THE EFFECT OF MONEY ANNOUNCEMENTS ON INTEREST RATE EXPECTATIONS

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Abstract

The era of monetary targeting ignited research into the area of interest rate response to money supply announcements. During the 1980s and 1990s, research focused in this area; however, there is been a lack of updated research. This study examines the updated response of interest rates to unanticipated changes in M1 money supply announcements for the sample period 1985 to 2005. The crucial ideas behind this hypothesis include money demand, money supply, expectations, and the role the Federal Reserve plays in the interaction of the three. Data was taken from the Federal Reserves statistical and historical data release for weekly M1 money supply measures and for daily interest rates of treasury securities. The results revealed an inability of the presented model to capture the relationship between money supply announcements and interest rates; leading to the conclusion of a mis-specified model.

KEYWORDS: Money Announcements, Interest Rates, Monetary Surprises

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CHAPTER I

INTRODUCTION

In the 1980s, a large body of research accumulated on the response of interest rates to money supply announcements. The interest ignited with the 1979 start of targeting the monetary aggregates, and persisted because of the continuous empirical regularities observed of interest rate response to the weekly Federal Reserve announcements of the money stock. Recently, research in this area has stifled, which is why this paper is updating the analysis with inquiry into the response of interest rate expectations to unanticipated changes in the money supply. Specifically, studies were finding statistically significant correlations between unanticipated increases (decreases) in the money supply measured by M1 and increases (decreases) in interest rates.[1] Along the lines of market efficiency, interest rate response was only to the unanticipated component of the money supply announcement, known as a money surprise. This is

[1] Urich, Thomas and Paul Wachtel. "Market Response to the Weekly Money Supply Announcements in the 1970s." *Journal of Finance.* 36 (1981): 1063-1072.

Cornell, Bradford. "Money Supply Announcements and Interest Rates: Another View." *Journal of Business.* 56 (1983): 1-23.

Roley, Vance and Carl E Walsh. "Monetary Policy Regimes, Expected Inflation, and the Response of Interest Rates to Money Announcements." *The Quarterly Journal of Economics.* 100 (1985): 1011-1039.

because, part of the change is expected to occur and those expected changes would already have been incorporated into the market prior to the announced change.[2] Due to the value of information provided by changes in the money supply, these statistically significant changes varied in degrees according to the financial environment and the time period of monetary policy.[3] At certain times, like with monetary targeting, changes in M1 are more valuable indicators of future moves by the Fed. At other times, like in 1982 when the Fed announced a lowered commitment to meeting monetary targets, the money supply provides less valuable information. In either case, changes in the money supply provided information about the direction of the economy and, as such, reactions were felt in the financial market. This paper looks into these reactions, specifically, the current affect money supply announcements have on interest rates and what sort of environments and events explain the different degrees of responses.

In recent years, research has strayed away from investigating the effects of money supply announcements on the market, with most researchers concluding that money supply announcements now have muted affects.[4] Today, the Fed targets the federal funds rate and, thus, research has been attracted to this area; but what of money supply announcements? Up until the year 2000, money announcements should still have provided indication of future Fed movements, since the Federal Reserve was still under

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[2] Deaves, Richard, Angelo Melino, and James E. Pesando. "The Response of Interest Rates to the Federal Reserve's Weekly Money Announcement: The 'Puzzle' of Anticipated Money." *NBER Working Paper No. 2125.* (1987).

[3] Hafer, R. W. and Richard G. Sheehan "The Response of Interest Rates to Unexpected Weekly Money: Are Policy Changes Important?" *Southern Economic Journal*, 56 (1990): 588.

[4] Kearney, Adrienne A. "The Changing Impact of Employment Announcements on Interest Rates." *Journal of Economics and Business.* 54 (2002): 417.

mandate to set targets for all monetary aggregates.[5] After this date, the Fed no longer had to set targets for monetary aggregates and an even lower response of interest rates should be observed; as money announcements would provide less valuable information about the direction of monetary policy. Nevertheless, money supply should still provide indications about where the economy is going and with gains to be had from predictions, participants should be sure not to overlook any signal of where the economy is heading. Are money surprises being overlooked in research, do they still provide a good signal? This study attempts to answer this question.

Monetarists still emphasize the importance of the money supply: "Inflation is always and everywhere a monetary phenomenon. To control inflation, you need to control the money supply."[6] People must think that money supply's implications to the market for its increases and decreases are still there. For instance, growth in the money supply leads to inflation; more money is chasing the same number of goods, thus, in the medium run when prices can adjust, prices go up. According to monetarist theory, if money growth and GDP growth are not closely matched, then, inflation will occur. Consistent with this train of thought, the Fed looks to changes in the money supply as indications for what they should be doing for the economy.[7] As illustrated in Chapter III, the theory chapter, changes in the actual money supply cause changes in rates in the

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[5] This is due to the Humphrey-Hawkins Act of 1978 discussed in chapter II.

[6] Adam Smith Institute, "Milton Friedman: Great Monetary Economist and Libertarian Policy Guru"; available from http://www.adamsmith.org/milton-friedman/; Internet; accessed Feb. 2009.

[7] Federal Reserve Bank of New York, "The Money Supply": July 2008; available from http://www.newyorkfed.org/aboutthefed/fedpoint/fed49.html; Internet; accessed Dec. 2008 – Feb. 2009.

financial markets; as such, market participants form expectations as to the direction and level of the money supply. Market participants want to know what is going to happen to rates and therefore use changes in the money supply as one form of information for predicting the direction. When these predictions are incorrect the financial market should correct itself, in order to better align with new expectations. So then what of the market's reactions to unexpected changes in the money supply? Is there still a statistically significant response to money surprises? This paper posits that there is still such a response and investigates into its affects on interest rate expectations. This research is extended to the current environment to discover whether the aforementioned assumption holds; whether researchers were wrong to shift focus away from money supply announcements. However, I will update the examination by incorporating the current market trend of focus shifting to interest rate expectations. Little research has been done in this area, and none has been done to include the year 2000, when the act which required monetary targets by the Fed expired.[8] How did the markets respond to this change in policy? There should be a difference before and after this change. Thus, I will be adding to the literature by investigating the effect of money supply announcements on expectations of future interest rates. If money supply growth provides information about future economic activity, then unexpected growth, in such, should have an effect on the future course of interest rates.

This first chapter provided a brief introduction to the research trends thus far and the direction this current research will be taking. The rest of the paper is as follows;

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[8] One paper including interest rate futures:
Mann, Thomas and Richard Dowen. "The Influence of Monetary Conditions on the Response of Interest Rate Futures to M1 Releases: 1976-1998." *Journal of Business Finance and Accounting.* 31 (2004): 1125-1150.

chapter II provides background into the area of monetary aggregates and the trends of monetary policy. It is important to have a sufficient understanding of the background surrounding this topic in order to understand market response to changes in the money supply. Without background, the progression to emphasis on money supply announcements is misunderstood. The answer to the question, why do interest rates respond to money supply, will be provided in chapter III, which covers an explanation of the macroeconomic theory surrounding money supply and interest rates. After providing a brief explanation of money demand, money supply, the influence of monetary policy, the role of banks, and the effect expectations have; one should be able to understand why the market looks to changes in the money supply for future indications of interest rate movement. With this theory background, chapter IV will provide an overview on the empirical studies which have investigated into this relationship. Chapter IV focuses on the findings previous research have reached in this area, the strength of differing hypotheses, and provides a review of literature in the topic to date. None of these competing hypotheses individually have absolute support from the academic community, however, some authors conclude that the absolute effect is more important then the actual hypothesis that leads to such an effect.[9]

Chapter V presents the empirical test. The first section describes the methodology and the compilation of the data. Simple regressions were run for three month, six month, and twelve month treasury securities for the sample period 1985 to 2005, and for the sub-periods 1985-1993, 1995 – May 2000, and July 2000 – 2005. The simple regressions are trying to determine the effects unanticipated changes in the money

[9] Sheehan, Richard G. "Weekly Money Announcements: New Information and Its Effects." *Federal Reserve Bank of St. Louis.* (1985): 31.

supply have on interest rates for treasury securities of differing maturities. Lastly, a multiple regression was run for the three month, six month, and twelve month securities for the entire sample period, to determine the effects future expectations for money supply changes have on current reactions of interest rates. The third section presents the results and interpretations of the regressions, with the three month treasury security returning the only statistically significant response to M1 money supply announcements.

Chapter VI provides a summary of the paper and conclusions, as well as areas for further research. The ultimate goal of this study is to resolve whether there is still something to learn from M1 money supply announcements for the determination of changes in interest rates.

CHAPTER II

BACKGROUND

In order to understand the topic of money supply announcements and interest rates, one must first understand monetary policy's role in the economy and also the development of the monetary aggregates which allow for monitoring of the money supply. This background provides the framework for understanding the development of the Federal Reserve, the monetary aggregates, the trend of predicting the direction of the Fed, and the different sub-periods of monetary policy. With this background, readers will be able to understand the initial start of research into this topic and the evolution of such, which has led to the development of the current study.

In the United States money plays a role that touches every phase of economic and political life. The definition of money has been a historical issue from gold, subsidiary coinage, state bank notes, greenbacks issued to finance the civil war, national bank notes, to all the financial innovations which have followed. Throughout history, the Government has constantly been changing how people view money and what they define as money. Money stock's instability and its critical importance arise from its involvement in every aspect of life. Acknowledging this importance, the Government has tried many different ways to stabilize the behavior of money. One of the earliest examples is the establishment of the first central bank in 1791. However, partially due to

the fear of the power a central bank held, the charter was not renewed when it expired twenty years later. The subsequent financial chaos led to the development of a second central bank in 1816, yet, again, for similar reasons, the charter expired with no renewal. Once more, economic instability developed and it was not until 30 years later that the National Banking Act of 1863 was created; with which the government established national charters for banks and encouraged a national currency for the United States. However, even this act proved inadequate with its inability to stabilize the economy through expansion or contraction of currency; a necessary control for influencing the health of the economy. From 1863 to the establishment of the Federal Reserve in 1913, the US experienced boom and bust cycles, frequent financial panics, and multiple economic recessions.[1] The government looked at many proposals and established various committees and commissions to sort through the problems, and finally passed the Federal Reserve Act of 1913. The establishment of the Federal Reserve led to the ability to manipulate the money stock of the economy and, as such, led to the trend of predicting the direction of the economy by looking at the moves of the Fed. With predictions, market participants may be able to anticipate changes before they occur in the market and, therefore, be able to maximize their returns.

