THE INTEREST ELASTICITY OF EXCESS RESERVES HELD AT THE FEDERAL RESERVE

by

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DEFINITIONS

Great Recession: The term Great Recession refers to the recession in the United States economy from December 2007 to June 2009, as identified by the Business Cycle Dating Committee of the National Bureau of Economic Research.[1] An alternative specification of the dates of the Great Recession is from the first quarter of 2008 through the second quarter of 2009, when GDP growth was negative. This discrepancy has minimal impact, since the recession deteriorated rapidly during the fall and early winter of 2008, and disturbances in the financial markets during the early months of the Great Recession are treated with different definitions in this paper.

Financial Panic of 2008: Also referred to as the Financial Crisis of 2008, the Financial Panic of 2008 was a period of acute financial strain globally that was set off by the bankruptcy of Lehman Brothers on September 15, 2008. The Financial Panic extended into the winter and dissipated as market confidence returned in the spring of 2009.

Maintenance Period: The contiguous two-week periods (for most banks) over which banks must account for their reserves. Maintenance periods begin on Thursdays and end two Wednesdays afterwards (Federal Reserve Account Management Guide).

[1] http://www.nber.org/cycles/sept2010.html

Sub-Prime Mortgage Crisis: The Sub-Prime Mortgage Crisis is broadly defined as the financial crisis that preceded the Great Recession and the Financial Panic of 2008. The Sub-Prime Mortgage Crisis began in 2007 with asset write-downs at several major banks, the bankruptcy of mortgage lenders such as Countrywide Financial, and the failure of a number of prominent hedge funds. The Sub-Prime Mortgage Crisis extended into 2008 with the failure of Bear Sterns and the government takeovers of Fannie Mae and Freddie Mac.

ABSTRACT

This paper identifies the interest elasticity of excess reserves held at the Federal Reserve in order to critically analyze the Federal Reserve's plan to exit the extreme level of monetary policy accommodation used to combat the Great Recession. An econometric model is developed and estimates are drawn from a time-series data set ranging from 2007 to 2010. Particular attention is given to the Federal Reserve's new ability to pay interest on reserves and how this tool will affect the Federal Reserve's exit strategy and the interest elasticity of excess reserves. Results indicate that the semi-elasticity of excess reserves is -0.34. Furthermore, expectations of future interest rates have the most substantial effect on the level of excess reserves. These results imply that the Federal Reserve will not be able to implement the channel-corridor system in the United States banking system to exit the current extreme level of monetary accommodation.

Chapter 1

INTRODUCTION

1.1 The Federal Reserve, the Sub-Prime Mortgage Crisis, Financial Crisis of 2008, and the Great Recession

By the fall of 2008 a confluence of economic and financial conditions were threatening to plunge the United States into a second Great Depression. The Federal Reserve, led by Chairman Ben Bernake, was at the forefront of the government response to the crisis. Prominent economic theory at the time clearly dictated that during times of financial stress central banks need to supply the banking system with money so that the availability of credit does not contract and further threaten the economy. In late 2008 the Federal Reserve unleashed the largest liquidity expansion in history on the United States economy, and in doing so expanded the power of the Federal Reserve further than it had ever been before.

The most predictable step that the Federal Reserve took was the lowering of the target Federal Funds interest rate[2] to the lowest level it has ever been (since December 2008 the Federal Funds rate has not actually been a level, but a targeted range between 0% and 0.25%) (FOMC Statement 12/16/2008). Prior to the Great Recession the lowest that the target had ever stood was 1.00% following the recession in the early 2000's. The Federal Reserve also eased the terms on its standing liquidity facilities and created a new one in 2007 called the Term Auction Facility (Press Release 12/17/2007). Nevertheless, these actions proved insufficient to prevent a

[2] The Federal Funds rate is the interest rate at which banks lend money to each other overnight. It is the primary operating target of the Federal Reserve.

financial panic and the most severe post-war recession. In late 2008 the Federal Reserve dove deeper into uncharted waters by authorizing the Federal Reserve Bank of New York to initiate a round of large-scale asset purchases (Chairman Bernake has publically referred to this as "credit easing" but it is commonly referred to as *quantitative easing*, based on a similar campaign the Bank of Japan embarked on to end its country's Lost Decade) (Bernake 2009).

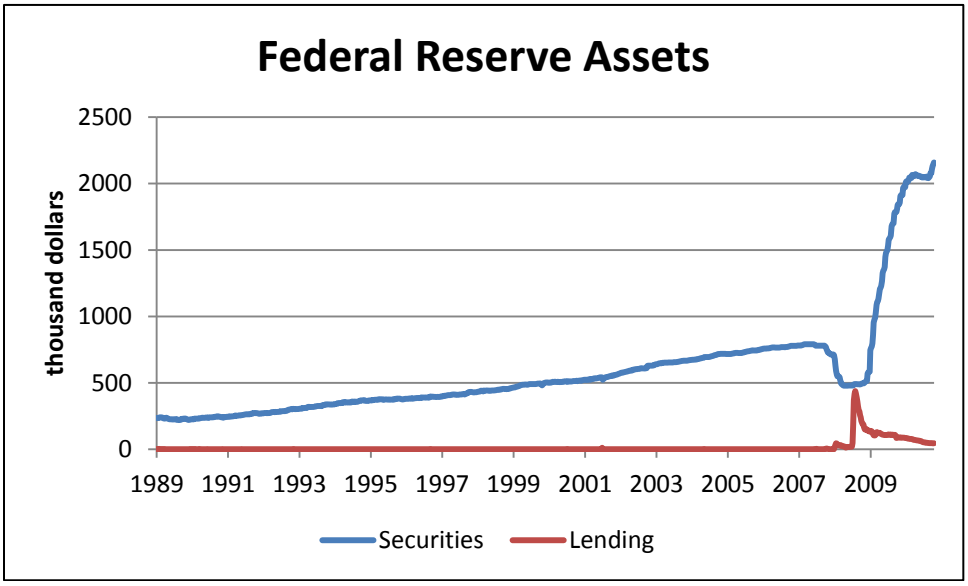

Figure 1.1.1. Federal Reserve Assets, 1989-2010

Before the financial crisis the Federal Reserve had $850 billion in assets. In late 2008, all of 2009, and the first two quarters of 2010 the Open Market Desk in New York purchased $300 billion of Treasury notes, $1.25 trillion of mortgage backed securities, and $170 billion of GSE/Agency Bonds. By the end of this program the balance sheet had nearly tripled to $2.3 trillion. In November 2010 the Federal Open

Market Committee[3] (FOMC) again approved a second round of large-scale asset purchases totaling $600 billion. At the close of 2010 the Federal Reserve had $2,407.7 billion in assets, which is continuously rising in 2011 as a result of QE II implementation.

The merits of the Federal Reserve's response to the Sub-Prime Mortgage Crisis and the ensuing Financial Crisis of 2008 and the Great Recession will be researched and debated for years to come, but this "Bernake Put," as it has been called by investors, does not come without consequences. Just as economic theory prescribes liquidity for an ailing economy, theory also stipulates that increases in the money supply are the primary cause of excess inflation. As a result, the Federal Reserve has fielded widespread criticism for its response to the Great Recession. Federal Reserve officials have not been deaf to their critics. In 2009 and 2010 the Federal Reserve continuously reassured the markets through speeches and press releases that it had an exit strategy to counter inflation. The worry for the exit strategy is the same as it was during the depths of the Recession. Just as the Federal Reserve has never been charged with preventing a financial and economic crisis as calamitous as the Great Depression in the modern era, never before has the Federal Reserve had to exit such enormous monetary support.

Exiting extreme monetary accommodation is a double edged sword. On one hand officials in a dual-mandate[4] system need to be cautious that their exit is not

[3] The Federal Open Market Committee is the main monetary policy making body in the United States. Its members include the Board of Governors of the Federal Reserve System and the President of the Federal Reserve District Banks. The FOMC meets every six weeks in Washington.

[4] The dual-mandate refers to the legislative directive for the Federal Reserve to ensure both price stability and full employment simultaneously.

too swift or extreme in nature, which would dampen the economic recovery. On the other hand, an improperly timed exit could unleash inflation in the United States economy that exceeds the high levels experienced in the late 1970's. Furthermore, there is relatively little empirical guidance for the Federal Reserve, since a monetary response of this magnitude has never been conducted in the United States prior to 2008.

1.2 Excess Reserve Shocks

Not only has the response of the Federal Reserve to the Great Recession been unusual and unprecedented, but so has the reaction of banks. Banks are required to hold reserves at the Federal Reserve which equal approximately 10% of total demand deposit liabilities. The Federal Reserve also allows banks to hold reserve in excess of their required amount. During normal times banks try to minimize the amount of reserves that they hold at the Federal Reserve because the funds are not generating profits for the banks. During financial crises banks draw up their excess reserve balances as cushions, but these are generally short lived. The average level of excess reserves from 1990 to 2008 was $1.428 billion.

The first reserve shock occurred between 1990 and 1991. It was a result of the Iraqi invasion of Kuwait and the uncertainty about oil availability surrounding the First Persian Gulf War. In addition, the Federal Reserve reduced reserve requirements in 1991 which led to volatility in the effective Federal Funds rate and a drawing up in excess reserves (Dow 2001). The next reserve shock occurred in late 1999 when banks held reserves in case Y2K had turned out to be more disruptive. The terrorist attacks of September 11, 2001 were the catalysts for the largest reserve shocks ever prior to 2008. In one month reserves spiked from $1.2 billion to $19.0 billion, but they had

returned to $1.3 billion by October 2001. The Sub-Prime Mortgage Crisis began in 2007, with hedge funds failing, a number of banks reporting write-downs, and more than one hundred mortgage lenders, including Countrywide Financial, going bankrupt. This also prompted a sharp, but temporary increase in the level of excess reserves.

