explanation is the non synchronous collected prices once we used the daily average price publish by the Brazilian Central Bank (via Quantum database). Another explanation is the treasury policy of repurchase of off-the-run bonds. They have a policy of providing liquidity for old bond. The exclusion of these bonds on an yearly basis, does turn the premium positive but still not significant.

One way that may improve our results would be to use some term structure fitting model (Bliss 1997) to find out a better mispricing among all the available bond. Then the long position could have a cheaper bond and the short position more expensive bonds, therefore capturing a fatter mispricing from liquid and illiquid bonds.

This trading strategy has been object of many hedging fund companies. It was the core strategy of the Long Term Capital Management - LTCM (Risk 1998).

References


Banco Central do Brasil at www.bcb.gov.br.