Historically, the US dollar was tied to and backed by silver and/or gold until the 1900 Gold Standard Act, which put a stop to bimetallism and linked the US dollar solely to gold. Subsequently, the US experimented with different exchange rate systems, switched to the Fiat Standard, and, finally, established the current system which was a

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[1] Meulendyke, Ann-Marie. *US Monetary Policy and Financial Markets.* Federal Reserve Bank of New York, 1998: 33 & 41.

result of the Nixon administration ending the last trace of the gold standard in 1971.[2] The Fiat system led to a government which can legally print money, with no backing; essentially, inject money into the economy whenever they deemed necessary. Thus, the US, with help from the Fed, now focuses on how to monitor and influence the monetary system instead of on how to change the system. With the new focus on how to influence the system, the public increasingly tries to predict the government's and/or the Fed's next move. Due to the fact that they now have the power to change the amount of money in circulation whenever they want to, and as such can affect the markets; people became increasingly interested in the information available in the market. Information could help possibly predict monetary policy's direction and/or what tools they will be using to get there. For example, changes in the money supply could provide information about future moves of the Fed. One way this happens is through actions of the open market desk, buying and selling government bonds, directed by the Federal Open Market Committee, the FOMC.

As the economy of the United States grows, the complexities of money and its relationship to world altering decisions become more and more evident. The clarity of this importance emerges constantly with every conducted study, developed financial innovation, and implemented monetary tool. The consequences of a meager understanding of money threaten the US economy and the economies of the interconnected world. In order to better monitor and understand money, the government began estimating the amount of money in circulation. In the 1940s the Federal Reserve Board began reporting monthly data on money levels and, in 1971, developed three

[2] Ibid, 49.

monetary aggregates; M1, M2, and M3. These measures try to encompass the different ways of storing and exchanging money. Due to studies revealing the insignificant benefit to funding M3 estimates, the Fed ceased publishing M3 in March 2006[3] and today, the government only measures weekly M1 and monthly M2. The three new measures, M1, M2, and M3, gave researchers fresh areas to test the predictability of relationships between money and economic activity. Measures of money meant that links between money growth and economic growth could be tested. Between the 1950s – 1980s, empirical data led to the belief that M1 growth was a predictable leading determinant of nominal activity.[4] The results were so convincing that, in order to achieve its purpose of stabilizing the economy and controlling inflation, the Fed began explicitly targeting M1 money growth in the 1970s. Then in 1975, the House Concurrent Resolution 133 and in 1978, the Full Employment and Balanced Growth Act (also known as the Humphrey-Hawkins Act) were passed; both ensuring Federal Reserve targeting of all three monetary aggregates.[5] This act coincided with the era of monetary targeting; an era where much of the research on the relationship between money supply and interest rates focuses.

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[3] "M3 does not appear to convey any additional information about economic activity that is not already embodied in M2 and has not played a role in the monetary policy process for many years."
Federal Reserve Board Statistical Release, "H.6: Money Stock Measures: Discontinuance of M3": March 2006; available from http://www.federalreserve.gov/releases/h6/discm3.htm; Internet; accessed Dec. 2008.

[4] Meulendyke, 11.

[5] Walsh, Carl E.. "The Impact of Monetary Targeting in the United States: 1976-1984." *NBER Working Paper Series. Working Paper No. 2384.* (1987).

Even though in 1985 evidence indicated the possible de-emphasis of M1, it was not until 1987, when the Fed de-emphasized M1 as a guide for monetary policy.[6] Prior to, and the reason for the Fed's de-emphasis of its ten year long policy of M1 targeting, was rapid growth in M1 and its correlation to minimal growth in nominal income (contradictory to previous consensus).[7] During which time, M2 was still believed to be reliable until the early 1990s, when the relationship between M2 growth and economic activity also seemed to diminish. Most researchers attribute the aforementioned events to the increase in financial innovations, which decrease the likelihood of a predictable relationship between money and economic activity.[8] More options for money lead to more difficulties of monitoring and connecting its movements throughout the economy.

Even with the de-emphasis, the Fed was still required by congress until the year 2000, to set monetary targets for calendar years and to explain any deviations in such, when the legislation of Humphrey-Hawkins Act expired; at which point the Fed announced it would no longer be setting such monetary targets.[9] Even with the act in effect, the Fed did begin using different targets in addition to monetary growth targets. They began targeting the federal funds rate, after which, it emphasized targeting of bank reserves. Following the stock market crash of 1987, the Federal Open Market Committee went back to targeting the federal funds rate. Henceforth (and currently) the federal

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[6] Gauger and Black, 677-691.

[7] Walsh, *Monetary Targeting and Inflation.*

[8] Meulendyke, 20.

[9] Federal Reserve Bank of New York, *The Money Supply.*

funds rate became (and is) the Federal Reserve's policy instrument. However, they still measure the monetary aggregates and use them as part of their analysis of the economy.[10]

Due to the fact that monetary aggregates are still used in the development of monetary policy, this study looks into the affects of changes in such, and the transmission into interest rates. Now that the background knowledge has been covered, the next chapter will introduce the macroeconomic theory behind the relationship between interest rates and money supply. The theory background is necessary to understand the importance changes in the money supply have for interest rates. Combining the background of monetary history and the following theory chapter of interest rate response, readers will be able to understand the direction of empirical studies to date and where the current research extends beyond the previous studies.

[10] Ibid.

CHAPTER III

THEORY

Changes in the money supply, expected future changes in the money supply, and changing expectations for future conditions of the economy; all have affects on movements in interest rates. The Federal Reserve Board can influence all three of the aforementioned changes and, as such, can influence the financial markets. In order to understand how changes in the money supply and changes in expectations can affect interest rates, one must first understand the theory behind such changes. The following theory chapter is provided to describe the inter-relationship between interest rates and money supply. First, we discuss what money is, then incorporate: the demand for and supply of money, how the Fed influences demand and supply, and what role banks play in the money supply process. Then, these ideas will be linked to expectations, which have led to the many theories presented as to why interest rates respond to money supply changes.

Money is anything generally accepted as payment for goods and services and repayment of debts. It is financial capital, in liquid form, which can be used in transactions as a medium of exchange. Classically, money has been defined to serve three roles; as a medium of exchange, as a unit of account, and as a store of value. Serving as a medium of exchange, money solves the 'double coincidence of wants'

problem. It allows society to avoid the inefficiencies of the barter system; allowing people to hold money in between trades versus being forced to find a person who has exactly what they want and, simultaneously, wants what they have to offer. The second role of money, as a unit of account, is a standard numerical measurement of the market value of goods, services, and other transactions. It allows for meaningful interpretation of prices, costs, and profits. In the barter system, trade would require constant relative re-evaluation of goods and services, while money, on the other hand, gives everyone the same reference. Lastly, the third role says that money serves as a store of value, which means that it can be reliably saved, stored, and retrieved to be used in transactions. Again this allows people to trade their own goods and services for money, even when they have not found anything they currently want; with a store of value they can hold the money until they do find something they want. The only problem with this role of money is inflation, which deteriorates money's value over time. The rate of inflation in an economy affects the amount of money people wish to hold, their demand for money, which in turn will affect interest rates; this relation is discussed below.

Demand for Money

There are two ways of looking at money: the nominal quantity of money and the real quantity of money. The nominal quantity is expressed in just a unit measurement; while real quantity takes into account the amount of goods one could purchase, the money's purchasing power. By incorporating the money's purchasing power, the real quantity takes into account inflation. The purchasing power of money and inflation both change when the prices of goods and services change. Thus, when prices increase (which

is an increase in inflation) people need to hold more money in order to maintain their purchasing power, which is being diminished by inflation. This increase in the demand for money is so people can buy the same amount of goods as they did before the change in prices. Therefore, one of the ways people determine the amount of money they wish to hold, their demand for money, is with the real quantity of money, the purchasing power of that money; and, one of the ways the demand for money increases is with increases in inflation.

To simplify the analysis of money demand, only currency, checkable deposits, and bonds will be considered as options to store money. People must decide how much money they wish to hold in the three aforementioned forms and from these decisions; one can derive the demand for money. Essentially, people are making a decision of how liquid they wish to be. They are deciding how much money they wish to hold that can directly make payments or purchase goods by keeping in mind the purchasing power and the real quantity of money. Holding money balances contains an opportunity cost, which are the foregone opportunities from the alternative interest earning options. A smart choice is to hold a mix of both money and bonds, where bonds are a store of money that earns interest. How much of each to hold, depends upon ones level of transactions and the interest rate on the bonds. Level of transactions considers one's payments habits (how often one makes payments) and the transaction costs, the fees associated with buying and selling bonds. While interest rates denote the amount of return one will earn; the higher the interest rate, the more one will be willing to deal with the hassle and the costs associated with buying and selling bonds. Along the same lines, the less often one makes payments and the lower transaction costs associated with switching back and forth

the lower the demand for money will be and the higher the demand for bonds. Thus, the market for bonds is affected by changes in the number of transactions and the expectations of future changes in interest rates.

The following equation (figure 3.1) portrays the demand for money, in terms of currency, as equal to nominal income times a function of interest rate, i. This equation does not include one's preferences between currency and checkable deposits; however this does not make a difference until we consider the role of banks:

FIGURE 3.1

DEMAND FOR MONEY

$$M^d = \$Y\ L\ (i)$$
$$(-)$$

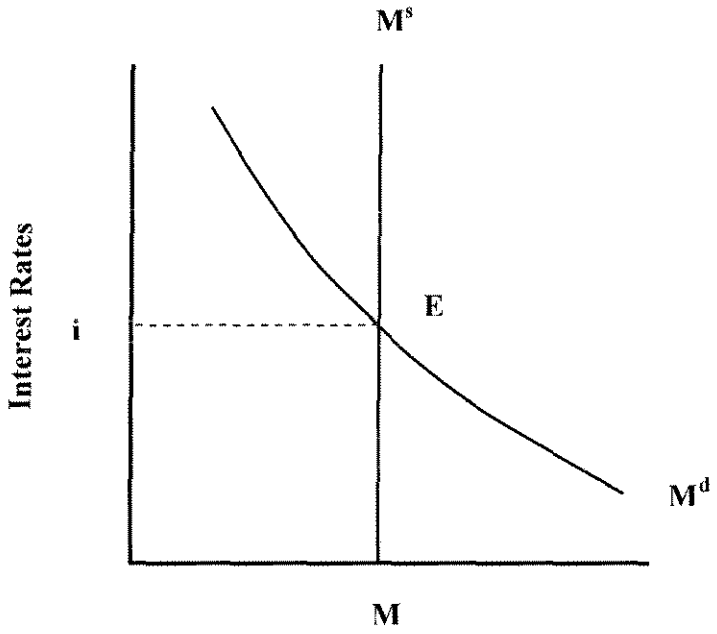
Y stands for nominal income, which is the flow of revenue from work, rental income, and interest, without incorporating inflation. Figure 3.1 assumes that the demand for money depends negatively on the interest rate; increases in interest rates lead to decreases in the demand for money (because interest earning assets are more attractive). Also demand for money increases in proportion to nominal income; if nominal income doubles, people are making more money and they will want to hold more money and, thus, the demand for money doubles.