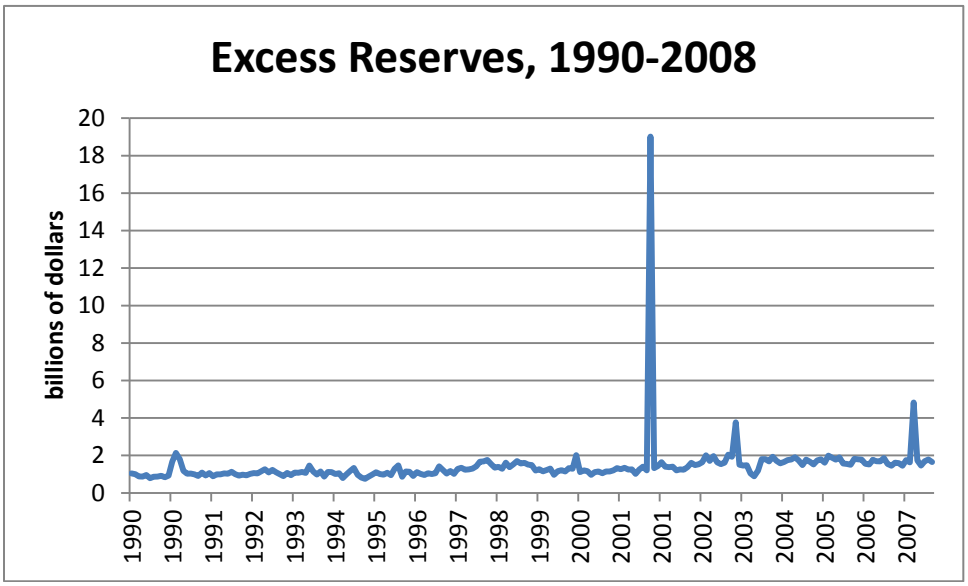

Figure 1.2.1. Excess Reserve, 1990-2008

The return to normalcy after the Sub-Prime Mortgage Crisis was relatively short-lived. On September, 15, 2008 Lehman Brothers declared bankruptcy, plunging the global financial markets into an unprecedented crisis. In one maintenance period excess reserves increased $65.6 billion dollars. By the end of 2008 they had increased to $798.3 billion. In February 2010 they reached their record maximum of $1192.0 billion. This is an 835% increase over the average level of excess reserves from 1990-

2008. With the resumption of quantitative easing in late 2010, excess reserves are again on the rise, closing the year at $1007.2 billion after falling slightly over the summer months.

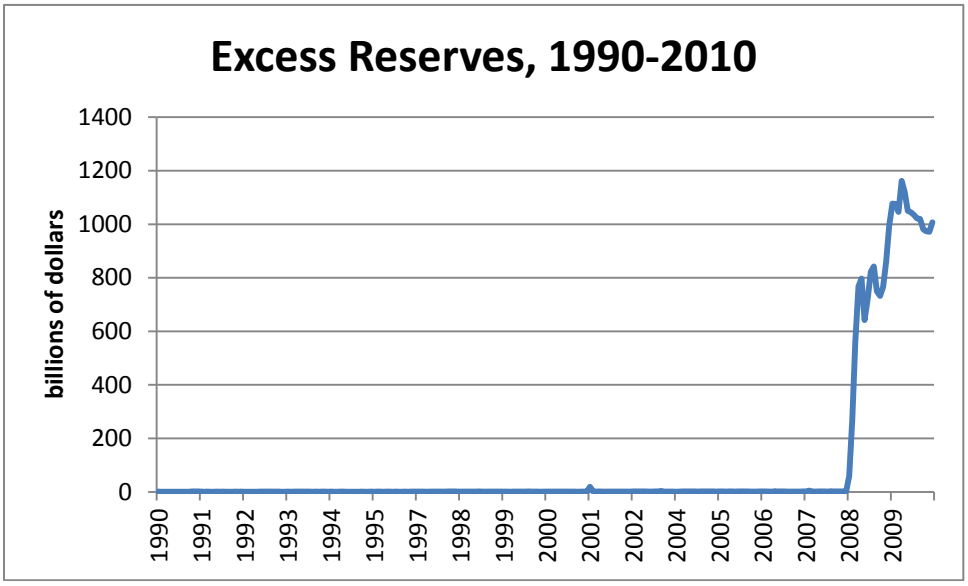

Figure 1.2.2. Excess Reserves, 1990-2010

The elevated level of excess reserves poses a unique and serious problem for the Federal Reserve's exit strategy. Raising the target Federal Funds rate may fail to achieve its intended consequences because banks with excess reserves can exert considerable downward pressure on interest rates if they chose to put their liquidity to work. The Federal Reserve needs to provide an incentive to unwind the level of excess reserves over time. Since 2009 they have been exalting the ability to pay interest on reserves (IOR), available to the Federal Reserve since the passage of the Emergency

Economic Stabilization Act of 2008, as the very tool that they need. Information about exactly how and to what degree the Federal Reserve will utilize this tool has not been released to the public, which has some of Chairman Bernake's most outspoken critics worried. On January 27, 2010 Allan Meltzer, an economist at Carnegie Mellon University and a historian of the Federal Reserve published on opinion piece in the Wall Street Journal. It was rather bluntly titled "The Fed's Anti-Inflation Strategy Will Fail." The reason: Meltzer believes that the FOMC has not sufficiently quantified the level to which they will have to raise the interest on excess reserves (IOER) rate to compel banks not lend out their excess reserves. The Federal Reserve is practicing "economics without prices (Meltzer, WSJ 2010)." Meltzer took his campaign to Washington on March 17, 2010 when he testified in front of the House Financial Services Committee. His message was as clear and unwavering as in his opinion piece. Meltzer doubts that the Federal Reserve has a clear plan to use IOER. Chairman Bernake and his cohorts have failed to offer any insight whatsoever on the issue. Furthermore, Meltzer testified that he believes the necessary interest rate would far surpass a level that is consistent with a sustained economic recovery. Because of this, Meltzer believes, Congress needs to take a far more proactive role in monetary policy and the issue of IOER as a component of the exit strategy in particular. (Meltzer, Testimony 2010). The recent deliberations on financial reform have cast a critical eye on the Federal Reserve, but not so much towards this aspect of monetary policy in particular.

1.3 Overview

This paper directly addresses Meltzer's criticism of the Federal Reserve by quantifying how sensitive excess reserves held at the Federal Reserve are to interest

rates. An econometric model is developed and discussed which quantifies the interest elasticity of excess reserves. Chapter Two of this paper will provide a broad overview of the Federal Reserve's exit strategy. Conclusions are generally drawn from official testimony and speeches delivered by Governors of the Federal Reserve Board. The exit strategy is divided into two different phases: normalization actions and contractionary tools. Normalization actions are the subject of Section 2.1, with particular discussions of the closing of short-term lending facilities in 2.1.1, the discount window in 2.1.2, and the Treasury Supplementary Financing Program in 2.1.3. Section 2.2, contractionary tools, has sections on reverse repurchase agreements, 2.2.1, the Term Deposit Facility in 2.2.2, and the prospect for asset sales in 2.2.3. Chapter Three expounds upon IOR, which is a component of the exit strategy not discussed in Chapter Three. Section 3.1 introduces the channel-corridor system as a monetary policy option, and Section 3.2 elucidates upon how the Federal Reserve envisions IOER playing a role as a contractionary tool.

Chapter Four is a survey of literature on bank reserve management. This chapter serves as the theoretical foundation for the empirical methods discussed in Chapter Five. Chapter Five explains the development of an econometric model to estimate the interest elasticity of excess reserves held at the Federal Reserve. Section 5.1 develops the primary explanatory variable, the opportunity cost of holding excess reserves. Sections 5.2, 5.3, and 5.5 explain additional variable included in the model. Section 5.4 discusses the structure of the data set used to evaluate hypotheses. In Section 5.6 the possibility of a break-point in the data is theorized. Chapter Six presents estimates from the econometric model, and Chapter Seven is an in-depth discussion of the implications these results have for monetary policy. Section 7.1

focuses on the implications of normalization actions, and 7.2 is devoted to contractionary tools. Section 7.3 touches upon the common question that arises about costs associated with Federal Reserve actions, and the paper ends with section 7.4, a conclusion.

Chapter 2

THE EXIT STRATEGY

The high levels of monetary support that the Federal Reserve has injected into the economy come with the risk that post-recovery, the United States could experience price inflation in excess of the rate central bankers deem acceptable. Indeed, the unprecedented size of the Federal Reserve balance sheet could stoke inflation higher than the United States has ever experienced in the modern era. Critics of the Federal Reserve have honed in on this aspect of the Federal Reserve's response to the Great Recession, exclaiming that the continuous "Bernake Put" is so ill conceived that hyper-inflation is a possible outcome for the United States.

Officials at the Federal Reserve have not turned a blind eye to their critics. Even during the depths of the Recession rhetoric was coming out of the Federal Reserve ensuring the public that they had a plan and the tools necessary to unwind the elevated levels of monetary support and prevent inflation without commensurately stifling economic recovery and growth. This plan has been dubbed the Federal Reserve's e*xit strategy*.

In early 2009 details from Federal Reserve officials about the exit strategy were rare. However, over time officials began to reveal more and more about their plan to prevent inflation while still simultaneously fostering economic growth. In March 2010 Chairman Bernake outlined in testimony to the House Financial Services Committee an exit strategy with six distinct components. In addition to the six tools that Chairman Bernake outlined the Federal Reserve can appeal to the Treasury

Department to implement one more tool, making the exit strategy a seven-pronged plan. It is listed here in the most likely order that its steps will be carried out:

1) Closing of short-term liquidity facilities,
2) Discount lending normalization,
3) The Treasury Supplementary Financing Program,
4) Reverse repurchase agreements,
5) Term Deposits,
6) Raising the Federal Funds target rate and interest rate paid on reserves,
7) Asset sales.

The first three steps of the exit strategy are not intended as contractionary measures meant to restrain the rate of growth in the economy. These measures are simply utilized to normalize Federal Reserve policy and return the Federal Reserve to operations that are familiar and it feels comfortable maneuvering with. The remaining four steps will be implemented once the Federal Reserve perceives that the economic recovery is strong enough to support itself without extreme monetary accommodation, and are meant to contain growth and prevent inflation. The first three *normalization actions* are discussed in Section 3.1, and the *contractionary tools*, with the exception of step six, raising the Federal Funds target rate and the interest rate paid on reserves, are the subjection of Section 3.2.

2.1 Normalization Actions

From 2007 to 2009 the Federal Reserve expanded from a lender of last resort for the commercial banking system into an entity with a much larger scope and commensurately much more power. Minutes from FOMC Meetings all indicate that

policy makers hope to return the Federal Reserve to its pre-Recession status and operations. The steps needed to unwind emergency policy are labeled as normalization actions of the exit strategy in this paper and are considered in this section.

