The Effect of Changes in the Fed’s Balance Sheet Size on the Level of the Yield Curve

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I. Introduction

The central bank of the US, the Fed, serves an important role in the US economy. Its main purpose is to dampen the business cycle and to prevent economic crises from happening. The Fed has gained a substantial political independence over the years and its policies are as powerful as those made by the government (Axilrod; 2009). The most popular and efficient way of enforcing its monetary policy is through open market sales or purchases of treasury securities (i.e. open market operations) (Harvey; 1994). Over the years, this method has been widely successful in navigating the economy on its bumpy path of growth.

By performing open market operations, the Fed is either increasing or decreasing its holdings of treasury securities. For example, if the Fed buys a T-bill (T-bill is a treasury security with maturity of 1 year or less), its assets would grow by the market value of the T-bill. Its liabilities will also increase by the same amount. This increase in liabilities will be constituted by the introduction of more cash into the economy which is a liability for the Fed. Therefore, the size of its balance sheet changes whenever a new treasury security is purchased or sold. Figure 1 gives us an idea of how the size of the Fed’s balance sheet has changed over the past 40 years.

The main purpose of open market operations is to help tighten or ease monetary policy. As a result, we observe increases or decreases in the monetary base that cause market interest rates to fluctuate. The yield curve captures this fluctuation by shifting up or down. Figure 2 summarizes the effects of open market operations on the position of the yield curve during the current financial crisis. As the Fed began open market purchases of treasury securities in mid-2007 when the financial crisis began, the price of various treasuries increased while their yields decreased. The yield curve responded by shifting down.

Figure 1: Treasuries Held by the Fed (1961-2008)

Figure 2: Yield Curve Comparison
This paper studies the relationship between the size of the Fed’s balance sheet and the overall level of the yield curve. Section II of the paper briefly reviews the fundamental concepts of the yield curve. Section III presents the background of economic theory and past literature. Section IV presents the empirical model and the data. Section V shows the results and section VI concludes.

II. Basic Definitions

The yield curve shows the relationship between interest rate and bonds with different dates of maturity. Many policy makers and economists use the yield curve as a predictor of future economic activity. Some argue that the slope of the yield curve has forecasting powers that could predict what the inflation rate will be. For example, a yield curve with a high positive slope could signal inflation. If we assume that the yield curve really holds some forecasting powers then we could argue that the Fed is susceptible to changing the size of its balance sheet in order to change the position or slope of the yield curve.

III. Background

Over the years, the US treasury department has issued hundreds of thousands of treasury securities to fund government spending. The Fed has played an important role in facilitating this process. Should there be an urgent need of funds for the government, the Fed would step in and buy treasuries for freshly printed cash (Axilrod; 2009). The short term market interest rates have shown high volatility over the years. From above 15% in the 1980s to less than 1% today, they have been fairly obedient to Fed’s policy actions. What follows next is an overview of the economic theory that would try to explain how interest rates, treasury maturities and balance sheet sizes could be interconnected.

In order to understand how the Fed affects the interest rates in the economy we should consider two markets: the market for reserves and the bonds market. Both markets are interconnected and whenever the Fed performs open market operations both markets are affected in a similar fashion. Figure 3 shows how the bond market responds to open market operations. When the Fed purchases bonds from the open public, it decreases the amount of bonds outstanding and therefore decreases their supply. This causes an upward shift in the supply for bonds from Bs to Bs’. The new equilibrium corresponds to a higher bond price and a lower yield. Yields and bond prices are inversely related. Hence, my hypothesis would be that as the Fed sells out bonds and therefore reduces the size of its balance sheet, the market interest rates fall.

Figure 3: Bond Market and Reserves Market
$10,000 worth of government bonds held in the Federal Reserve Bank while there is a total of $100,000 worth of government bonds circulating in the economy, the size of the Fed’s balance sheet would be 10%. This captures what percent of the bond market is controlled by the Fed. The higher the percentage is, the higher the Fed’s influence is. Also, the size of the balance sheet over time reflects changes in monetary policy (e.g. increased balance sheet size indicates open market purchases). The percent size of the Fed’s balance sheet can change even if no open market operations are in place. This would happen if the treasury department issues new securities and the overall supply increases while the Fed remains idle. This will correctly capture a reduced Fed’s Balance sheet size and an increase in interest rates (more supply of treasuries will cause prices to fall and yields to rise).