In summary, increases in the demand for money include; higher prices, higher nominal income, increased transaction costs, and decreased interest rates. Expectations of future price changes will also affect the amount of money people want to hold. With steady inflation people wish to hold more money because of the convenience of transactions. If inflation is expected to increase, then an increase in transactions is a trade

off. People will want to make a return sufficient enough to offset the detrimental effect inflation has on money balances and, thus, the demand for money decreases; with people looking instead to interest rates to get a sufficient return. The aforementioned demand for money then interacts with the supply of money in order to determine interest rates in the market. The equilibrium condition of this interaction is represented in figure 3.2.

FIGURE 3.2

MONEY DEMAND AND SUPPLY EQUILIBRIUM CONDITION



Supply of Money

In the above description, there are only two types of money; checkable deposits, which are supplied by banks, and currency, which is supplied by the central bank, the Fed. For the following analysis of the supply of money, assume there is only currency

and bonds; another choice is of course checkable deposits which are important when considering the role of banks. Equilibrium in the financial markets requires that money supply be equal to money demand (see figure 3.2). In order to reach this equilibrium, interest rates adjust to influence how much money people wish to hold until money demand lines up with money supply. Given income of Y, the interest rate is such that people are willing to hold an amount of money equal to the existing money supply, M (See figure 3.2). Thus, changes in nominal income or changes in the money supply by the central bank affect the equilibrium interest rate (see figures 3.3 and 3.4 respectively). This study will be focusing on the effects changes in money supply have on interest rates. Therefore, the next two sections looks at how the money supply is affected by changes in policy.

FIGURE 3.3

INCREASE IN NOMINAL INCOME ($Y)

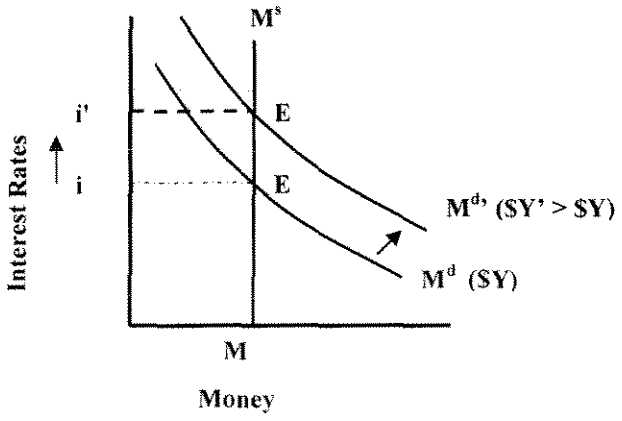
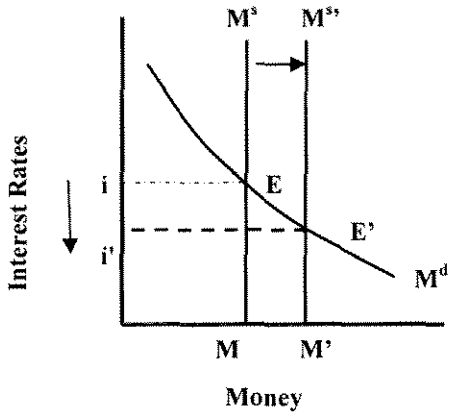


FIGURE 3.4

INCREASE IN MONEY SUPPLY (M^S)



Monetary Policy and Open Market Operations

To affect the money supply, the central bank participates in open market operations. Open market operations are called such because; to influence the money supply the central bank participates in the buying and selling of bonds in the open market for bonds. If the central bank wishes to increase money supply, considered expansionary monetary policy, then they will buy bonds and pay for them by creating money, thus, introducing new money into circulation. On the other hand, if they wish to decrease the money supply, considered contractionary monetary policy, then they will sell bonds and take the received revenue and remove that money from circulation. So the Fed can easily increase or decrease the money supply by buying or selling bonds, respectively; however, how does the Fed entice people to buy more bonds or to sell their existing bonds? They do so by adjusting the return, the interest rate, they offer, relative to the market, in essence influencing the attractiveness of holding bonds. If the Fed wants people to buy bonds, then they will offer enticing rates relative to the market.

A bond is a financial asset that promises a stream of known payments over some period of time or one lump payment at the maturity of the bond or a combination of both. The lender, the bond holder, pays the principal and at maturity receives the principal plus interest from the borrower. This study looks into Treasury Securities, which are coupon bonds offered by the Government. Coupon bonds are the most common bonds. They offer multiple coupon payments throughout the life of the bond, and one payment equal to face value at its maturity. The coupon payments are essentially interest rate payments determined by the coupon rate of the bond.[1] The face value is the amount the company or the government owes the bond holder at maturity, which does not change throughout the life of the bond (see figure 3.5). So in order to compute the return on a bond, one must incorporate the face value, the coupon rate, and the price, which is the amount the bond was purchased for. If comparatively, interest rates are higher (lower) than the coupon rate, then the bond will sell for a discount (premium), which means below (above) face value. The reason for this discount or premium is that by lowering or raising the price of the bond, the bond's effective yield (the return) will come closer to what the market is offering at the time.

FIGURE 3.5

DERIVATION OF BOND YIELD

$$\textbf{Yield(\%)} = \left(\frac{\textbf{Face Value} - \textbf{Purchase Price}}{\textbf{Face Value}} \right) \times \frac{\textbf{360}}{\textbf{Days Til Maturity}} \times \textbf{100\%}$$

[1] However, the actual interest rate of a bond incorporates whether it is sold for a discount or premium, that is below or above face value; essentially, the price of the bond and the coupon payments together determine the interest rate.

The sale of bonds above or below its price is important because of the secondary market for bonds, which allows people to buy and sell bonds before the maturity date. This secondary market makes the decision to buy bonds easier, because one can more easily sell bonds, instead of having to hold bonds to maturity. In essence, the secondary market makes bonds more easily converted to a form for payment, increasing the liquidity of bonds. So, for example, if a bond is halfway through its life and someone wishes to sell, the bond's coupon rate and face value are the same as they were when the bond was initially created. And therefore, in order to sell, the price of the bond must be either lowered or raised above the face value, depending upon the comparative return in the market. If the comparative return in the market is lower, then the bond will sell for a premium, which decreases the return of the bond in order to match the relative return in the market. In this manner, the bond market determines the price of the bond, which in turn implies the interest rate, the effective yield for the remaining life of the bond (yield to maturity). As the bond price gets bid up in the bond market, the effective yield, the interest rate received, based on the premium or discount of the bond, then decreases.

This interaction is what the Fed plays into as one of the ways to influence the money supply. As such, the Fed's intentions for the money supply have implications for returns in the bond market. In order to buy or sell bonds, the Fed has to play into the market for bonds, thus affecting the supply and demand for bonds. Interaction in the market for bonds derives the current return in the market.

What Banks do

If people held all money as currency then banks would have no role to play in the economy. People's preference for holding currency versus checkable deposits has an affect on money creation through the banking system. The more checkable deposits people wish to hold the more funds banks will receive.[2] These funds are then employed to buy bonds, stocks, or to make loans to other people and firms. By making loans, banks are essentially increasing the amount of money in circulation; because the money used to make the loans comes from money people have in the banks in the first place. For precautionary reasons, the central bank, the Fed, requires these banks to not employ a certain proportion of the funds received, known as the reserve requirement ratio. These reserves are mainly to ensure sufficient funds for covering withdrawals and honoring checks written against accounts held. These unused funds are then held, in part, at the bank as cash and, in part, in an account at the Fed. The reserve requirement ratio can then be used as a tool to influence the amount of money released into the economy. By lowering the RRR, the amount of funds that are required to be unused is decreased. So the Fed would be allowing banks to employ a greater proportion of their total funds, which enter the economy through bonds, stocks, or loans. Loans inject more money into the hands of both people and firms. Thus, by lowering or raising the RRR, the Fed is increasing or decreasing, respectively, the amount of money in the hands of people and firms; affecting the money supply. Combining open market operations and the required reserve ratio, the Fed has two tools that directly affect the amount of money in circulation and two areas where they can influence expectations. Predictions concerning the Fed's

[2] This also applies to savings accounts.

intentions with the money supply have an affect on interest rates before the actual mechanisms are allowed to interact as described above. This is due to the fact, that widely held expectations instigate people to act accordingly and cause what was expected to happen to begin to happen. Expectations lead to changes in the market like a self-fulfilling prophecy.

Expectations: the Interaction of IS-LM

Nominal interest rates take center stage in the financial markets. When people look up the current rates, they are looking up nominal interest rates. The interest rate tells us how many dollars we have to pay in the future in exchange for having one more dollar today. However, a crucially important factor, when looking for a suitable return in the market, is the amount of money being depreciated by inflation. If inflation is at 4% and the interest rate being received is 3%, then the real return being earned is a negative 1%. Therefore, most people account for inflation's affect on money, by incorporating the real interest rate into their decision. The real interest rate tells us the dollar amount relative to a basket of goods today versus a basket of goods in the future; which means to derive the real interest rate one must incorporate the expected rate of inflation over the holding period of the interest earning asset. Therefore, the real interest rate is equal to the nominal interest rate minus expected inflation ($r = i - \pi^e$). What people expect to happen to future nominal interest rates and/or future inflation – in essence expected future real interest rates – effects current behavior. The analysis of such expectations will be explained below.

The IS curve represents equilibrium in the goods market, following the condition that the supply of goods must be equal to the demand for goods. While the LM curve represents equilibrium in the financial market, following the condition that the supply of money be equal to the demand for money. The IS curve describes how interest rates affect output, while the LM curve tells us how output affects interest rates.[3] Together the two curves determine output and the interest rate, see figure 3.9 below. What is expected to happen in the goods and financial market, the IS-LM relation, can lead to what is to be expected for interest rates and output. The LM curve uses current nominal interest rates, while the IS curve uses current and expected future real interest rates. The LM curve is the decision between bonds and currency, currency pays zero interest, so LM equation is only affected by nominal interest rates. The equations for IS-LM are represents by figures 3.6 and 3.7, respectively.