2.1.1 Closing of Short-Term Lending Facilities

During the peak of the Financial Crisis of 2008 the Federal Reserve opened a number of short term emergency liquidity facilities, many of which invoking Federal Reserve Act Section 13 (3) emergency lending powers. These facilities were aimed at specific financial markets, such as commercial paper and money market mutual funds. They were specifically designed to only be attractive financing options during times of financial stress so that they would naturally unwind themselves as financial conditions improved (Bernake 2010, Wessel 2009). Most short-term liquidity facilities were closed in 2009 and left little residual balances on the Federal Reserve's balance sheet (Kohn 2009). The closing of short-term liquidity facilities is the only stage of the Federal Reserve's exit strategy, let alone necessary normalization actions, that has been completed.

2.1.2 Discount Lending Normalization

Even before the Financial Panic of 2008 threatened to spark the second Great Depression, the Sub-Prime Mortgage Crisis began straining interbank lending markets in 2007. In response, the Federal Reserve eased the financing terms of its discount window. The discount window is the tool the Federal Reserve uses to fill its role as the lender of last resort. During normal times, banks can apply for collateralized loans directly from the Federal Reserve at an interest rate 100 basis

points[5] (bps) above the targeted Federal Funds interest rate. This rate is referred to as the discount rate, although technically it is the primary credit rate, because banks under financial stress can apply for secondary credit (at the Federal Funds target rate plus 150 bps, or 50 bps more than the primary credit rate), and seasonal credit is also available from the Federal Reserve for specific banking requirements. In September 2007 the Federal Reserve Board decreased the spread between the targeted Federal Funds rate and the primary credit rate by 50 bps (to a 50 bps spread) and made discount loans available for up to 30 days (previously they were overnight loans) (FOMC Statement, 9/17/07).

This action and all of the other actions that central bankers were taking globally proved to be insufficient. In the years prior to the Sub-Prime Mortgage Crisis the 30-Day LIBOR[6] rate averaged below one percentage point. At the end of 2007 it was at 5.24%. The discount window was not being heavily utilized by banks. Banks did not want other banks or the public to think that they were under any sort of financial stress. This was a particularly acute problem given the fragility of markets at the time. In response, the Federal Reserve inaugurated the Term Auction Facility (TAF) on December 17, 2007. The TAF allowed banks to secure funds for 24 or 84 days at a rate set by auction, not predetermined by the Federal Reserve Board (Press Release, 12/12/07). Since the TAF was administered as a competitive auction, not an open window, it eliminated the "stigma problem" that was inherent to discount borrowing (Bernake 2010).

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[5] A basis point is equal to 0.01%, or one hundredth of a percentage point.

[6] LIBOR stands for London Interbank Offering Rate and is computed daily by the British Banking Association as a trimmed-mean of the interbank interest rate between a group of large banks in London

Even despite these efforts severe financial stress persisted. TAF auctions consistently cleared at an interest rate below the primary credit rate, indicating that the premium on the discount window was still too high relative to strained financial conditions. The Federal Reserve did not act on these concerns until March 18, 2008, the day that it stepped in to prevent the bankruptcy of Bear Sterns. The primary credit rate was reduced another 25 bps to a 25 bps premium, and the availability of funds was expanded further to 90 days (Press Release, 3/16/08).

These conditions for discount lending remained in place for over one year, until November 17, 2009, when the Federal Reserve Board announced that effective January 14, 2010 the maximum duration of discount loans would be reduced from 90 days to 28 days (Press Release 11/17/2009). One month later the Federal Reserve Board announced further discount lending normalization. The discount rate was increased 25 bps (to 50 bps), and loans were once again restricted to overnight maturities (Press Release 2/18/2010). Bernake had all-but announced this change a week prior during Congressional testimony, but he included the ubiquitous Federal Reserve disclaimer that, “These changes, like the closure of a number of lending facilities earlier this month, should be viewed as further normalization of the Federal Reserve’s lending facilities, in light of the improving conditions in financial markets; they are not expected to lead to tighter financial conditions for households and businesses and should not be interpreted as signaling any change in the outlook for monetary policy, which remains about as it was at the time of the January meeting of the FOMC (Bernake 2010).” At that time it was predicted that in the months to come the spread between the Federal Funds rate and the primary credit rate would increase until it reached its pre-crisis level of 100 bps, but at the close of 2010 there had not

been any new changes to discount lending procedures. It is likely that this was due to stress that emerged in the inter-bank lending market due to the European Fiscal Crisis.

2.1.3 Treasury Supplementary Financing Program

The Treasury Supplementary Financing Program was announced through the dust of the Lehman Brothers collapse. On September 18, 2008 the Treasury opened a new account with the Federal Reserve. The Treasury usually holds tax receipts at accounts at individual banks and then transfers funds to the Treasury's General Fund when the Treasury needs to use the funds. This procedure helps prevent Treasury activities from disrupting bank reserves and the Federal Funds market (Fullwiler 2005). In the TSFP the Treasury auctions T-Bills and deposits the proceeds at the TSF Account at the Federal Reserve. But instead of using the capital to finance government expenditures and transfers, the Treasury simply leaves the funds at the Federal Reserve. This has the effect of reducing the monetary base since funds are transferred from banks to the TSF Account, without the Treasury once again dispensing them. Adding to the TSF Account has the same effect as offensive open market operations, when the Federal Reserve sells short-term T-Bills to extract liquidity from the banking system and raise short-term interest rates in response to Federal Reserve lending activity.

Less than two months after the TSFP was created its account was valued at $560 billion. The Treasury let its value naturally decrease as bills matured, until it reached $200 billion, where it has remained constant ever since, except on two occasions. In late 2009 the US Treasury began to approach the statutory limit that Congress has placed on outstanding United States debt. The Treasury drew down the TSFP to finance government operations until Congress increased the debt ceiling. At

the time of writing the Treasury is again reaching the debt ceiling, and the size of the TSFP account is decreasing as a result.

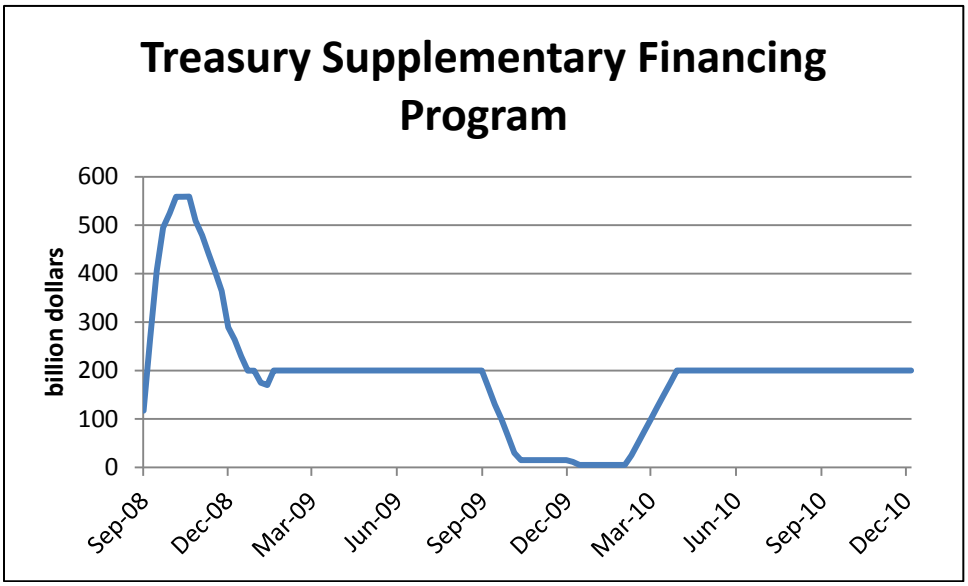

Figure 2.1.3.1. Treasury Supplementary Financing Program

If the debate over the debt ceiling is resolved the TSFP can be used as a tool in the exit strategy. The TSFP has a direct effect on the monetary base. Therefore, the Federal Reserve could appeal to the Treasury to scale up or down the size of the TSF Account as they see necessary for the proper implementation of monetary policy.

2.2 Contractionary Tools

Normalizing the functions of the Federal Reserve can occur without restricting the liquidity available in financial markets. However, the Federal Reserve will not be able to reduce the size of its bloated balance sheet without taking actions that remove liquidity from the banking system. Moving to the second phase of the exit

strategy in which the Federal Reserve employs these contractionary tools needs to be a carefully considered decision. On one hand, initiating this second stage of the exit strategy will restrain growth. Poorly timed and the economic recovery could be compromised. On the other hand, if the Federal Reserve waits too long the excess liquidity now cushioning the system could run hot, fuel a credit expansion and ultimately cause the inflation rate to exceed target.

2.2.1 Reverse Repurchase Agreements

Most times when the Open Market Desk conducts open market operations the operations are not in response to the FOMC changing its Federal Funds target rate. Rather, they are responding to changes in the Federal Funds market which have pressured the FF rate to deviate from the FOMC's target rate. These are known as defensive operations, and frequently they are not outright purchases or sales of T-Bills. Usually, the Desk engages in repurchase agreements with its Primary Dealers.[7] In a repurchase agreement the Desk borrows a T-Bill for a short amount of time at an agreed upon interest rate and then returns the security to the Primary Dealer at a specified date. A repo puts money into the banking system for a specified amount of time, and then removes the money when the repo expires. A reverse repurchase agreement is the exact opposite. One party (in this case the Federal Reserve) lends out a security to a second party for a pre-determined amount of time at a market interest rate, and then reclaims the security. Federal Reserve officials have stated time and time again that reverse repurchase agreements are one of the key components of the Federal Reserve's exit strategy.

[7] Primary Dealers are the 20 large banks that the Federal Reserve directly trades securities with.

The Fed is not planning on engaging in traditional reverse repos. The large number of unconventional and illiquid assets that the Federal Reserve is holding on its balance sheet would make conventional monetary policy actions, such as raising the target Federal Funds rate, ineffective. Reserves are far too excessive, and long-term interest rates have been perverted by the Federal Reserve's purchasing programs. Selling mortgage backed securities, Agency debt, and long-term Treasuries would remedy this situation, but policy makers are reluctant to do this because of the fragility of these debt markets. Therefore, the FOMC sees reverse repos of their unconventional securities as the best compromise to manage the balance sheet without disrupting the recovery. The reverse repos would last up to 65 days, while typical reverse repos are overnight agreements. In addition, the scope of the program would require the agreements to have more counterparties than just the Primary Dealers. Currently, the Open Market Desk is conducting a pilot program with money market mutual funds as counterparties. If the Federal Reserve can successfully expand their reverse repo operations then it will greatly expand their ability to manage bank reserves without jeopardizing the recovery.