Researchers have found that open market operations have the most significant impact on market yields. They measure both shorter term and longer term impacts. Some of them (Brandt and Kavajecz 2003) found out that order flows directly affect the yields over various maturities while others (Thornton 2009) could establish no significant relationship. This paper tries to supplement the already existing literature with some additional evidence that the size of the Fed balance sheet is directly related with treasury yields. To measure this effect it uses the change of the balance sheet’s size over a period of 22 years.

Gurkaynak, Sack and Wright (2007) have reconstructed the yield curve since 1961 on a daily basis. In their paper, they found several key aspects of the yield curve that will be employed. (1) On-the-run treasuries (those are treasuries which were newly issued by the treasury department) are in general more liquid than off-the-run treasuries (those that have been in the open market for more than 2 weeks) and therefore are selling at premium. This premium varies through the years and therefore they suggest that only off-the-run treasuries are used in estimating yield curve slope. (2) 1 to 9-month Treasury bills are often disconnected from the rest of the yield curve. (3) Treasuries with option-like features are excluded as well since they might distract the yield curve.

IV. Empirical Model and Data

Based upon the background section the following is a description of the empirical model:

\[ \Delta r_{market} = \beta_1 + \beta_2 \Delta FedBalSheet + u \]

- $\Delta r_{market}$ – Dependent variable, change in market interest rate
• **ΔFedBalSheet**: Independent variable, change in Fed’s balance sheet

### IV.I Data Construction

Past studies that focus on establishing the effects of open market operations on market interest rates have employed either the target federal funds rate or the 10-year Treasury note yield as a measure of overall market rate. In constructing the dependent variable $Δr_{market}$ this paper uses a different methodology. It employs a weighted average index that captures the value of $r_{market}$ at each specific point in time and then calculates the change between each two points. No other major publication uses the weighted average index and therefore testing for the usefulness of such an index would be important for future research. To construct the weighted average, this model uses the weights assigned to three different maturity groups and then multiplies these weights by their corresponding yields. It sums up the resulting weighted yields to get a proxy of the overall market rate. Table 1 below provides a hypothetical situation to demonstrate how the market weighted average rate is calculated.

#### Table 1: Hypothetical Weighted Average Market Rate Construction

<table>
<thead>
<tr>
<th>T-Bills (1yr or less)</th>
<th>Treasury notes (2yr-10yrs)</th>
<th>Treasury Bonds (11yrs-30yrs)</th>
<th>Weighted average market rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield 2%</td>
<td>Weight 25%</td>
<td>Yield 4%</td>
<td>Weight 5%</td>
</tr>
<tr>
<td>Weight 25%</td>
<td>Yield 50%</td>
<td>Weight 25%</td>
<td>Yield*Weight 1.25%</td>
</tr>
<tr>
<td>Yield*Weight .5%</td>
<td>Weight 2%</td>
<td></td>
<td>3.75%</td>
</tr>
</tbody>
</table>

For T-Bills, only yield on 1-yr Treasuries is used since Gurkaynak, Sack and Wright (2007) found that yields on Treasuries with maturities of less than 1-yr are disconnected from the yield curve. For Treasury Notes, we add up the yields for treasuries with maturities of 2 to 10 years and divide the sum by 9 (this is done since there is no data on individual maturity securities). This way we get an average yield that we use to calculate the weighted market rate. For Treasury bonds we employ the same approach where we add treasury yields with maturities of 11 to 30 years and then divide the sum by 19.

In order to get the weights for each of the three maturities we divide the value of the total treasuries outstanding for each maturity by the total treasuries outstanding of all maturities. Table 2 provides a hypothetical situation that explains how the weights are assigned.

#### Table 2: Hypothetical Weight Calculation

<table>
<thead>
<tr>
<th>(1) T-Bills (1yr or less)</th>
<th>(2) Treasury notes (2yr-10yrs)</th>
<th>(3) Treasury Bonds (11yrs-30yrs)</th>
<th>Total Value (sum of (1), (2) and (3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Value</td>
<td>$10 Million</td>
<td>$20 Million</td>
<td>$10 Million</td>
</tr>
<tr>
<td>Equation</td>
<td>$10 M. / $40 M.</td>
<td>$20 M. / $40 M.</td>
<td>$40 Million</td>
</tr>
<tr>
<td>Weight</td>
<td>25%</td>
<td>50%</td>
<td>25%</td>
</tr>
</tbody>
</table>

To construct $ΔFedBalSheet$, the model employs a simple procedure where it divides the total value of treasuries held by the Fed by the total value of treasuries outstanding. For example, if we have $10,000 worth of government bonds held in the Federal Reserve Bank while there is a total of $100,000 worth of government bonds circulating in the economy, the size of the Fed’s balance sheet would be 10%. Therefore, $ΔFedBalSheet$ would capture any change in the percentage holdings of treasuries by the Fed.