FIGURE 3.6

IS EQUATION

$Y = C(Y-T) + I(Y, r) + G$

Y = Output C = Consumption G = Government Spending
T = Taxes I = Investment $r = i - \pi^e$

FIGURE 3.7

LM EQUATION

$M/P + YL(i)$

M = Money P = Price Level Y = Income
L(i) = Function of nominal interest rates

[3] This interconnection comes from the derivation of both curves, see chapter 5 in Blanchard, Oliver. *Macroeconomics.* New Jersey: Pearson Prentice Hall, 2006.

FIGURE 3.8

REAL INTEREST RATE

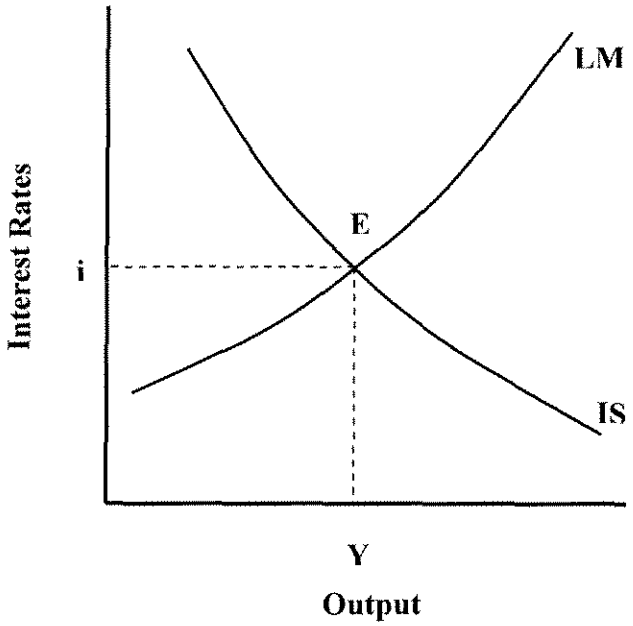
$r = i - \pi^e$
$r'^e = i'^e - \pi'^e$

where:
π^e = expected inflation
i = nominal interest rate
$'^e$ = future expected value

Expectations play a major role in interaction of the IS curve. With lower current or expected future interest rates people are more inclined to consume more and companies are more inclined to invest more. Investment decisions are concerned with the real interest rate. Companies are involved in the goods market and, therefore, need to know how much they are going to pay back in terms of goods. The real interest rate is affected by inflation expectations. If inflation expectations are high, then the real interest rate is lowered. In the future the pay back in terms of goods will be lower. However, the LM relation is concerned with the nominal interest rate, and thus not affected by expectations, see figure 3.7. Monetary policy can only directly affect nominal interest rates, and thus can directly affect the financial markets through the LM relation. On the other hand, monetary policy can indirectly affect real interest rates through its effect on inflation expectations, and, as such, can indirectly affect the goods market. Thus, the effects of monetary policy on output depend on how movements in the nominal interest rate translate into movements in the real interest rate. A lot of this translation has to do with the expectations of the market.

FIGURE 3.9

IS – LM RELATION EQUILIBRIUM CONDITION



Short Run versus Medium Run

Popularized macroeconomic theory denotes that when expected inflation plays a role, the affects of money supply changes on interest rates are different for the short-run and the medium-run. Higher money growth in the short-run leads to lower interest rates, while in the medium run can lead to an increase in interest rates depending on the expectations associated with inflation. In the short-run the price level is sticky (doesn't adjust immediately) and so an increase in the money supply, leads to an increase in the real money stock (M/P). However in the medium run, prices adjust, they increase incorporating the delayed affects of an increase in the money supply (this occurs with inflation).

There is much empirical evidence displaying short run decreases and increases in nominal interest rates due to monetary expansions and contractions, respectively.[4] The following analysis assumes the economy begins at the natural level of output, which is the output level associated with the natural level of employment.[5] The central bank increases the rate of money growth, M. The price level does not adjust in the short run, thus M/P, the real money stock, increases. This increase shifts the LM curve and assuming inflation expectations do not change, the IS curve will not shift. As a result, interest rates decrease and output increases (see figure 3.10).

In the medium-run it becomes important whether or not the moves by the Fed are permanent or temporary. For instance, if the public believes the Fed is going to allow an increase in inflation, then they may believe that the increase in the money supply described above is permanent. As a result, the public will adjust upwards their expectations for inflation. Thus, the medium run incorporates the idea of how moves by the Fed translate into affects on expectations in the markets.

The IS curve is affected by expectations through both consumption and investment. Expectations directly affect the determination of consumption spending through future income, interest rates, and taxes. Expectations indirectly affect consumption spending through stocks, bonds, and housing – the values of such are affected by the future expected and current conditions in the financial markets.

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[4] Blanchard, 306.

[5] The natural level of employment asserts that a certain level of unemployment is necessary in order for the market to function smoothly.

FIGURE 3.10

INCREASE IN REAL MONEY STOCK

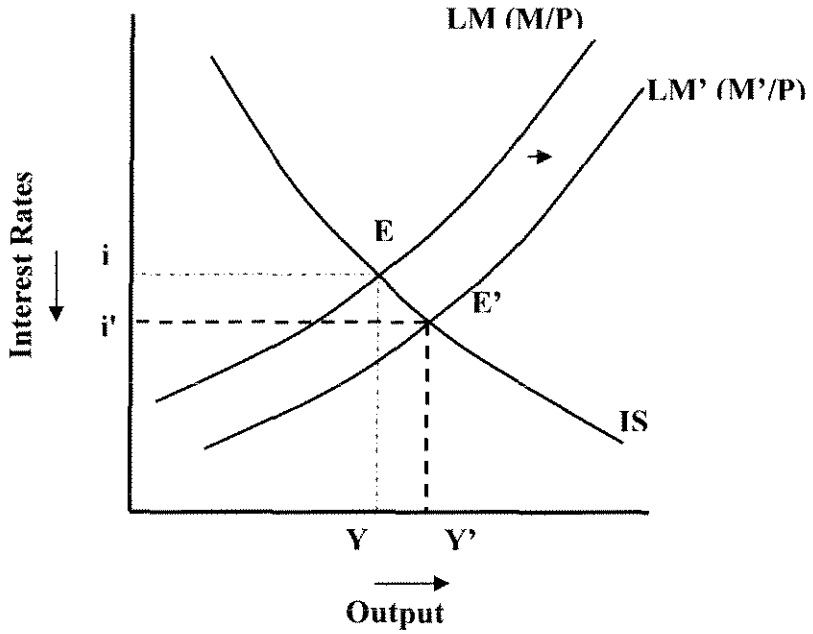

FIGURE 3.11

CONSUMPTION EQUATION

$Ct = C$ (total $wealth_t$, $Y_{Lt} - T_t$)
(+ , +)

Where:
Total wealth incorporates non human wealth (stock and bonds and housing values) and human wealth (income).

The consumption model denotes that increases in total wealth and increases in after tax income increase consumption; which would result in increases in the IS curve. Expectations affect investment through future expected profits and future expected real interest rates. The present value of future expected profits is one of the main determinants in an investment decision, where the higher current or expected real interest rates are, the lower the expected present value and future profits. If the present value is lower then aggregate investment and, thus, aggregate spending will be lower. As a result, the IS curve would decrease.

FIGURE 3.12

PRESENT VALUE DETERMINATION

$$PV = \frac{1}{1+r_t} \times P^e_{t+1}$$

Expectations of both future output and future interest rates affect current spending and therefore current output. The affect usually moves consumption and investment together and thus to simplify the analysis, consumption and investment in figure 3.6, ($Y = C(Y-T) + I(Y, i - \pi^e) + G$), are lumped together into aggregate spending.

FIGURE 3.13

IS EQUATION INCORPORATING EXPECTATIONS

$$Y = A(Y, T, r, Y'^e, T'^e, r'^e) + G.$$
$$(+, -, -, +, -, -)$$

Figure 3.13 now illustrates that changing expectation causes shifts in the IS curve. Aggregate spending is an increasing function of income (Y), a decreasing function of taxes (T), and a decreasing function of real interest rates (r). Shifts of the IS curve affect

output and interest rates, see figure 3.9. Increases in current or expected future income and/or output cause increases in aggregate spending and shift the IS curve right. Increases in current or expected future taxes cause decreases in aggregate spending and shift the IS curve left. Increase in the current or future expected real interest rates cause decreases in aggregate spending and shift the IS curve left. For all three aforementioned scenarios the opposite affects also hold.

When the money supply increases, nominal interest rates decrease, and the effects on current and expected future real interest rates depend on whether the change causes revision of future expected nominal interest rates and current or future expected inflation. Therefore, in the medium run, the effects of the Fed's increase of the money supply on the financial markets, thus, depends on its effect on the determination of future nominal interest rates, i'^{e}, and whether it changes both current and/or future inflation expectations, π^{e} and π'^{e}. Changes in the current interest rate, unaccompanied by changes in expectations, have only a small effect on spending and, in turn, a small effect on output. Thus, the effects of monetary policy depend crucially on its effect on expectations. The biggest effect will be seen when the change is a surprise and expected to last; such as a surprise increase in the money supply which is expected to be accommodated by the Fed. The concern is how macroeconomic news, such as the money supply announcement does, change the expectations of future interest rates and future income for people and firms, and as such leads them to act accordingly in their current environment.

The incorporation of expectations in the above section bases from the rational expectations hypothesis, which describes the formation of expectation in a forward-looking rational manner; that people use all of the available information in the markets

and do the best possible job of predicting future movements. This hypothesis leads to the inclusion of the following additional hypotheses: the liquidity effect, policy anticipation, expected inflation, and the risk premium; which are described in the literature review below. This chapter has provided a brief overview of the macroeconomic theory concepts which have led to interest in the area of market reaction to money supply announcements. Now that the how of the reaction has been described, the literature review will give an overview of the actual reactions observed in the markets to changes in the money supply. The next chapter examines empirical studies of the many theories and varying reactions of interest rates to money supply announcements, as well as other directions studies have taken. Some studies try to discriminate among the theories, while others conclude this either irrelevant or that there are more important gaps in the research needed to be filled; such as the environmental factors involved in interest rate response. Another gap is the lack of up to date research describing the relationship between money supply announcements are interest rates. This study is concerned with this gap: the recent behavior of interest rates as predicted by changes in the money supply.