2.2.2 Term Deposit Facility

One of the most intriguing proposals yet to be made by monetary policy makers is the establishment of a Term Deposit Facility (TDF). Essentially, the TDF would operate similar to the Term Auction Facility, but rather than loaning money out to banks, depository institutions would be bidding to secure their money at the Federal Reserve for a pre-specified amount of time. However, unlike a certificate of deposit you take out from commercial banks with an APY set by the bank, the TDF rate would be set by auction. In the minutes from the March meeting of the FOMC policy makers

indicated that the terms of the deposits would not exceed one year, and likely they would be between one and six months (Minutes, 3/2010).

The TDF has the potential to be one of the more promising components of Bernake's exit strategy. Depending on the pace of the eventual credit expansion and the success of the other exit strategy measures, the TDF can be scaled up or down. In addition, the TDF will not be subject to the same problem that paying interest on reserves faces: banks will be able to set the interest rate by auction mechanism; the Board of Governors will not have to speculate as to what the opportunity cost of holding money at the Fed actually is. In fact, the TDF may reveal to monetary policy makers how sensitive reserves are to interest rates, because banks will be putting in their bids based on current market conditions and expectations. Information collected from TDF auctions may actually help to improve IOER rate setting procedures. The European Central Bank began accepting term deposits in May 2010 in an effort to sterilize their purchases of Euro Area sovereign debt, and the Federal Reserve has been offering small-scale term deposits in a test of the efficacy of the facility.

2.2.3 Asset Sales

Although Allan Meltzer and other critics are stirring up a lot of acrimony about interest on reserves outside of the halls of the Federal Reserve, the large stock of mortgage backed securities and agency bonds in the System Open Market Account (SOMA) is proving to be one of the most contentious components of the exit strategy inside of the Federal Reserve itself. In total the Federal Reserve purchased $1.72 trillion of unconventional securities ($1.25 trillion of mortgage backed securities, $300 billion of Treasury Bonds, and $170 billion of Agency/GSE bonds) in the first round of quantitative easing, and is adding another $600 billion through June 2011. All of

the aforementioned exit strategy tools affect the liability side of the Federal Reserve's balance sheet. These tools all reduce the liquidity of central bank liabilities so that money is less likely to turn hot and fuel a credit expansion, but it does not reduce the total supply of money outstanding. In order for the Federal Reserve to reduce total money in the aggregate, it needs to reduce the asset side of its balance sheet, which is extremely inflated because of these asset purchases. The only thing that policy makers can agree on is that if the Federal Reserve does not eventually remove these securities from its balance sheet then the extra money in the economy will put upward pressure on prices. In the Minutes from the April 2010 meeting of the FOMC all of the members unanimously supported reducing Federal Reserve assets to its historical levels, because if they do not do so an expanding money supply will put upward pressure on prices. They simply disagree on how to go about shedding assets and when to begin doing so (Minutes, 4/2010).

FOMC members seem to fall into two general camps. Some members want to see asset sales as an early component of the exit strategy, even before the FOMC raises its interest rate target. This camp is led by St. Louis Bank President Thomas Hoenig. The other group, which is currently guiding policy, would like to wait to sell assets until after the FOMC raises its target interest rates. Chairman Bernake is the most powerful proponent of this choice of policy (Minutes, 4/2010).

Chapter 3

INTEREST ON RESERVES

3.1 The Channel-Corridor System

Congress gave the Federal Reserve statutory authority to pay interest on reserves in 2006's Financial Services Regulatory Relief Act starting on October 1, 2011. At that time, interest on reserves was seen as a method to help the Open Market Desk in New York set a floor on the effective Federal Funds rate (Fullwiler 2005). Monetary policy makers originally envisioned interest on reserves as a measure to institute the channel-corridor system in the American banking system. The channel-corridor system targets the Federal Funds rate, but then it creates effective floors and ceilings with the discount rate and the rate paid on reserves. The purpose of this system is to give the central bank increased control over interest rates, which periodically show volatility for a number of reasons. Banks would never seek loans from other private institutions above the discount rate, because they know with certainty they can get the loan from the discount window. And banks would never loan funds to other institutions below the IOR rate, because they could increase their returns by lending to the Federal Reserve. These opportunity-relationships create a channel that the interest rate will not deviate from. In a footnote to prepared Congressional testimony in February, Bernake stated that the Federal Reserve may begin to employ the channel-corridor approach to interest rate setting given that the Federal Reserve now has Congressional approval to pay interest on reserves (Bernake 2010).

The problem with this system is that GSE's such as Fannie Mae and Freddie Mac are large Federal Funds lenders while being institutions that are ineligible to receive interest on reserves. This bifurcates the Federal Funds market into GSE's and banks. Banks conform to the channel corridor system because they are not compelled to loan money below the interest rate paid on excess reserves, but GSE's have a higher opportunity cost of holding reserves because they do not receive interest on reserves, so they will loan below the interest rate. The GSE's market share in the Federal Funds market is sufficiently large, and growing, making paying interest on reserves an ineffective price floor (Bech & Klee 2009).

3.2 Interest on Reserves as the Sixth Component of the Exit Strategy

Among the options Federal Reserve officials have listed as part of their exit strategy, the new ability to pay interest on reserves stands out as the most important. In the fall of 2008 policy makers realized that the Federal Reserve required the ability to pay interest on reserves immediately. Since 2007 the Federal Reserve had been pumping liquidity into the system at an accelerated rate through term auction credit, discount lending, and other support measures. This had the effect of increasing the monetary base, but the FOMC was not decreasing the target Federal Funds rate at a pace matching the rate that liquidity was entering the system, so the Open Market Desk in New York was continuously sterilizing the effects of these liquidity programs. The sterilization measures were carried out by selling SOMA Treasury securities on the open market. The size of the SOMA was shrinking at an alarming rate. When the Sub-Prime Mortgage Crisis began the SOMA held $790 billion of securities outright. By the summer of 2008 the SOMA had decreased 39% to $479 billion, as illustrated in

Figure 1.1.1. If nothing was changed then the channels through which the Federal Reserve conducted monetary policy would have been completely inaccessible.

Relief first came as the FOMC began to decrease the Federal Funds target rate. Throughout the summer the target remained at 2.0%. On September 8th the FOMC lowered the target 50 bps to 1.5% (FOMC Statement 9/18/2008). Then again at the end of October the FOMC lowered the target to 1.0%, another 50 bps (FOMC Statement 10/29/2008). The Open Market Desk was no longer under pressure to sell such a large number of securities in order to maintain a high interest rate relative to weak financial conditions.

The second piece of relief was the creation of the Treasury Supplementary Financing Program. Although the TSFP is now a component of the exit strategy, in 2008 it was conceived of as part of the solution to the impending depletion of the SOMA. Since TSF activity had the same effect on the monetary base as open market sales, the Treasury was effectively able to act as a proxy for the Open Market Desk, sterilizing Federal Reserve liquidity measures without compromising the SOMA.

The last piece of relief came on October 3, 2008, with the passage of the Emergency Economic Stabilization Act (lovingly referred to as the bailout by some, or TARP or the Troubled Asset Relief Program by others). Tucked away in this legislation was a provision that allowed the Federal Reserve to pay interest on reserves on October 1, 2008, three years earlier than the 2006 legislation had permitted.[8] The ability to pay interest on reserves greatly reduced the disruptive effect that emergency liquidity loans had on the interbank lending markets. New liquidity in the system was

[8] The Federal Reserve began paying IOR on October 6, 2008, retroactive to October 1, 2008.

no longer loaned out by banks. Instead, banks had the incentive to just leave funds at the Federal Reserve as reserves and accrue interest on them. The Open Market Desk no longer needed to sell securities out of the SOMA as a sterilization measure, because most emergency lending funds were being stored as excess reserves at the Federal Reserve.

The Federal Reserve Board of Governors officially reports four different rates for interest on reserves:

1) Excess Reserve Balances for Institutions with 1-Week Maintenance Periods,

2) Required Reserve Balances for Institutions with 1-Week Maintenance Periods,

3) Excess Reserve Balances for Institutions with 2-Week Maintenance Periods,

4) Required Reserve Balances for Institutions with 2-Week Maintenance Periods.

For more than two years now all four categories have paid 25 bps, which has been the upper bound of the Federal Funds rate target range. However, the rates changed frequently in late 2008. Originally, the FOMC established the rate paid on required reserves as 10 bps below the average target Federal Funds rate for institutions with one and two week maintenance periods. If the FOMC altered its target during a maintenance period, then the IOR rate would be 10 bps below the average of the two (or more) targets. In October the target rate was 1.50%, so the rate paid on required reserves was 1.40%. Required reserves received such a tight spread on the target rate to, “essentially eliminate the opportunity cost of holding required reserves, promoting efficiency in the banking sector (Press Release, 10/6/08).”

The rate paid on excess reserves was set 75 bps below the lowest targeted FF rate during the maintenance period in order to set a floor in the Federal Funds market. For excess reserves, if the FOMC changed the target FF rate then the IOR rate would be 75 bps less the lowest of the two (or more) targets during the maintenance period. For two week institutions, the rate paid was 75 bps, or half of the 150 bps target rate.

Table 3.1. Changes in the Interest Rate Paid on Reserves in 2008

1-Week	Oct. 15, 2008	Oct. 29, 2008	Nov. 5, 2008	Nov. 12, 2008	Dec. 17, 2008	Dec. 25, 2008
Excess	0.75%	0.65%	no Δ	1.00%	0.25%	no Δ
Required	1.40%	1.33%	0.90%	1.00%	0.79%	0.25%
2-Week		Oct. 22, 2008	Nov. 5, 2008	Nov. 19, 2008	Dec. 17, 2008	Dec. 31, 2008
Excess		0.75%	0.65%	1.00%	0.25%	no Δ
Required		1.40%	1.11%	1.00%	0.89%	0.25%

On October 22, 2008 the first change was announced. The rate paid on excess balances was reduced to a 35 bps spread (Press Release, 10/22/08). The Federal Reserve Board reported this as a measure to further decrease effective FF rate volatility, but reducing the spread can also be seen as foreshadowing future decreases in the FF target rate. Just a week later the FOMC decreased the target rate 50 bps to 1.00% and kept it there until December when the 0-25 bps range was established. If the formula to determine the rate paid on excess reserves had not changed then the rate

would have been near or below 0%. In November and December the FOMC continued its process of reducing the spread between the target FF rate and the rate paid on required and excess reserves. By the beginning of 2009 all four reported rates on reserve balances were equal to 25 bps, the upper bound of the target FF rate.