#### IV.II Data Sources

The data on **treasury yields** are taken from the Federal Reserve website. They contain yields on maturities from 1 year to 30 years since 1961. The yields are quoted daily and T-Bills with maturities of less than a year are excluded since they are disconnected from the construction of the yield curve (Gurkaynak, Sack and Wright, 2007). Unfortunately, the data on treasuries with maturities of 15 years and above are not reported for any year before 1988 and therefore this study only includes observations from 1988. The data on total value for Treasuries with different maturities, necessary for computing the weights, are taken from the economic report of the President, Table B-83. The report is
published once a year and goes back to 1961. It reports values on a monthly basis.

The data on $\Delta \text{FedBalSheet}$ are taken from the monthly publications of the Fed bulletin and the Treasury bulletin. The data are available since 1961 on a quarterly basis but yields are only available since 1984, we only analyze results from 1984 and on. The most recent treasury publication revealed that the Fed owned $0.8$ trillion of treasuries while total treasuries outstanding were $11.4$ trillion. $7.2$ trillion were held by the open public while the rest $4.2$ were held by government agencies (Figure 5).

![Figure 5: Total Outstanding US treasuries](image)

**Source: Treasury Bulletin, 2009**

Figure 6 on the next page reveals how the Fed has changed its policy during the recent financial crisis. Before 2008 the Fed clearly held mostly treasury securities while after the beginning of the crisis it has absorbed many other types of financial assets including swaps, TAC, AIG holdings etc. Therefore, it will exclude data from 2008 and 2009 since it only looks at treasury holdings in the Fed and I assume that the Fed only holds treasury securities.
V. Results

Table 3. The effects of changes of Fed’s balance sheet size on the overall market interest rate (t-statistic)

<table>
<thead>
<tr>
<th>Least square regression</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>12.299*** (8.267)</td>
</tr>
<tr>
<td>ΔFedBalSheet</td>
<td>-0.769*** (4.348)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.169</td>
</tr>
<tr>
<td>Sample Size</td>
<td>92</td>
</tr>
</tbody>
</table>

**Significance levels:** ***at the .001 level, **at the .01 level, *at the .05 level

Least square regression analysis yielded significant results that support the hypothesis. ΔFedBalSheet is significant at the .001 level which means that the Fed really does have an effect over market interest rates. According to the regression results, every 1% increase in the size of the Fed’s balance sheet as measured by the percent of the Fed Debt held by the Federal Reserve Bank would cause the market interest rates to fall by .769%. The R² is close to 17% which is a good number, keeping in mind that we are only using one independent variable. An R² of 17% tells us that the Fed is accountable for about 17% of the variation in the market interest rate. That seems to be quite plausible since the Fed only owns between 10-15% of total treasuries outstanding.
(Figure 5) and therefore should not have too much power over interest rates.

VI. Conclusion

The US central bank, the Fed, has many powers. It has almost complete political independence and is quite flexible in implementing its monetary policy. Still, open market operations seem to be the most efficient tool that the Fed uses to implement its policy. This study proves that purchasing and selling treasury securities measured through the size of the Fed’s balance sheet has a significant effect on the market interest rates. This means that open market operations can indeed affect and shift the yield curve.

Another important fact that we could derive is that taking an indexed weighted average market interest rate could be a great substitute for the federal funds rate or for the 10-year treasury rate. It could be employed in future studies that deal with the position of the yield curve and serve as a tool to create an index measuring the slope of the yield curve. The next hypothesis that I am planning to study would benefit significantly from the use of the weighted average market interest rate. It will try to explain why the yield curve changes its slope and if the Fed have anything to do with it.

Some of the problems that I encountered were mainly connected with the limited availability of data. If I had the information on yields prior to 1984 I could have more time periods to study. This could have strengthened my results and could have predicted more accurate coefficients. Another important independent variable that is missing is the inflation rate. Even though inflation rate numbers are readily available, I omitted their use for this particular study. There is almost certainly a chance that inflation plays an important role for market interest rate determination. I will address this problem in future studies. Overall, this study proves that the Fed has a substantial market power when determining market interest rates. For every percent increase of the Fed’s balance sheet we observe a .769% decrease in market yields.

REFERENCES


Mishkin Frederic, “The Economics of Money, Banking and Financial Markets.”