CHAPTER IV

REVIEW OF LITERATURE

The last theory chapter described how interest rates respond to changes in the economy, especially changes in the money supply. This review of literature chapter will discuss the observed reactions interest rates have had to changes in the money supply. The idea of changes in the money supply and its effects on the financial markets began with the concept of monitoring flows of money which initially appeared in research in 1947, when the first statistical paper was published on the fluctuations of currency and vault cash.[1] This first attempt to combine all available information on money flows, paved the way for continued research and better monitoring of the money supply. With more attention to the fluctuations of money, a connection was made to its implications for changes in the economy. As such, people became interested in the implications of money, especially dealing with interest rates. Empirical studies have confirmed the theory that changes in the money supply cause changes in short run interest rates.[2] The question still remained of how exactly markets respond to expected and unexpected changes in the money supply. What is expected to happen to money supply begins to

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[1]Schwartz, Anna Jacobson and Elma Oliver. "Currency held by the Public, the Banks, and the Treasury, Monthly, December 1917-December 1944." *NBER. Technical Paper 4.* (1947).

[2] Blanchard, 306.

affect interest rates even if the expectations turn out to be incorrect. The idea of expected changes in money supply being reflected in interest rates has resulted in the consensus in literature that only money surprises matter; the unexpected portion of the money supply is consequential for financial market impact.[3] This chapter is dedicated to studies on the topic of unexpected changes in the money supply and their affects on interest rates. With this review of literature one can see where the extension of the study to current times dealing with interest rate expectations is necessary.

Theories

There are currently many hypotheses in research trying to explain the mechanism through which money announcements affect interest rates. The possible hypotheses include the following: policy anticipation, expected inflation, risk premium, and the liquidity effect hypothesis (which uses Keynesian theory through money demand). The risk premium hypothesis has lost popularity due to the lack of evidence for the hypothesis discovered by Cornell, and Belongia and Kolb.[4] The liquidity effect only holds when prices are sticky and disappears when prices adjust; it indicates that increases (decreases) in the money supply leads to decreases (increases) in interest rates. When prices are sticky, the real money stock, M/P, will change as much as the money supply, raising or

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[3] Sheehan, *New Information and Its Effects*, 26.

[4] Belongia, Michael T. and Fedric Kolb. "Risk Aversion and Weekly Money: Does the Market Expect the Fed to Offset Large Increases in M1?" *Economics Letters.* 16 (1984): 327-330.

Cornell, *Another View*, 1-23.

lowering short-term interest rates, see figure 3.10. However, once prices adjust, M/P, moves back towards the direction it started; when M increases, prices increase, thus, the real money stock M/P, decrease. Strongin and Tarhan's 1990 study extended the liquidity effect to include expected liquidity effect.[5] They concluded that expectations of a liquidity effect explain short term rate variations and most of long term rate variations, with expected inflation hypothesis explaining the rest. Next, the real activity hypothesis deals with how money announcements affect the public's expectations of future real output. If money growth is higher than expected, it may indicate increases in future real output, which would lead to an increase in interest rates. Joines' 1991 article rejects two versions of the real activity hypothesis and finds that the policy anticipation hypothesis works the best.[6]

By far the two most popular and supported hypotheses have been policy anticipation and expected inflation. The expected inflation hypothesis explains changing interest rates through market participants reactions to changing expectations about future inflation; such as an increased expectation of future inflation due to a higher than anticipated money announcement. The public would act according to expectations of a future increase in prices and through their actions there would be an increase in short-term interest rates. The expected inflation hypothesis has been supported to explain most

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[5] Strongin, Steven and Vefa Tarhan. "Money Supply Announcements and the Market's Perception of Federal Reserve Policy." *Journal of Money, Credit, and Banking.* 22 (1990): 135-153.

[6] Joines, Douglas H.. "Money Supply Announcements and Real Economic Activity." *Journal of Monetary Economics.* 28 (1991): 391-410.

of the interest rate response to money announcements.[7] There are also a handful of studies which discovered that most of the variations in nominal interest rates were caused by changing inflation expectations during 1953-1971.[8] However, Ulrich and Wachtel disagree on the degree that inflation expectations affect interest rates.[9]

With increasing popularity was the policy anticipation hypothesis, which follows the reasoning that the public uses money announcements as an indication of the possibility between contractionary versus expansionary monetary policy. If money stock announcements indicate higher than anticipated money growth, then the public may anticipate that the Fed will be implementing a contractionary monetary policy and therefore will act according to the anticipation of future increases in interest rates. Support for this hypothesis is found in Roley and Walsh 1985 article with the conclusion that the 1982 commitment to monetary control strengthens policy anticipation due to better prediction of the actions of a more committed Fed.[10] Such findings, led the way

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[7] Fama, Eugene F. "Short-Term Interest Rates as Predictors of Inflation." *The American Economic Review.* 65 (1975): 269-282;

Urich, Thomas and Paul Wachtel. "Market Response to the Weekly Money Supply Announcements in the 1970s." *Journal of Finance.* 36 (1981): 1063-1072;

Cornell, Bradford. "The Money Supply Announcements Puzzle: Review and Interpretation." *The American Economic Review.* 73 (1983): 644-657;

Hardouvelis, Gikas A. "Market Perceptions of Federal Reserve Policy and the Weekly Monetary Announcements." *Journal of Monetary Economics.* 14 (1984): 225-240.;

Woodward, R.S. "The Effect of Monetary Surprises on Financial Futures Prices." *The Journal of Futures Markets.* 6 (1986): 375.

[8] Fama, 269-282.

[9] Urich and Wachtel, *Announcements in the 1970s*, 1063-1072.

[10] Roley and Walsh. *Monetary Policy Regimes*, 1011-1039.

for incorporation of Federal Reserve policy as an influencing factor on the strength of the relationship between money announcements and interest rates. This new parameter led research away from discussing which hypotheses hold and towards what environments caused stronger correlations.[11] Therefore, I provide the above discussion of theory to present the different ways money announcements affect interest rates, but will not be attempting to discriminate among the different hypotheses. For a more thorough overview of the different hypothesis readers are directed to Sheehan's 1985 article.[12]

Sub-periods of Significance

More recent research has incorporated the study of monetary policy and the effect of financial environments on interest rate variations into the continuing study of money supply announcements. The environment can indicate to the public the Fed's commitment to action, their ability to act as intended, and the speediness of their reaction. Shifts in Federal Reserve Policy alter the value of the information content of the money stock announcement and, thus, affect the responses in the market.[13] The majority of studies on money announcements have focused on the regime effect of the sub-periods pre-1979, 1979-1982, and post 1982. Pre-1979 contains positive correlations between money stock and interest rates, however, the correlations are not as large as would have

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[11] Roley, Vance V. and Simon M. Wheatley. "Shifts in the Interest-Rate Response to Money Announcements: What Can We Say About When They Occur?" *Journal of Business and Economic Statistics.* 14 (1996): 135-138.

[12] Sheehan, *New Information and Its Effects*, 25-34.

[13] Santomero, Anthony M.. "Money Supply Announcements: A Retrospective." *Journal of Economics and Business.* 43 (1991): 1-23.

been expected for the period. One would have expected that with the summer of 1975, a time of economic recovery; time of rapid money growth and/or rising short-term interest rates. However, these expectations failed to occur and small response of interest rates to money supply announcements was observed starting in 1976. One reason for this observation, was an over prediction of money demand, with econometric studies finding a 1976 downward shift in money demand.[14] Post-1979, significantly larger responses are found; coinciding with the start of explicit monetary growth targeting.[15] Also in 1979, the Federal Reserve made a policy statement on October 6th, with Chairman Paul Volcker incorporating dramatic changes into monetary policy. This statement signaled to the public a more committed Fed, who would more greatly utilize open market operations and place more emphasis on monetary control; they would be utilizing "additional measures to restrain growth of the monetary aggregates."[16] Thus, money announcements became a useful signal to Fed actions and had greater influence on interest rates. The findings conclude that 1979-1982 is the most statistically significant period for interest rate responses to money announcements, because the policy followed signaled that the monetary aggregates were the best indicator of future monetary policy (see Cornell 1983, Roley and Walsh 1985, Deaves and Melino and Pesando 1987, Haudouvelis 1984). However, post-1982 the significance declines, as the Federal Reserve lowered its

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[14] Enzler, Jared, Lewis Johnson, and John Paulus. "Some Problems of Money Demand." *Brookings Papers on Economic Activity.* 1976 (1976): 261-280.

[15] Cornell, *Review and Interpretation*, 644-657.

[16] Federal Reserve Bank of San Francisco, "FRSBSF Economic Letter: Number 2004-35": Dec 2004; available from http://www.frbsf.org/publications/economics/letter/2004/el2004-35.html; Internet; accessed Dec. 2008 – Feb. 2009.

commitment to control of the monetary aggregates (see Loeys (1985), Roley 1986, Huizanga and Leiderman 1987).[17] Logically, this policy change signaled market participants that unexpected money announcements now gave a smaller predictive power for future monetary developments. However, monetary targeting was incorporated into Fed policy until the year 2000, when the congress mandate of monetary targeting expired, and as such monetary aggregates were directly incorporated in monetary policy until the above date.

Beyond Sub-periods

Currently, the Fed targets the federal funds rate and makes immediate announcement of any changes in their federal funds rate target. This increased communication began as an experiment in 1994 and was made official in 1995, with the FOMC announcing their policy decisions on the day they are made.[18] This new practice led to a decline in market response,[19] better anticipation of FOMC decisions by the federal funds futures market,[20] and a decrease in short-term surprises.[21] Less change is

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[17] Huizinga , John and Leonardo Leiderman. "Interest Rates, Money Supply Announcements, and Monetary Base Announcements." *NBER Working Paper Series No. 1705.* (1985).

[18] Meulendyke, 55.

[19] Urich, Thomas and Paul Wachtel. "Financial Market Responses to Monetary Policy Changes in the 1990s." *Contemporary Economic Policy.* 19 (2001): 254-267.

[20] Swanson, E. "Have Increases in Federal Reserve Transparency Improved Private Sector Interest Rate Forecasts?" *Journal of Money, Credit, and Banking.* 38 (2006): 791-819.

[21] Swiston, Andrew. "Where Have the Monetary Surprises Gone? The Effects of FOMC Statements." *IMF Working Paper. WP/07/185.* (2007).

seen with the actual announcements because better anticipation means more of the change will already have been incorporated into the market by the time of the announcement.

The over-arching conclusions are that interest rates respond to the value of information in the market, the Federal Reserve alters the value of information, and the Fed influences what acts as the best indicator of future policy. Even if it appears that money supply announcements give less valuable information, this paper posits that it still influences interest rates through indications of future changes in the economy. Therefore, I posit that even if unanticipated changes are smaller, market participants still react to unanticipated changes in the money supply. The money supply still has implications for the economy and, thus, market participants should react to unexpected changes in it.