Chapter 4

BANK RESERVES MANAGEMENT

Theoretical work on the excess reserve market began in the 1960's. Poole (1968) presented a model for bank reserves that is still utilized. Holding excess reserves implies an opportunity cost equal to the interest the funds could be earning for a bank. Therefore, banks seek to minimize their excess reserves relative to the opportunity cost of holding them. However, it behooves banks to hold some excess reserves to avoid paying penalties due to required reserve deficiencies. Excess reserves can also become attractive when banks migrate toward cash, because the opportunity cost of holding excess reserves is drastically reduced due to the inherent risks in alternative investments and the low interest rates accompanying them.

Prior to October 2008 when the Federal Reserve began paying interest on reserves, the opportunity cost of holding excess reserves was relatively high because the funds could easily be put towards short term interest bearing securities. Paying IOER decreases the opportunity cost of holding excess reserves by the interest rate paid.

Empirical work did not begin until a few decades after Poole's publication. The literature does not emphasize the opportunity cost of holding excess reserves. Opportunity cost is not even part of Poole's (1968) model. Frost (1971), Evanoff (1990), Hamilton (1997), and Dow (2001) included opportunity cost in their models, but they do not emphasize it. Prior to 2008 the opportunity cost was simply a prevailing market interest rate, so they mentioned that opportunity cost would be more

dynamic of a variable if the Federal Reserve began to pay interest on reserves. Lacking this importance, the experimenters simply selected market interest rates to use as proxies for the banks' next-best asset alternatives. Hamilton (1997) and Dow (2001) both selected the Federal Funds rate as their benchmark interest rate, while Frost (1971) and Evanoff (1990) used the T-Bill rate.

In the current monetary environment the Federal Funds rate seems like an unlikely candidate for the benchmark interest rate. Excess reserves have fluctuated between $800 billion and $1.2 trillion for two years, which exceeds the daily volume in the Federal Funds market (Beecher & Klee 2007). Frost (1971) and Evanoff's (1990) models seem more relevant in the current monetary climate, since short-term and risk free US government securities are a highly liquid market that banks remained active in throughout the Financial Crisis of 2008.

In addition to differences in their opportunity cost proxies, the experimenters used different dependent variables, which complicate the process of comparing models. Frost (1971), Dow (2001), and Evanoff (1990) use the level of excess reserves as their dependent variables. However, Hamilton (1997) uses non-borrowed reserves.[9]

A fifth researcher, Vernon (1990) is a unique case. Vernon (1990) produces the only bona-fide interest elasticity in the literature by using a log-log econometric model. However, the purpose of Vernon's (1990) research was to

[9] Non-borrowed reserve equal total reserves of depository institutions held at the Federal Reserve minus reserves that are borrowed directly from the Federal Reserve discount window and other lending programs. Borrowings can exceed the total level of reserves, and as a result non-borrowed reserves can have a negative value, as was seen in most of 2008.

determine what the interest elasticity of reserves would have been if the Federal Reserve had paid interest on reserves during the 1920's. At that time not all banks were legally required to be members of the Federal Reserve System (and many were not), so Vernon compared reserve management behavior of member banks to non-member banks. Vernon (1990) assumed that member banks would have deposited their cash in interest-bearing time deposits at other banks were they not required to hold the cash at the Federal Reserve instead. To quantify this difference, Vernon (1990) used the yield on four to six month prime commercial paper issued by New York City banks (which was incorporated into the econometric model as an independent variable logarithm). The dependent variable was the logarithm of the ratio of reserves to total deposits at banks. The estimation resulted in an interest elasticity of -0.2402. Nevertheless, the national economy and the banking industry have changed considerably since the 1920's. This historical elasticity offers little credible guidance to modern day monetary policy makers.

Tabe. 4.1. Summarized Results of Previous Empirical Research

Author	Dependent Variable	Benchmark (Independent Variable)	Relationship
Hamilton	non-borrowed reserves	Federal Funds rate	- $300 mln
Dow	excess reserves	Federal Funds rate	- $120 mln
Evanoff	excess reserves	30-day T-Bill rate	- $150 mln
Frost	Excess reserves	91/182-day T-Bill rate	N/A
Vernon	log, ratio of reserves/total deposits	log, commercial paper rate	-0.2402

Chapter 5

METHODS

In order to estimate the interest elasticity of excess reserves, an econometric model was developed that incorporates time series data for all of 2007, 2008, 2009, and 2010 (n=104). Observations are structured by maintenance period. Based on the relevant literature pertaining to bank reserve management discussed in the previous chapter, the following model was developed:

$$Y_t = \beta_0 + \beta_1 R_t + \beta_2 Y_{t-1} + \beta_3 C_t + \beta_4 P_t + \beta_5 F_t + \beta_6 M_{t+1} + \beta_7 (F_t \times M_{t+1})$$

Y = ln(Excess Reserves), in billions of dollars

R = Opportunity Cost, in basis points

C = Carryover as a Percent of Excess Reserves

P = Penalty of Required Reserve Deficiency, in basis points

F = Expected Change in the Federal Funds Rate, in basis points

M = 1 if FOMC releases a statement in the maintenance period, 0 if not

5.1 Opportunity Cost, R

The opportunity cost of holding excess reserves, R, is calculated by subtracting the interest rate paid on excess reserves from a prevailing benchmark interest rate. The benchmark selected is the 3-month LIBOR-OIS spread. The LIBOR-OIS Spread is the difference between LIBOR and the OIS[10] rate. The spread is

[10] An OIS is an overnight indexed swap. Banks purchase these interest rate derivatives to protect their assets against short-term interest rate volatility

generally considered to be an indication of stress and liquidity in the interbank lending market and as a result monitored very closely by market participants. Although the spread is not an interest rate, it does have certain qualities that make it the best candidate. Firstly, when tested against other possible benchmark rates (such as T-Bills, overnight LIBOR, overnight commercial paper, and overnight repurchase agreements), the LIBOR-OIS spread had a strong fit with the data and a high significance. Secondly, the inclusion of the overnight indexed swap (OIS) rate is generally considered by economists to be a measure of risk in the interbank lending market and the financial markets more broadly. Therefore, using LIBOR-OIS to calculate the opportunity cost eliminates the necessity to include an additional variable to stand as a proxy for risk.

5.2 Penalties, P and Carryover, C

Banks are required to hold reserves at the Federal Reserve which equal approximately 10% of total demand deposit liabilities. The Federal Reserve uses a lagged system to implement this requirement. Banks are required to hold reserves in one maintenance period for the average level of deposits in the preceding period. If they fail to meet requirements the Federal Reserve imposes a penalty, P, equal to one percentage points more than the primary credit rate. The Federal Reserve does allow a small margin of error in maintaining required reserves of 2.0% or $25,000, whichever is greater (Federal Reserve Account Management Guide). If banks are within the margin, they can make up the deficiency in the following maintenance period without penalty. Likewise, banks can carry over a small amount of excess reserves from one maintenance period into the following period in order to compensate for comparably

small deficiencies. This is known as carryover, C, which is incorporated into the model as a percent of total excess reserves.

5.3 Expected Change in the Federal Funds Rate, F and M

In Evanoff (1990) the experimenters noted the importance of including a variable for the expected change in the Federal Funds rate, but they were unable to devise a suitable method to estimate this value. Therefore, the actual change in the Federal Funds rate was substituted for the expected change. However, since the early 1990's a market has developed for Federal Funds futures, so the expected change can be calculated using quotes from this market. 100 minus the quoted price is the rate that market participants believe the Federal Funds rate will be at the delivery date of the futures contract. The shortest duration contracts available are one month forward. Therefore, the expected change in the Federal Funds rate for the following period, F, is estimated as (100 – price of one month forward Federal Funds futures contracts) – the effective Federal Funds rate.

It is likely that bank reserve managers anticipate changes in the Federal Funds rate to occur when the FOMC has scheduled meetings, so a binary variable, M, was included to capture this effect on excess reserves. This variable was interacted with F to produce β_7, which is the effect an expected change in the Federal Funds rate has at times when the FOMC releases its monetary policy stance.

Using the effective Federal Funds rate in the formula to calculate the expected change in the Federal Funds rate, F, rather than the official rate targeted by the FOMC does have drawbacks, but they do not seem to seriously affect results. The targeted rate would be superior because the FOMC announces changes in the Federal Funds rate target, not the effective rate, so the targeted rate would better capture

expectations. However, since December 2008 the FOMC has had a target range, not a specific target rate, which makes estimates based on a singular target rate unfeasible. Estimates were gathered which split this component of the model into two variables: expected change from the top of the targeted range and expected change from the bottom of the targeted range (prior to December 2008 the variables were identical). This formulation of F reduced the significance of the variable and the overall model, so the reported formula was adopted instead.

5.4 Data Structure

Excess reserves and carryover are reported by the Federal Reserve on a bi-weekly basis (due to the duration of maintenance periods). However, LIBOR (and subsequently the LIBOR-OIS spread) is reported daily by the British Bankers Association. Federal Funds futures contracts trade continuously during Chicago market hours, and the Federal Funds market is also an active over the counter market. In addition, the discount rate and IOER rate are subject to change by the Federal Reserve Board at any time. Therefore, with the exception of excess reserves and carryover, all other variables are averages over maintenance periods.

5.5 Partial Adjustment

In order to correct for auto-correlation in the data a lagged dependent variable was included in the estimation. An AR(1) assumption would not have been sufficient because it would require strict exogeneity. This assumption is exceedingly unlikely since expectations of future interest rates are used by banks to make current reserve management decisions. Instead, a Koyck model was estimated with the assumption that bank reserves take more than one period to fully-adjust to changes in

market conditions. The inclusion of a lagged-dependent variable produced results that had a higher adjusted R^2 than a Newey-West least squares estimation. This log-linear model does not calculate a true elasticity because this requires that the dependent and the independent variables are both natural logarithms. However, this is not possible with this set of data because the opportunity cost was at times a negative number. Therefore, the results are semi-elasticities.