Research into the area of money supply and interest rates has recently been sparse. Studies post-year 2000 are mostly looking in retrospect at the era of monetary targeting ending their sample periods in the 1990s. Any studies with sample periods beyond the 1990s have no mention of the expiration of the Humphrey-Hawkins act, or the Fed's announcement to no longer set monetary targets. Berument and Froyen extend their sample period from 1975-2002, yet, focus much of their research on the well documented sub-periods pre- and post-1979.[22] The lack of literature post 1990s makes interesting the extension of the enormous number of previous studies in this area. What does the response of interest rates to unanticipated changes in the money supply look like now? So short-term surprises have decreased, what is the reaction to the small surprise

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[22] Berument, Hakan and Richard T. Froyen. "Monetary Policy and Long-Term US Interest Rates." *Journal of Macroeconomics.* 28 (2006): 737-751.

that still exists?[23] The next chapter, the empirical test, will be looking at what the current response of interest rates to money supply is and will be explaining the observed response using the theories described in the previous theory chapter and through connections to what has previously been found in the research to date.

[23] Swiston, 1.

CHAPTER V

THE EMPIRICAL TEST

Methodology and Data

The current model is concerned with the behavior of interest rate expectations and the information content of weekly money supply announcements over the sample period 1985 to 2005. This sample period will be able to incorporate the 1987 de-emphasis of M1, the 1994 announced increase of Fed communication, and the 2000 expiration of the Humphrey-Hawkins Act. The objective of this empirical work is to investigate the significance of these sub-periods, which have the affect of changing the value of information provided by money supply announcements. The money supply announcement is made up of two components; the expected portion and the unexpected portion. The expected portion goes along with rational expectations hypothesis; that people look to all the available information in the market and make the best possible prediction. As such, some future change in the money supply is expected and already incorporated into the market. Grossman, and Urich and Wachtel look into the implications of the two components and both found that unanticipated changes in the money supply quickly affect the market through interest rates, while anticipated changes

have no effect on interest rates.[1] These findings led both studies to the conclusion of money market efficiency in respect to new information on money supply announcements and treasury bills.[2] Money market efficiency means that the market reflects all of the available information. From 1977-1988, Santomero confirmed and extended the same previous study results.[3] Therefore, to go along with the assumption that the market is efficient, this study will exclude expected money from its analysis, and employ unexpected changes in the money supply for its effect on interest rate expectations.

To determine unexpected money, previous studies have utilized Money Market Services, Inc. of San Francisco, MMS, for their attempt to determine the expected portion of the money supply. However, due to their technique of surveying market professionals, some skepticism into their results has arisen. Ordinary market participants may not have the same expectations and, thus, the stated expected growth could actually be unexpected to non-professionals. Cunningham and Cunningham (1991) discuss the implications of this skepticism, and conclude that the expected future money supply announcement by MMS acts as a money surprise in it as itself. Due to my inability to find any current future money supply survey from MMS, and the aforementioned criticism of it actually being unexpected, this study utilizes statistical forecasting techniques in order to estimate the expected portion of the money supply. The forecasting techniques include: a 13-week

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[1] Grossman, Jacob. "The 'Rationality' Money Supply Expectations and the Short-Run Response of Interest Rates to Monetary Surprises." *Journal of Money, Credit, and Banking.* 13 (1981): 4.

Urich and Wachtel, *Announcements in the 1970s*, 1063-1072.

[2] Gauger and Black, 677-691.

[3] Santomero, 1-23.

moving average change model, a one period naïve percent change model, a Holt's exponential smoothing model, and Brown's method of double exponential smoothing model. Support for the use of these techniques can be found in Down and Mann's 2004 article.[4] The moving average change model is used to incorporate the more relevant recent observations of the M1 money supply versus a less useful total average. This is due to the fact that the trend growth of money supply from week to week and month to month fluctuates between increases and decreases, while, from year to year there is an overall increase in M1.[5] This study has chosen a thirteen week period as the most relevant period and computes a mean for this thirteen week period of observation. In doing so, the average of the most recent thirteen week period of past changes is added to the most recent value of M1 to forecast the next release. The second technique, the naïve one percent change model, develops a M1 forecast for the next period by taking the most recent percent change in M1 and adding it to the most recently published value of M1. Holt's exponential smoothing model and Brown's double exponential smoothing model are applied as found in the text called Business Forecasting.[6] The equations for each of the above techniques may be found in appendix B. The median of the forecasting results for the above techniques are used in order to benefit from the greater accuracy of combining multiple forecasting techniques. This median forecast is then used as the

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[4] Mann and Dowen, 1125-1150.

[5] Federal Reserve Board Statistical Release, "H.6: Money Stock Measures: Historical Data"; available from http://www.federalreserve.gov/releases/h6/hist/; Internet; accessed Feb. 2009.

[6] Hanke, John and Arthur Reitsch. *Business Forecasting.* New Jersey: Prentice Hall, 1992.

expected portion for the money supply. However, the results from the individual forecast numbers are also presented for reference.

The actual money supply is obtained from the historical weekly H.6 release of the Board of Governors of the Federal Reserve System.[7] In order to be consistent with the numbers announced at the time of the change in interest rates, this study uses the seasonally unadjusted measure of the M1 weekly money supply, the level historically announced. The M1 money supply level is measured for the day ending Monday, however, is not announced to the public until Thursday afternoon of that week. If Thursday is a federal holiday then the announcement is made on Friday afternoon. The actual money supply announcement is subtracted by the median forecasted expectation for the money supply announcement in order to derive a model of the unanticipated money supply. Unanticipated money supply allows for interpretation of market reaction to the announcement, rather than interest rate reaction to actual changes in the money supply; that is how interest rates respond to new information. Since unexpected changes must be to new information, the lag between money supply measurement and announcement of the level creates an opportunity for research to separate the results of actual changes in the money supply affecting interest rates and market participants' reaction to new information.

The increasing attention markets are paying to interest rate expectations, led to the incorporation of such in this study. Due to the lack of historical data available for interest rate futures, this study will be incorporating interest rate expectations through the utilization of the term structure of interest rates. Bond prices and bond yields depend on

[7] Federal Reserve Board Statistical Release, *H.6: Money Stock Measures: Historical Data*.

current and expected future short-term rates; so that long-term interest rates reflect current and future expected short-term interest rates. Three month, six month, and one year nominal Treasury Securities of constant maturities are used from the Federal Reserves H.15 statistical release.[8] Daily rates for the securities are collected for the Wednesday before the announced money supply and the Friday following the announcement. If the announcement was to occur on a federal holiday this study uses data for the following Monday. Thus, the model uses the change in interest rate from the Wednesday before the announcement to the Friday after the announcement. Since the money supply is measured Monday of a certain week, the affect changes in the actual money supply will have on interest rates will already have affected interest rates before the Wednesday prior to the announcement. With this being the case, this study is able to analyze the effect that just the announcement of the money supply has on interest rates. The money supply level is announced on Thursday and this study looks at the change this announcement has on interest rates from the Wednesday prior to the Friday after.

This study incorporates U.S. government bonds, which range in maturity from a few days, to 30 years. T-bills are bonds with maturities up to a year, Treasury notes are between 1-10 years, and beyond that are T-bonds. Government bonds are incorporated in this study to limit the effect of exogenous factors on the results. Government bonds, have the lowest risk of any instrument and thus are least effected by risk premium factors. The only risk being that interest rates can change beyond what is expected; that based on expectations one can lock into low interest rates for an extended period of time and in the

[8] Federal Reserve Board Statistical Release, "H.15: Selected Interest Rates: Historical Data (updated every business day, excluding holidays)"; available from http://www.federalreserve.gov/releases/h15/data.htm; Internet; accessed Feb. 2009.

future market rates increase. Government bonds are also closely linked to monetary policy. These financial instruments are monitored by the Open Market Desk at the Federal Reserve Bank of New York, who is one of the primary dealers in the buying and selling of them. The above role acts under the guidance of the Federal Open Market Committee and as such gives t-bills, t-notes, and t-bonds the closest link to Federal Reserve monetary policy.[9] Thus, this study will look at the term structure of interest rates of government bonds to determine the effect money supply announcements have on the expected course of interest rates. Combining expectations of future interest rates with unanticipated changes in the money supply, this study will determine the varying degrees of this relationship between 1985 and 2005.

The Model

This study utilizes the model presented in Santomero's 1991 article.[10] His article looks at the impact of unanticipated changes in the money supply on all treasury securities from ninety days to thirty years during the sample period 1977 – 1988. A main difference for this study, is the use of forecasting techniques as an alternative to the lack of continuous Money Market Services data; which was available for the above sample period. The alternative forecasting techniques are used to create a model of the expected money supply, which is then subtracted from the actual money supply announcement to determine the unexpected portion of the M1 money supply. The derived unanticipated money supply announcement data will then be applied to the compiled data of three

[9] Mizrach, Bruce and Christopher J. Neely. "The Microstructure of the U.S. Treasury Market." *Federal Reserve Bank of St. Louis. Working Paper.* (2007).

[10] Santomero, 3.

month and six month t-bills and one year t-bonds in order to determine how much effect money surprises have on future interest rates. The efficient market model approach is used and linearity of the model is assumed. Due to the long time horizon, the data is de-trended by expressing the aggregate variables as logs. Regressions are run using the first following model, as described in Santomero's 1991 article[11]:

FIGURE 5.1

MODEL 1

$$\Delta R_{it} = \beta_0 + \beta_1 \left[\ln M_t - \ln M_t^e \right] + \varepsilon_t$$

Where:

ΔR_{it}	= change in interest rate from Wednesday before the money supply announcement to the Friday after the announcement.
M_t	= the announced level of money stock in week t.
M_t^e	= the median of the four forecasting techniques as an estimate for expected M1 money supply level.
ε_t	= random error term.
β_0, β_1	= estimated coefficients.

By subtracting the log of the week's expected M1 money supply from the log of the actual level of M1 for the week, the model is able to describe the relationship between relative unanticipated changes in money supply and absolute changes in interest rates.