5.6 Breakpoints

The data likely supports the existence of a systemic breakpoint at the onset of the Financial Panic. Many of the functional channels of the financial system, such as securitization, overnight repo funding, and the investment banking model were upended. Compounding the crisis, unprecedented moral hazard was introduced to the system with the concept of "too big to fail," and the Federal Reserve's authority to pay interest on reserves was accelerated, ending hopes that the tool could be integrated into the system without disruption. Therefore, the model was estimated with a breakpoint after the maintenance period ending September 10, 2010 (the last maintenance period prior to the Lehman Brothers bankruptcy).

Chapter 6

RESULTS

6.1 Breakpoint Test Results

A Chow-Breakpoint test evaluated the null hypothesis that there was not a structural break in the sample at 9/10/2008. The test results in the rejection of the null hypothesis with more than 99% confidence. Full results are presented in Table 6.1.1. This result supports the hypothesis that the Financial Panic of 2008 has had a permanent effect on the structure of global financial markets which was outlined more extensively in section 5.6. Results presented in this chapter will be for the second period, unless otherwise noted.

Table 6.1.1. Chow Breakpoint Test at 9/10/2008

Chow Breakpoint Test: 9/10/2008
Null Hypothesis: No breaks at specified breakpoints
Varying regressors: All equation variables
Equation Sample: 1/17/2007 12/29/2010

F-statistic	15.52254	Prob. F(8,88)	< 0.0001
Log likelihood ratio	91.53036	Prob. Chi-Square(8)	< 0.0001
Wald Statistic	87.05657	Prob. Chi-Square(8)	< 0.0001

6.2 Calculating Semi-Elasticities

The existence of a break-point in the time series and the inclusion of a lagged-dependent variable in the econometric model require the coefficients to be adjusted before they can be considered semi-elasticities. Coefficients for the second

sub-period, β^2_i, are calculated by adding coefficients estimated for the first sub-period, β^1_i, to the estimated break-adjustment coefficients, γ_i. Let i = 0 through 7, with each number corresponding to the β-coefficients hypothesized in Chapter Five.

$$\beta^2_i = \beta^1_i + \gamma_i$$

Estimates for the first-sub-period, β^1_i, are presented in Table 6.3.1, and estimated break-adjustments, γ_i, are in Table 6.3.2. Second sub-period estimates, β^2_i, are presented in Table 6.3.3.

Once the break-adjusted coefficients are calculated for the second sub-period, they need to be lag adjusted as well to produce the semi-elasticities for the second sub-period, β^*_i.

$$\beta^*_i = (\beta^1_i + \gamma_i) / [1 - (\beta^1_2 + \gamma_2)]$$

Substituting equations results in the consolidated equation:

$$\beta^*_i = \beta^2_i / (1 - \beta^2_2)$$

Semi-elasticities are presented in Table 6.3.4.

6.3 Model Estimation Results

The results support a semi-elasticity of excess reserves of -0.34. A one basis point increase in the opportunity cost of holding excess reserves causes a 0.34% decrease in the level of excess reserves. A Wald test of the joint significance of the opportunity cost coefficients in the first period and the second period show that the semi-elasticity is significant at the 99% significance level. It is also important to note that during the first sub-period, the β_1 coefficient is 0.37 (p-value = 0.0562). A positive coefficient was unanticipated, but changes in the banking industry since then make the coefficients from the second sub-period far more relevant as well as significant.

The carry-over variable, C, is expressed as a percentage of excess reserves. As a result, it is the only coefficient which is expressed as a bona fide elasticity. A 1% increase in carry-over as a percent of excess reserves leads to a 201.9% decrease in excess reserves. A change this enormous would seem to dominate changes in the level of excess reserves, but C's standard deviation is a more reasonable estimate of likely movements in carryover as a percent of excess reserves. In the second sub-period C has a standard deviation of 0.0004%. A one standard deviation increase in carry-over only has a 0.09% inverse effect on the level of excess reserves.

In maintenance period t banks need to hold required reserves according to the average level of deposits in the preceding maintenance period, t-1. A deficiency in required reserves in maintenance period t leads to a penalty imposed on the bank equal to the primary credit rate plus 1.00%. Since banking needs during t may put pressure on a bank's reserve position banks will hold more reserves in excess as the penalty of a reserve deficiency increases to prevent falling below their level of required reserves. Model estimates do not support this theory but they also lack significance.

This result is rather puzzling. Altered policies at the discount window may partially explain the unexpected result. Any time that a bank foresees that it will not meet its reserve requirements for a maintenance period the bank can always resort to borrowing at the discount window if they cannot make up the shortcoming in the Federal Funds market or by selling short-term assets. The Federal Reserve has set the penalty at the primary credit rate plus 100 bps because that is seen as a sufficient

Table 6.3.1. First Sub-Period Model Estimation

	R_t	Y_{t-1}**	C_t**	P_t	F_t	M_{t+1}*	F_t x M_{t+1}	Intercept*
Coefficient	0.373228	0.475889	-2.338734	0.048900	-0.128606	-0.185888	0.015454	3.653751
t-Statistic	1.935226	2.874611	-3.797300	0.887919	-0.098876	-2.149377	0.011532	2.439623
p-value	0.0562	0.0051	0.0003	0.3770	0.9215	0.0343	0.9908	0.0167

Table 6.3.2. Sub-Period Break Adjustments

	R_t**	Y_{t-1}	C_t*	P_t	F_t	M_{t+1}	F_t x M_{t+1}	Intercept**
Coefficient	-0.563977	-0.034158	-110.3599	-0.133595	0.144623	0.170517	-.0951177	4.423553
t-Statistic	-3.299204	-0.503417	-2.259688	-1.849216	0.103080	1.926005	-0.682491	16.24978
p-value	0.0014	0.6159	0.0263	0.0678	0.9181	0.0573	0.4967	< 0.0001

Table 6.3.3. Second Sub-Period Model Estimation

	R_t**	Y_{t-1}**	C_t*	P_t	F_t	M_{t+1}	F_t x M_{t+1}**	Intercept**
Coefficient	-0.190749	0.441731	-112.6986	-0.084694	0.016017	-0.015372	-0.935722	8.077304
F-Statistic	9.321498	19.69601	5.351165	1.260939	0.002189	0.552741	7.193743	31.13734
P-value	0.0030	< 0.0001	0.0230	0.2645	0.9628	0.4592	0.0087	< 0.0001

Adjusted-R^2 = 0.994680

* Indicates 95% significance

** Indicates 99% significance

penalty to discourage banks from allocating required reserve balances to more profitable yield-bearing alternatives. However, as the spread between the primary credit rate and the targeted Federal Funds rate was narrowed in 2007 and 2008 it is likely that the penalty premium became more and more reasonable, so banks became less risk averse to a reserve deficiency, because they could recoup penalties with interest. Once discount lending normalization is complete bank reserve will begin to react to changes in the penalty in a more predictable manner. However, discount lending normalization began in early 2010 (see Section 2.1.2), so the Federal Reserve's unconventional response to the Sub-Prime Mortgage Crisis cannot bear the full brunt of the blame for this disappointing result.

The expected change in the Federal Funds rate, F, also fails to meet its hypothesis and lacks significance. In order to capture profits, banks ought to move funds out of reserves and into interest-bearing assets when they perceive that interest rates are going to increase. Unlike P_t, it seems that the Federal Reserve's unprecedented response to the Financial Crisis can explain the failure of the hypothesis for this variable. The Federal Reserve has been consistently communicating in its FOMC Statements that the Federal Funds rate will remain exceptionally low "for an extended period" since March 2009 (FOMC Statement, 3/18/2009). In light of these results it seems that this policy has been extremely effective. The standard deviation of the expected change in the Federal Funds rate in the second sub-period is only 0.07 bps. Although the lack of variation in the sample makes F_t an insignificant variable in this estimation, as the Federal Reserve begins to raise and modulate short-term interest rates once again this variable will probably produce estimates as hypothesized.

Table 6.3.4. Semi-Elasticites

	Semi-Elasticity	F-Statistic	p-value
R_t**	-0.341680	18.72657	< 0.0001
C_t*	-201.8714	5.340979	0.0232
P_t	-0.151709	1.457190	0.2306
F_t	0.028691	0.002199	0.9627
M_{t+1}	-0.027534	0.528689	0.4691
F_t x M_{t+1}*	-1.676113	5.699881	0.0191

* Indicates 95% significance
** Indicates 99% significance

Although F_t lacks significance in this sample, results confirm the hypothesis that activity in reserves intensifies in the maintenance period preceding the release of an FOMC Statement. Although the Federal Open Market Committee has taken action during inter-meeting periods (a tactic it used quite regularly during the Financial Panic of 2008), the FOMC prefers to limit its policy decisions to its pre-scheduled meetings which financial markets are aware of. Therefore, reserve managers are likely to position their reserve positions in the maintenance period before an FOMC Statement in order to fully capture the opportunities afforded to a bank if the stance of monetary policy were to change. The semi-elasticity of M_{t+1} = -0.03 (although it lacks significance), and the interaction between F_t and M_{t+1} has a semi-elasticity of -1.68, significant at the 95% level. Excess reserves will decrease 0.03% in the maintenance period preceding an FOMC meeting, and an additional 1.68% for every bps that financial markets expect the Federal Funds rate to change. With the exception of carry-over this is the strongest elasticity in the model and has the most explanatory power for extrapolating policy implications from the estimates. Estimates suggest that the opportunity cost of holding excess reserves has the

hypothesized inverse effect on the level of excess reserves, but the most important factor on the level of excess reserves is actually expectations of future interest rates.

6.4 Comparison to Literature

Results in this paper and previous literature on the topic are not directly comparable because of the type of elasticities produced. Although most of the other research also produced semi-elasticities, they were expressed in millions of dollars. Semi-elasticities are presented in this paper as a percent of excess reserves. Presenting them in dollar amounts for previous research was feasible since the level of excess reserves had remained fairly stable. However, excess reserves are currently showing far more volatility. Approximating elasticies in millions of dollars would only be applicable for a narrow band of reserve levels.

Dow (2001) and Evanoff (1990) provide the research that is the most relevant for comparison because their dependent variable is the level of excess reserves. Frost (1971) also uses the level of excess reserves as the dependent variable, but he does not produce a consistent semi-elasticity. Instead, he analyzes relationships during various time periods in the banking industry. Dow found that the level of excess reserves decreased approximately $120 million for every percentage point increase in the Federal Funds rate. Evanoff was not far off at $150 million, although he used the 30-day T-Bill rate. Roughly, for every 25 bps increase in the interest rate, Dow would predict a $30 million draw down in excess reserves and for Evanoff a drawdown of $37.5 million. For Dow this is 2.1% of the average level of excess reserves from 1990-2008, and 2.62% based on Evanoff's estimates. Based on estimates in Table 6.3.4, a 25 bps increase in the opportunity cost would result in excess reserves decreasing 8.54%, which is considerably more than previous empirical

estimates. This difference can be attributed to the changes in monetary policy and the banking system since Dow and Evanoff produced their models and estimates.