Regressions are also run using a second model, with the equation in figure 5.2. This model is an extension of Santomero's model with the addition of the affect of future expected changes in the money supply on current changes in interest rates. This idea was to include Sheehan and Wohar's idea of a measure of future expected changes in

[11] Ibid, 3.

monetary policy.[12] They utilize expected future changes in money supply as a way of incorporating expectations for future monetary policy on changes in exchange rates. This study uses the same idea, however, applies it to changes in treasury securities. Since the money supply is measured on a Monday and announced the following Thursday, then by the time the announcement is made the money supply is already different than the announced level. With this in mind, the announced change in money supply could cause market participants to react to the announcement by re-forecasting and causing changes in the market based on that newly formed forecast. Due to the fact that changes have already been occurring in the actual money supply, participants want to use the announcement information as an indicator of what will be happening to interest rates. Therefore, the announced change in money supply should cause participants to react to what they feel next weeks money supply will be.

FIGURE 5.2

MODEL 2

$$\Delta R_{it} = \beta_0 + \beta_1 \left[\ln M_t - \ln M_t^e \right] + \ln M_{t+1}^e + \varepsilon_t$$

Where:

$\ln M_{t+1}^e$ = expected money supply level for the following week.

Figure 5.2 represents the idea that interest rates would have already responded to where money supply is expected. In week "t" they should begin to reflect what is expected to happen next week, "t +1." Models 1 and 2, represented in figures 5.1 and 5.2, are used for regression analysis of the whole sample period, 1985-2005. Then sub-periods are examined with model 1: 1985 to 1993, 1995 to May 2000, July 2000 to 2005. These sub-

[12] Sheehan and Wohar, *Foreign Exchange Futures Prices for Five Countries*, 699.

periods were to chosen to help analyze the way and if the following events alter the value of information provided by the M1 money supply; 1987 de-emphasis of M1, the 1994 increase in Fed communication, and the expiration of the Humphrey-Hawkins Act in mid-2000.

Results

The null hypothesis for the statistical testing of models 1 and 2 is that the slope coefficient would be equal to zero. In order to reject this null hypothesis, economic research typically calls for a 95% level of confidence, with some occurrence of 90% confidence levels.[13] The regression results for all data are displayed in tables 5.1 – 5.3. These include results for regressions run on three month, six month, and twelve month treasury securities using model 1 and model 2, found in figure 5.1 and 5.2, respectively. The tables state the coefficient values, the p-values of the coefficient, and the R-squared values for the two different models. The intercept values are not included as they do not give any information about the predictive relationship between changes in interest rates and changes in the M1 money supply. The results for fitting model 1, figure 5.1, are presented in table 1 and the results for fitting model 2, figure 5.2, are in table 5.3. Table 5.1 and 5.3 display regression results for model 1 and model 2, respectively, during the entire sample period 1985 to 2005. The two tables use all five of the expected money supply forecasting techniques described in the methodology and data chapter and found in appendix B. The research trend is to use the median forecast, however, the other forecasts are run for reference.[14] Table 5.2 displays the regression results for model 1

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[13] Dielman, Terry E. *Applied Regression Analysis: A Second Course in Business and Economic Statistics.* Southwestern Educational Publishing, 2004.

[14] Mann and Dowen, 1142.

over the three different sub-periods: 1985 to 1993, 1995 to May 2000, July 2000 to 2005 using the median technique of forecasting the expected money supply.

Previous research has shown a statistically significant relationship between unanticipated changes in M1 money supply and changes in interest rates. Model 1 was applied as represented in Santomero's 1991 article, however, extending the time period found no statistically significant results. The lack of statistically significant results indicates a change in the relationship between money supply and interest rates during the updated time period. There is something occurring in the markets causing this relationship to disappear. As predicted, in the literature, the post 1985 time periods it seems there is a diminished relationship between unanticipated changes in money supply and interest rates.[15] The relationship was predicted to be weakened but not to have disappeared. This is due to the fact, that during 1985 the Fed began de-emphasizing M1 as a targeting tool for monetary policy. Also during this time, research surfaced showing the lack of connection between economic activity and changes in M1. Looking only at model 1, leads to the conclusion that researchers were right to shift focus away from M1 money supply announcements toward other areas of possible economic indicators. However, it is possible that the simple linear regression model is just mis-specified and there is something being left out of the model. The relationship between money supply announcements and interest rates may have changed and a model has not yet been presented to represent the change in the relationship. Sheehan's and Wohar's 1995 article indicates the possibility of a lag between money supply announcements and

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[15] Loeys, Jan G.. "Changing Interest Rate Responses to Money Announcements: 1977-1983." *Journal of Monetary Economics.* 15 (1985): 330.

changes in the financial markets.[16] Strongin and Tarhan's 1990 article highlights the possibility of greater measures of monetary policy changes to be incorporated in the modeling of the relationship.[17] The possible mis-specification of the model opens up future possibilities of capturing a relationship between changes in interest rates and unanticipated changes in the money supply. A more inclusive model may be able to express the idea of money announcements giving supplementary information for other indicators; due to the Fed using money supply as a supplementary indicator. Now that the Fed uses the Federal Funds Rate (FFR) as their target, it is possible that changes in FFR and changes in money supply may be able to predict changes in interest rates.

Model 2 was applied to incorporate the implications of changing future expectations presented in Sheehan's and Wohar's 1995 article; their model used different types of data, however, this study incorporates their idea of information altering future expectations of monetary policy.[18] The results of Model 2 are represented in table 5.3. Table 5.3 shows results overall better than table 5.1, indicating that expectations for changes next week have some sort of an effect on changing interest rates during the current week. When the money supply announcement is made, expectations for the next week's announcement are formed and, as such, have an effect on current changes in the interest rates. Where participants expect interest rates to go are where they are going to start to go. Therefore, model 2, is able to incorporate the changing expectations that occur on the day of the M1 money supply announcement.

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[16] Sheehan and Wohar, *Foreign Exchange Futures Prices for Five Countries*, 704.

[17] Strongin and Tarhan, 137.

[18] Sheehan and Wohar, *Foreign Exchange Futures Prices for Five Countries*, 699.

Model 2, using the equation in figure 5.2, was the only model to return a statistically significant result. Table 5.3 displays two statistically significant results for the 3 month treasury security. Both the first median forecasting technique and the second 13-week forecasting technique returned statistically significant results for the 3 month treasury security. The first technique returned results significant to the 90% level of confidence, while, the second technique returned results significant to the 95% level of confidence. Model 2 represents a semi-log model, where the dependent variable is linear and the independent variable is a log. This model, thus, returns absolute changes in interest rates for relative expected changes in money supply. The results in table 5.3 of the first forecasting technique for 3 month treasury securities, infers that for every 1 percent increase in actual money supply relative to future expectations of the money supply, there are increases in the change of interest rates by 0.0149 basis points. The coefficient implies that the larger the unexpected change between actual money supply and forecasted money supply is, the larger the change in interest rates will be. The same interpretation goes for the second technique in table 5.3, although with a higher level of significance. The second technique infers that for every 1 percent increase in actual money supply relative to future expectations of the money supply, there are increases in the change of interest rates by 0.0344 basis points. This result indicates that the M1 money supply expected for t+1, made at the time of the money supply announcement during week t, has an effect on interest rates during week t.

The transitory nature of money supply announcements indicates the possibility of a more complex model. When the announcement of the money supply, measured on Monday is made on Thursday, the money supply has already begun to change before the

announcement from the announced level.[19] The money supply has been changing during Tuesday, Wednesday, and Thursday. Therefore, the current actual money supply is already at a level different then the announced money supply. This could have an impact on the effect unanticipated changes in the money supply may have. If the money supply was different than expected and the current actual money supply is already different then announced, participants may not react very much to the unanticipated changes in the money supply. Market participants should be reacting to what they think is going to be happening in the markets. The actual money supply announcement acts as new information in the markets, however, it also causes participants to form expectations for where they believe the money supply level will be in the next week. Along the lines of this train of thought a more inclusive model could incorporate participants' change in expectations of the money supply on the day of the announcement.

[19] Federal Reserve Board Statistical Release, "H.6: Money Stock Measures: Release Dates"; available from http://www.federalreserve.gov/releases/h6/; Internet; accessed Feb. 2009.

TABLE 5.1

1985 – 2005 RESULTS FOR FIGURE 5.1

Model 1 1985-2005			
Techniques	3 month	6 month	1 year
1. Median	0.01342	0.08664	0.11339
	{0.91689}	{0.51067}	{0.43538}
	[0.00001]	[0.00040]	[0.00056]
2. 13 week	0.01495	0.07909	0.10812
	{0.91195}	{0.56791}	{0.47934}
	[0.00001]	[0.00030]	[0.00046]
3. Naïve	0.02351	0.02058	0.01059
	{0.79584}	{0.82498}	{0.91790}
	[0.00006]	[0.00004]	[0.00001]
4. Holt	-0.00299	0.08494	0.13609
	{0.98027}	{0.49228}	{0.31882}
	[0.00000]	[0.00043]	[0.00091]
5. Brown	0.01687	0.08291	0.10712
	{0.88873}	{0.50188}	{0.43180}
	[0.00002]	[0.00041]	[0.00057]

β1 coefficient {p-value} [R2]

TABLE 5.2

SUB-PERIOD RESULTS FOR FIGURE 5.1

Model 1: Median Forecast			
Sub-period	3 month	6 month	1 year
1985 - 1993	0.05483	0.29075	0.23829
	{0.84150}	{0.31141}	{0.42377}
	[0.00009]	[0.00219]	[0.00137]
1995 - mid 2000	0.12060	0.23683	0.37457
	{0.62118}	{0.34477}	{0.22523}
	[0.00087]	[0.00319]	[0.00525]
mid 2000 - 2005	-0.00417	-0.07889	-0.02316
	{0.97753}	{0.55663}	{0.88766}
	[0.00000]	[0.00120]	[0.00007]

β1 coefficient {p-value} [R2]

TABLE 5.3

1985 – 2005 RESULTS FOR FIGURE 5.2

Techniques	Model 2 1985 - 2005					
	3 month		6 month		1 year	
	β1	β2	β1	β2	β1	β2
1. Median	-0.07837	1.49184*	0.01973	1.14331	0.11196	0.09046
	{0.57465}	{0.09417}	{0.89033}	{0.21048}	{0.47865}	{0.92849}
	[0.00257]		[0.00185]		[0.00060]	
2. 13 week	0.03175	3.43686**	0.08931	2.09087	0.10996	0.37715
	{0.81419}	{0.01703}	{0.51935}	{0.15672}	{0.47267}	{0.81704}
	[0.00521]		[0.00213]		[0.00051]	
3. Naïve	0.06155	0.07597	-0.02406	-0.08915	-0.08964	-0.20016
	{0.65049}	{0.70632}	{0.86270}	{0.66596}	{0.55935}	{0.37981}
	[0.00019]		[0.00022]		[0.00072]	
4. Holt	-0.23774	0.62278	-0.05440	0.36966	0.16704	-0.08210
	{0.27873}	{0.20027}	{0.80882}	{0.45800}	{0.50091}	{0.88127}
	[0.00150]		[0.00094]		[0.00093]	
5. Brown	-0.08198	0.78283	0.03634	0.36882	0.13960	-0.25725
	{0.56378}	{0.18849}	{0.80280}	{0.54532}	{0.38486}	{0.70231}
	[0.00160]		[0.00075]		[0.00070]	

coefficient {p-value} [R2] *significant at 10% **significant at 5%

CHAPTER VI

CONCLUSIONS

This thesis attempted to portray a significant response of interest rates to money supply announcements and to update the research, on such, to include more recent time periods. However, the results are inconclusive. Model 1 returned insignificant results for all three treasury securities; three month, six month, and twelve month. While model 2 returned significant results for only the three month treasury security. The speculation from the results for model 2 is that there is still a relationship between money supply announcements and interest rates which has not been able to be captured by the presented models. The avenue for future research should be directed to the lag between when the money supply is measured and when it is announced and what that means for interpretation of the announcement in the financial markets. A model needs to better incorporate the fact that the level of the money supply is already different at the time of the announcement.

Chapter I provided a brief introduction into the ideas leading to the relationship between money supply announcements and interest rates and the current trends in research. The money supply gives information about what the Fed is doing and/or what the Fed may be planning on doing. For this reason, market participants look to the

announcement as an indicator for future monetary policy. During the era of monetary targeting, the 1970s and the 1980s, much research found statistically significant results between the response of interest rates and unanticipated changes in M1 money supply announcements. Research changed gears with the end of monetary targeting in 1987, and began looking at other areas for economic indicators and their influences on financial assets. The lack of current research is where this study stepped in to investigate into and update the analysis to fill in the gap.

Chapter II, then, gave the background behind the monetary system and described how it has evolved to the point where somebody controls the amount of money in circulation. This led to the start of financial markets looking to indications as to when and in what direction the money supply is going to change as consequential for directional changes in interest rates. The evolution of the system changes the value of information the money supply provides to the financial markets and, thus, is important for understanding the accumulation of research.

Chapter III, the theory chapter, explained the different implications changes in money supply have for interest rates. Changes in the money supply can send differing signals to market participants and, so, depending on what is expected, interest rates react accordingly. The theoretical relationship between interest rates and the money supply is what has led to the changing expectations market participants have for interest rates due to changes in monetary policy.

Chapter IV, the review of literature, presented the varying research which has accumulated in the topic of interest rates and money supply to date. This research focused most of its attention on the era of monetary targeting. Even research released

after the era of monetary targeting still focused on the strength of the relationship during this era and on how to explain the relationship even better. The relationship had been proven to be there, however, researchers continually attempted to explain why and to add improvements to the predictive ability of the models. The review of literature highlighted the lack of current sample period research, leading this study to update the empirical observations; in order to see whether there is still something to learn from money supply announcements.

Chapter V, the empirical test, described the development and application of the model and the interpretation of results. Linear regressions were run for three month, six month, and twelve month treasury securities in order to determine their response to unexpected changes in the M1 money supply announcement. The results of this regression, presented in tables 5.1 – 5.3, show only statistically significant result for the three month treasury security in table 5.3; leading to the conclusion of a mis-specified model. The relationship between M1 money supply and treasury security interest rates was not captured by the models presented in figures 5.1 and 5.2; however, figure 5.2 provides some idea to what the correct model could be. Table 5.3 implies that money supply announcement may provide information for what to expect and that the difference between expected and actual is not where market participants look. They look at what the new information means for the changing expectations for the next week t+1. Not for a possible reaction to the difference between what was expected for the measured money supply, three days earlier, and the actual announced in week t. The question arises what the money supply announcement actually tells the market about current conditions in the

financial market; specifically what the new information provides for interpretation of the current money supply and for future expected changes.

The current model highlights some areas of interest but also demonstrates weaknesses. It appears that the relationship between interest rates and money supply has changed since Santomero's 1977 – 1988 sample period; where he found statistically significant results.[1] The model applied in this study comes from the model applied in his 1991 study. Even though the model applied was the same, the statistical significance was drastically different. There are a number of possibilities for this, such as a changing relationship, leading to the possibility of the omitted variables bias. The omitted variables bias occurs with the omission of an independent variable that could help explain variations in the dependent variable. One of the main concerns with the omitted variable bias is poor specification of one's model. It is also possible that some of the effects of the omitted variable could be captured in the results of the included variable, meaning the possible bias of the estimated parameters. There could be a variable acting in the other direction of changes in unanticipated money supply, which could help explain the relationship between interest rates and money supply.

A more comprehensive forecasting model may also be in order, one that also takes into account the monetary stance of the Federal Reserve. There is the possibility that the model may not be a simple linear model, as well as the possibility that variables reflecting more environmental stances are in order. One major difficulty in studying interest rates is that many factors influence their changes. It is impossible to control for all variables, therefore a definite predictive model is impossible. However, running a

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[1] Santomero, 1.

multiple regression with the different variables may be able to indicate which are the most predictive. Some authors have suggested that markets may have different magnitude of responses when the money surprise is negative and that larger magnitude of responses are seen during periods of tight monetary policy.[2] Thus, the information value of the money supply announcement may also incorporate the direction of the surprise and whether the public views monetary policy as tight or loose. In order to capture such ideas a more elaborate model is necessary.

For the purpose of this study, to derive a model for expected money a median forecasting technique was best.[3] However, the method of forecasting an expected money supply announcement may be improved upon. In order to have a more informed forecast, one would have to indicate whether there was historical data, other than previous trends and movements, which would inform the direction market participants thought money supply was most likely to take. One way of doing so would be to use the non-continuous Money Market Services data for the times available, and compile a model for the missing periods, with some indicator that measured the intention of the Fed for the money supply. By doing so one would get a better picture of what was historically expected for the money supply.

The results indicate a lack of ability to capture the relationship between M1 money supply and interest rates. The mis-specification of the model gives opportunity for future possibilities of creating a model to capture the relationship. I propose a more comprehensive and inclusive model with the incorporation of monetary policy stance and the direction of the money surprise to be able to return more concrete results. Also

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[2] Mann and Dowen, 1147.

[3] Ibid, 1142.

adjustments should be made to include the complication of differences in the actual money supply at the announcement and the announced money supply which was measured three days earlier. The recent unimportance placed on the signaling role money supply announcements play in the markets may be correctly placed. However, this conclusion can not be reached by the model presented in this study.

The relationship between economic indicators and the economy has increased in complexity and, thus, the economic models must also increase in complexity. The fact that previous studies were able to get statistically significant results with simple linear regression does not mean that simple linear regression should continue to work for present time periods to get statistically significant results. The relationship between interest rates and money supply announcements may have changed with the changing environment and that change just has to be captured in research. The ability of individuals to get information and the amount of innovations in the financial markets has increased and, thus, it makes sense that now models need to incorporate this increase in complexity. As usual, additional research is needed to make any concrete conclusion about the relationship between interest rates and money supply.

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APPENDIX A

Glossary of Terms

M1: currency in circulation (notes and coins) + demand deposits (checkable deposits) + traveler's checks.

M2: M1 + savings deposits, time deposits less than $100,000, and balances in retail money market mutual funds.

M3: M2 + large-denomination ($100,000 or more) time deposits, balances in institutional money funds, repurchase liabilities issued by depository institutions, and Eurodollars held by U.S. residents at foreign branches of U.S. banks and at all banks in the United Kingdom and Canada.[1]

Monetary Targeting: Money supply growth targets set by the Federal Reserve, with allowed disparity around the target.[2]

Production Possibilities Frontier: The production possibilities of a certain economy. Example: Operations anywhere on the production possibilities frontier are considered at full capacity. However, the economy has a choice between what outputs to produce with their available inputs. For the Productions Possibilities Frontier to expand there must be an increase in the number of inputs, this is assumed to be fixed in the short run and medium run; with possible expansion in the long run.

Recession: Usually refers to at least two consecutive quarters of negative GDP growth.

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[1] M1, M2, and M3 definitions from:
Federal Reserve Bank of New York, "The Money Supply": July 2008; available from http://www.newyorkfed.org/aboutthefed/fedpoint/fed49.html; Internet; accessed Dec. 2008 – Feb. 2009.

[2] Meulendyke, 36.

APPENDIX B

Forecasting Techniques

1. 13-week Moving Average Change Model

$$\hat{y}_{t+1} = y_t \left[\frac{1}{13} \sum_{t=1}^{13} \left(\frac{y_t}{y_{t-1}} + \frac{y_{t-1}}{y_{t-2}} + \ldots + \frac{y_{t-12}}{y_{t-13}} \right) \right]$$

2. One Period Naïve Percent Change Model

$$\hat{y}_{t+1} = \left(\frac{y_t - y_{t-1}}{y_{t-1}} \times y_t \right) + y_t$$

3. Exponential Smoothing Adjusted for Trend: Holt's Method

   1. The exponentially smoothed series:
   $A_t = \alpha\, y_t + (1-\alpha)(A_{t-1} + T_{t-1})$

   2. The trend estimate:
   $T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$

   3. Forecast p periods into the future:
   $\hat{y}_{t+p} = A_t + pT_t$

   A_t = new smoothed value
   α = smoothing constant for the data (for this study = 0.5)[1]
   y_t = new observation or actual value of series in period t
   β = smoothing constant for trend estimate (for this study = 0.5)

[1] Neutral constants of 0.5 as used in: Mann and Dowen, 1141.

T_t = trend estimate

p = periods to forecast into the future

$\hat{y}_{t+p}$ = forecast for p periods into the future

4. Brown's Method: Double Exponential Smoothing

A_t = exponentially smoothed value of y_t at time t

A'_t = double exponentially smoothed value of y_t at time t

$$A_t = \alpha\, y_t + (1-\alpha) A_{t-1}$$

$$A'_t = \alpha\, A_t + (1-\alpha) A'_{t-1}$$

The difference between the exponentially smoothed values:

$$a_t = 2A_t - A'_t$$

An additional adjustment factor, which is similar to a slope measurement that can change over the series:

$$b_t = \frac{\alpha}{1-\alpha}\left(A_t - A'_t\right)$$

To forecast into the future:

$$\hat{y}_{t+p} = a_t + b_t p$$

α = smoothing constant (for this study = 0.5)

y_t = actual series value at time period t