A more relevant comparison between model estimates and the literature would be to compare the semi-elasticities from the first sub-period to Dow and Evanoff's estimates. The semi-elasticity for opportunity cost in the first sub-period is 0.65. The positive sign of β_1 is contradictory to the theory, but it is also a statistically insignificant variable, so no direct comparisons can be made between estimates from the first sub-period and relevant research already in the literature.

Chapter 7

POLICY IMPLICATIONS

7.1 Normalization Actions

Even before the Federal Reserve moves to the contractionary tools stage of the exit strategy (as outlined in Section 2.2) and begins to raise interest rates it will continue the process of normalizing policy which was described in Section 2.1. Short-term liquidity facilities are already closed, so there is no further anticipated effect by them on the level of excess reserves. However, discount lending policies, as described in Section 2.1.2, have a dynamic effect on the level of excess reserve.

The discount rate is expected to increase another 50 bps, which would increase the penalty of a required reserve deficiency (primary credit rate + 100 bps) by 50 bps. Unfortunately model estimates were inconclusive as to how this will impact the level of excess reserves. Theory still holds which would have this action increase the level of excess reserves, but estimates partially contradict this.

Every instance in which the Federal Reserve has engaged in normalization actions rhetoric has accompanied the actions assuring participants in the economy that the action does not constitute a current or near-term change in the stance of monetary policy. Nevertheless, as the Federal Reserve brings its plan to normalize discount lending practices to fruition, bank reserve managers and other market participants will begin to revise their expectations of when the Federal Reserve will raise interest rates. Market participants may actually believe the disclaimers and not think that the actions indicate a change in monetary policy, but the timing of the actions informs banks

managers about the pace of the recovery and the timeline that the FOMC is using for its exit strategy. This will alter F_t. Similar to P_t, no implications can be drawn from F_t due to the inconclusive nature of β^*_5, but M_{t+1} and $F_t \times M_{t+1}$ still bear significance in the model and will play a dynamic role when contractionary tools begin to be implemented.

7.2 Contractionary Tools

A 25 basis point increase in the interest rate, to the exclusion of other significant factors, would decrease excess reserves $82.60 billion, given the level of excess reserves at year end 2010.[11] This is equivalent to a 25 bps increase in the opportunity cost. A 100 bps increase in the interest rate (which would most likely occur over the span of a few FOMC meetings) would cut excess reserves $291.92 billion. This action would permeate through the economy, lead to loan expansion, and actually fuel growth. It would have the opposite effect from what the FOMC desires. However, the FOMC has the option to raise the interest rate paid on excess reserves the same amount that the Federal Funds target is raised. This would have no effect on the opportunity cost of holding excess reserves.

Although in this likely scenario the lack of variation in the opportunity cost would result in no effect on the level of excess reserves, changes in the other variables will still account for a draw down in reserves. When the FOMC hoists the

[11] The level of excess reserves that monetary policy accommodated at the close of 2010 will probably be far below the actual level of excess reserves when the Federal Reserve begins to use contractionary tools. The implementation of QE II is raising the level of excess reserves in 2011. In addition, normalization actions will likely increase the level of excess reserves further, although this assumption is based on unsubstantiated hypotheses. Nevertheless, policy implications are based on the level of excess reserves at the end of 2010 because that is the extent of the data-series.

anchor and begins to raise interest rates the expected change in the Federal Funds rate will increase. If market participants expect a 25 bps increase in the FOMC meeting directly following the first meeting where the interest rate target was raised 25 bps (a process that Bernake favors known as *gradualism)*, excess reserves will be drawn down approximately $350.04 billion over the inter-meeting period ($347.27 billion due to the interaction variable between F_t and M_{t+1} and $2.77 billion due to the anticipated FOMC Statement). In order to prevent these outflows from bank coffers, the Federal Reserve would have to effectively decrease the opportunity cost of holding excess reserves more than 126 bps.

The efficacy of the Federal Reserve's maneuvering in this scenario depends on the operating paradigm that the Federal Reserve is using to regulate the Federal Funds market. If the FOMC chose to counteract the market optimism prompted by its initiation of the exit strategy then the interest rate paid on excess reserves would immediately be more than the Federal Funds target rate. However, this policy stance contradicts policy makers' intentions to implement the channel-corridor system described in Section 3.1. For the channel-corridor system to be operational, the interest rate paid on excess reserves needs to be below the Federal Funds target rate so that it sets a floor on the Federal Funds market. An alternative operating paradigm described by Bernake in testimony scheduled to have been delivered February 10, 2010 (it was postponed due to Washington D.C.'s "Snowmagedon") temporarily abandons the Federal Funds rate as the primary monetary policy stance communicated by the FOMC. Instead, the IOER rate would be the primary monetary policy guidance offered in FOMC statements and other official communication. This may also be used in conjunction with explicit targets for the level of excess reserves. Chairman Bernake

also noted that in the future, careful manipulation of the interest rates paid on reserves could allow the Federal Reserve to eliminate reserve requirements altogether.

This option may prove to be more fruitful, although it is more difficult to analyze. Since theory and model estimates are all based on the current framework of monetary policy, it would be difficult to quantify and judge the effects that this operating paradigm would have. Changes in the opportunity cost as well as the expected change in the Federal Funds rate would be far more opaque. However, it is important to note that in this framework even if the FOMC does not report the Federal Funds rate they still very well may be directing the Open Market Desk in New York to target it. It will simply be more difficult to judge if the Desk is successful since the targeted rate cannot be compared to the effective rate.

Other worries persist as well. Jacking up the interest rate paid on excess reserves could be detrimental to the reputation of the Federal Reserve. Fixed income market makers would perceive that the Federal Reserve is worried about inflation, which would cause them to preemptively drive up interest rates and soften the Federal Reserve's reputation as a an institution capable of preventing inflation beyond target. This would also dislodge the relationships identified in this study, because market participants would no longer respond in a predictable manner to Federal Reserve actions and communication. In addition, the FOMC is unlikely to stop raising the Federal Funds rate after 50 bps over two meetings. Once the FOMC initiates this phase of the exit strategy, if there are no unexpected shocks to the economy then the Federal Funds target will probably be on a long gradual march upwards of 2.00% (1.00% was the low record prior to the Financial Panic of 2008). Market participants

would anticipate these changes and continue to move funds out of excess reserves and into other money markets.

These concerns are not insurmountable. The Federal Reserve will have at its disposal the other contractionary components of the exit strategy described in Section 2.2; particularly the Term Deposit Facility and the use of reverse repurchase agreements as well as the Treasury Supplementary Financing Program. Over time these options can be used to safely restrain hundreds of billions of dollars in liquidity. The other option is to begin selling assets outright, although many FOMC participants look down on this option because of the adverse effects it would have on sensitive interest rates and growth. In particular, the sale of the large stock of mortgage backed securities the Federal Reserve is holding could drive up mortgage rates and further depress the housing market, leaving the unemployment rate higher for longer. In this scenario the Federal Reserve would be failing to sufficiently achieve both aspects of its dual mandate. In addition, to ensure policy certainty the Federal Reserve needs to address the distortions that GSE's place on the Federal Funds market explained in Section 3.1. This is best resolved by reducing the GSE's market share in the Federal Funds market or changing their incentive structures so that they are less likely to lend funds below the IOER rate.

7.3 Cost Implications

Raising the interest rate paid on excess reserves in the current environment when excess reserves are at levels surpassing $1 trillion raises the question of how can the Federal Reserve simply afford such a policy stance? In 2010, the Federal Reserve had reported interest payments of $2.7 billion (Press Release 1/10/2011). However, the Federal Reserve earned $80.9 billion in the same calendar

year due to its elevated level of holding in US government securities and mortgage backed securities. The difference, after operating expenses are also subtracted out, is transferred to the US Treasury. Even if interest payments increased 300% as a result of the Federal Reserve Board increasing the interest rate paid on excess reserves, the level of excess reserves, or a combination of the two, the Federal Reserve would still be operating with a $70.3 billion surplus. It is unlikely that this would upset the Treasury either because the annual surplus transfer is usually between $20 billion and $30 billion when the Federal Reserve is operating under its normal parameters.

7.4 Conclusions

On its own merits, the challenges facing IOER as the tool to control the level of excess reserves seem too great. It is unlikely that the Federal Reserve could gradually draw down excess reserves with predictable movements in the Federal Funds rate and the IOER rate alone. However, when used in conjunction with the other contractionary tools of the exit strategy the Federal Reserve might have a fighting chance to unwind the enormous amount of liquidity that three years of emergency lending and quantitative easing have injected into the banking system. The Federal Reserve has sufficient tools to combat inflation, but the question remains whether one of these necessary tools will be asset sales, which are likely to have adverse effects on employment and call into question the Federal Reserve's commitment to both aspects of its dual mandate.

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Appendix A

TIME-SERIES DATA SET

Table A.1. Time-Series Data Set, Full Sample

Maintenance Period	Y	R	C	P	F
1/17/2007	1643	0.083125	0.053561	7.25	-0.005
1/31/2007	1304	0.07985	0.095859	7.25	0.015
2/14/2007	1282	0.0764	0.035101	7.25	0.005
2/28/2007	1623	0.080513	0.001232	7.25	0.02
3/14/2007	1570	0.081663	0.036943	7.25	0
3/28/2007	1606	0.076719	0.094022	7.25	0.005
4/11/2007	1889	0.077588	0.041821	7.25	0.02
4/25/2007	1344	0.081577	0.115327	7.25	-0.01
5/09/2007	1598	0.079751	0.038173	7.25	-0.005
5/23/2007	1218	0.08	0.062397	7.25	0.005
6/06/2007	1708	0.077	-0.0685	7.25	0.01
6/20/2007	1532	0.07595	0.009791	7.25	0.01
7/04/2007	2088	0.08275	-0.00766	7.25	0.025
7/18/2007	1473	0.0816	0.04277	7.25	0
8/01/2007	1666	0.103644	-0.01501	7.25	0.035
8/15/2007	9219	0.314175	0.01345	7.25	0.05
8/29/2007	1154	0.609964	0.624783	6.8	-0.025
9/12/2007	1359	0.850889	0.119205	6.75	0.09
9/26/2007	1955	0.706226	-0.12532	6.4	0.005
10/10/2007	2074	0.624939	0.029412	6.25	-0.005
10/24/2007	810	0.605663	0.397531	6.25	0.01
11/07/2007	1877	0.504713	-0.065	6.1	0.13
11/21/2007	1514	0.618664	0.046896	6	0.075
12/05/2007	1828	0.928252	0.023523	6	0.295
12/19/2007	1281	0.925151	0.260734	5.84	0.035
1/02/2008	2352	0.716063	0.019133	5.75	-0.17

Maintenance Period	Y	R	C	P	F
1/16/2008	1783	0.572401	0.035895	5.75	0.095
1/30/2008	1423	0.426463	-0.05481	5.18	-0.18
2/13/2008	1483	0.469614	0.018881	4.5	0.05
2/27/2008	1766	0.526001	0.023783	4.5	-0.01
3/12/2008	1404	0.080709	0.035613	4.5	0.28
3/26/2008	4033	0.716414	-0.05703	3.78	-0.165
4/09/2008	1729	0.727726	0.249855	3.5	0.025
4/23/2008	1685	0.830107	-0.13709	3.5	0.055
5/07/2008	1851	0.819183	-0.01837	3.35	0.12
5/21/2008	1591	0.699827	0.040855	3.25	-0.01
6/04/2008	2172	0.662842	-0.03177	3.25	0.015
6/18/2008	1549	0.675439	0.032924	3.25	-0.04
7/02/2008	3028	0.716328	-0.00165	3.25	0.01
7/16/2008	1833	0.738103	0.176214	3.25	-0.015
7/30/2008	1829	0.735227	0.014762	3.25	0.02
8/13/2008	1948	0.75259	0.047228	3.25	0.0025
8/27/2008	1694	0.775377	0.105667	3.25	0
9/10/2008	2270	0.79715	-0.00573	3.25	-0.03267
9/24/2008	67863	1.175273	0.001562	3.25	-0.04208
10/08/2008	135279	2.496512	0.000784	3.18	-0.21325
10/22/2008	280971	2.502818	0.002904	2.75	-0.31583
11/05/2008	362891	1.784455	0.003249	2.25	-0.33525
11/19/2008	604577	0.745227	0.002124	2.25	-0.08117
12/03/2008	589638	0.771183	0.002101	2.25	0.110083
12/17/2008	774390	1.498637	0.002102	2.04	-0.06775
12/31/2008	798346	1.024705	0.001886	1.5	-0.06058
1/14/2009	842567	0.878603	0.002035	1.5	-0.03842
1/28/2009	792069	0.682718	0.002361	1.5	0.034917
2/11/2009	610180	0.712218	0.003576	1.5	0.006167
2/25/2009	672572	0.742229	0.002435	1.5	-0.01442
3/11/2009	620612	0.782405	0.002583	1.5	-0.02092
3/25/2009	770040	0.785712	0.001971	1.5	-0.02708
4/08/2009	803442	0.711366	0.001516	1.5	-0.03583
4/22/2009	860881	0.668968	0.001932	1.5	-0.0175
5/06/2009	775785	0.582309	0.0022	1.5	0.011417
5/20/2009	875337	0.412002	0.002323	1.5	-0.02242
6/03/2009	836676	0.206444	0.00212	1.5	-0.005

Maintenance Period	Y	R	C	P	F
6/17/2009	789957	0.156389	0.002544	1.5	-0.00675
7/01/2009	686205	0.124331	0.002657	1.5	0.004417
7/15/2009	742848	0.083513	0.002739	1.5	-0.027
7/29/2009	728834	0.056513	0.002555	1.5	-0.01125
8/12/2009	708438	0.021691	0.003107	1.5	-0.00283
8/26/2009	794430	-0.02415	0.00234	1.5	-0.007
9/09/2009	823152	-0.09637	0.002563	1.5	-0.01475
9/23/2009	854527	-0.1346	0.002135	1.5	-0.00133
10/07/2009	918306	-0.12694	0.002191	1.5	-0.02058
10/21/2009	986654	-0.12582	0.002033	1.5	-0.00983
11/04/2009	1059122	-0.1243	0.001848	1.5	-0.01258
11/18/2009	1046082	-0.11977	0.002026	1.5	-0.00875
12/02/2009	1119387	-0.1272	0.001648	1.5	-0.00517
12/16/2009	1089599	-0.15151	0.002077	1.5	-0.00617
12/30/2009	1059827	-0.16267	0.001747	1.5	-0.0085
1/13/2010	1004634	-0.1509	0.002224	1.5	-0.02442
1/27/2010	1063315	-0.14393	0.001846	1.5	0.0045
2/10/2010	1119328	-0.1499	0.002054	1.5	-0.00175
2/24/2010	1192169	-0.15565	0.001616	1.5	-0.0075
3/10/2010	1163074	-0.16442	0.001716	1.71	-0.00392
3/24/2010	1103533	-0.1794	0.001805	1.75	0.004417
4/07/2010	1093690	-0.1657	0.001834	1.75	-0.00758
4/21/2010	1054935	-0.167	0.00195	1.75	0.000583
5/05/2010	1009472	-0.1441	0.002112	1.75	-0.00383
5/19/2010	1055068	-0.05198	0.002176	1.75	-0.0105
6/02/2010	1047819	0.042262	0.001978	1.75	-0.01033
6/16/2010	1041172	0.070176	0.002292	1.75	-0.01133
6/30/2010	1027062	0.07932	0.001972	1.75	-0.01775
7/14/2010	1030482	0.084098	0.002197	1.75	-0.01433
7/28/2010	1012067	0.067393	0.002041	1.75	0.005583
8/11/2010	1025817	-0.00293	0.002313	1.75	0.00225
8/25/2010	1020139	-0.08099	0.002059	1.75	0.007083
9/08/2010	1006871	-0.13855	0.002187	1.75	0.00575
9/22/2010	975904	-0.14824	0.002249	1.75	0.01145
10/06/2010	963512	-0.14505	0.002246	1.75	0.005
10/20/2010	980966	-0.13325	0.002297	1.75	-0.003
11/03/2010	980966	-0.13805	0.002084	1.75	0.00025

Maintenance Period	Y	R	C	P	F
11/17/2010	969432	-0.14362	0.002383	1.75	0.001
12/01/2010	978833	-0.1458	0.002104	1.75	0.00806
12/15/2010	1024844	-0.12777	0.002253	1.75	-0.001
12/29/2010	991200	-0.12995	0.002308	1.75	0.010833

Appendix B

DESCRIPTIVE STATISTICS

Table B.1. Descriptive Statistics of Time Series Data Set, Full Sample

	Y	R	C	P	F
Mean	504825.3	0.348974	0.023901	3.354615	-0.004651
Median	646592.0	0.083319	0.002248	1.750000	-0.002292
Maximum	1192169.	2.502818	0.624783	7.250000	0.295000
Minimum	810.0000	-0.179404	-0.137092	1.500000	-0.335250
Std. Dev.	468225.5	0.522636	0.087362	2.221254	0.077613
Skewness	-0.011088	1.605846	4.235522	0.817418	-0.655737
Kurtosis	1.196005	6.865906	26.55837	2.005514	11.14926
Jarque-Bera	14.10452	109.4609	2715.940	15.86733	295.2318
Probability	0.000865	0.000000	0.000000	0.000358	0.000000
Sum	52501826	36.29329	2.485674	348.8800	-0.483657
Sum Sq. Dev.	2.26E+13	28.13424	0.786111	508.1988	0.620448
Observations	104	104	104	104	104

Table B.2. Descriptive Statistics of Time-Series Data Set, First Sub-Sample

	Y	R	C	P	F
Mean	1909.955	0.462371	0.053532	5.589773	0.019087
Median	1675.500	0.589032	0.034013	6.050000	0.010000
Maximum	9219.000	0.928252	0.624783	7.250000	0.295000
Minimum	810.0000	0.075950	-0.137092	3.250000	-0.180000
Std. Dev.	1237.257	0.313075	0.129322	1.664816	0.084872
Skewness	4.938849	-0.209262	2.447572	-0.391013	0.797500
Kurtosis	29.23444	1.386734	10.83104	1.469866	6.779575
Jarque-Bera	1440.661	5.092611	156.3607	5.413602	30.85356
Probability	0.000000	0.078371	0.000000	0.066750	0.000000
Sum	84038.00	20.34433	2.355404	245.9500	0.839833
Sum Sq. Dev.	65824584	4.214677	0.719138	119.1793	0.309743
Observations	44	44	44	44	44

Table B.3. Descriptive Statistics of Time-Series Data Set, Second Sub-Sample

	Y	R	C	P	F
Mean	873629.8	0.265816	0.002171	1.715500	-0.022058
Median	972668.0	-0.013540	0.002122	1.500000	-0.007250
Maximum	1192169.	2.502818	0.003576	3.250000	0.110083
Minimum	67863.00	-0.179404	0.000784	1.500000	-0.335250
Std. Dev.	236195.1	0.623534	0.000424	0.368154	0.067363
Skewness	-1.519442	1.976293	0.430640	2.755483	-3.382782
Kurtosis	5.433051	6.825271	5.814640	10.89594	15.69685
Jarque-Bera	37.88636	75.63907	21.66000	231.7914	517.4574
Probability	0.000000	0.000000	0.000020	0.000000	0.000000
Sum	52417788	15.94896	0.130270	102.9300	-1.323490
Sum Sq. Dev.	3.29E+12	22.93886	1.06E-05	7.996685	0.267730
Observations	60	60	60	60	60

Appendix C

DATES OF FEDERAL OPEN MARKET COMMITTEE MEETINGS

Table C.1. Dates of FOMC Meeting Statement Releases, 2007-2010

2007	2008	2009	2010
January 31	January 21*	January 28	January 27
March 21	January 30	March 18	March 16
May 9	March 10*	April 29	April 28
June 28	March 18	June 24	May 9*
August 7	April 30	August 12	June 23
August 10*	June 25	September 23	August 10
August 16	August 5	November 4	September 21
September 18	September 16	December 16	November 3
October 31	October 7*		December 14
December 11	October 29		
	December 16*		

* Unscheduled FOMC Meetings